

Forbo Flooring AB  
August Barks gata 26  
421 32 Västra Frölunda  
SWEDEN

Eurofins Product Testing A/S  
Smedeskovvej 38  
8464 Galten  
Denmark

CustomerSupport@eurofins.com  
www.eurofins.com

## VOC EMISSION TEST REPORT

### M1

29 June 2023

## 1 Sample Information

Sample name	Tessera serie UNION (Accord, Harmony & Infused)
Batch no.	229785
Stated production date	26/04/2023
Product type	Textile flooring
Sample reception	15/05/2023

## 2 Brief Evaluation of the Results

Regulation or protocol	Conclusion	Version of regulation or protocol
M1	Pass	M1 Protocol of November 2017

Full details based on the testing and direct comparison with limit values are available in the following pages  
Regarding pass/fail decision rule please see appendix



Liva Kjær Hansen  
Analytical Service Manager



Rasmus Verdier  
Analytical Service Manager

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## 3 Applied Test Methods

### 3.1 General Test References

Regulation, protocol or standard	Version	Reporting limit VOC [ $\mu\text{g}/\text{m}^3$ ]	Calculation of TVOC	Combined uncertainty <sup>a</sup> [RSD(%)]
EN 16516	2017 + A1:2020	5	Toluene equivalents	22%
ISO 16000 -3 -6 -9 -11	2006-2022 depending on part	2	Toluene equivalents	22%
ASTM D5116-10	2010	-	-	-
M1	M1 Protocol of November 2017	5	Toluene equivalents	22%
EN 15251: appendix C*	2007	2	Toluene equivalents	22%

### 3.2 Specific Laboratory Sampling and Analyses

Procedure	External Method	Internal SOP	Quantification limit / sampling volume	Analytical principle	Uncertainty <sup>a</sup> [RSD(%)]
Sample preparation	ISO 16000-11:2006, EN 16516:2017+A1:2020, AgBB:2021, EMICODE:2022	71M549810	-	-	-
Emission chamber testing	ISO 16000-9:2006, EN 16516:2017+A1:2020	71M549811	-	Chamber and air control	-
Sampling of VOC	ISO 16000-6:2021, EN 16516:2017+A1:2020	71M549812	5 L	Tenax TA	-
Analysis of VOC	ISO 16000-6:2021, EN 16516:2017+A1:2020	71M542808B	1 $\mu\text{g}/\text{m}^3$	ATD-GC/MS	10%
Sampling of aldehydes	ISO 16000-3:2022, EN 16516:2017+A1:2020	71M549812	35 L	DNPH	-
Analysis of aldehydes	ISO 16000-3:2022, EN 16516:2017+A1:2020	71M548400	3-6 $\mu\text{g}/\text{m}^3$	HPLC-UV	10%
Sampling of Ammonia	NIOSH 6015:1994	71M549812	100 L	H <sub>2</sub> SO <sub>4</sub> coated Silicagel	-
Analysis of Ammonia	NIOSH 6015:1994	71M544430	10 $\mu\text{g}/\text{m}^3$	Spectrofotometry	10%
Odour/sensory testing	ISO 16000-28:2020	71M549821, 71M549822	-	Odour panel	10%

## 4 Test Parameters, Sample Preparation and Deviations

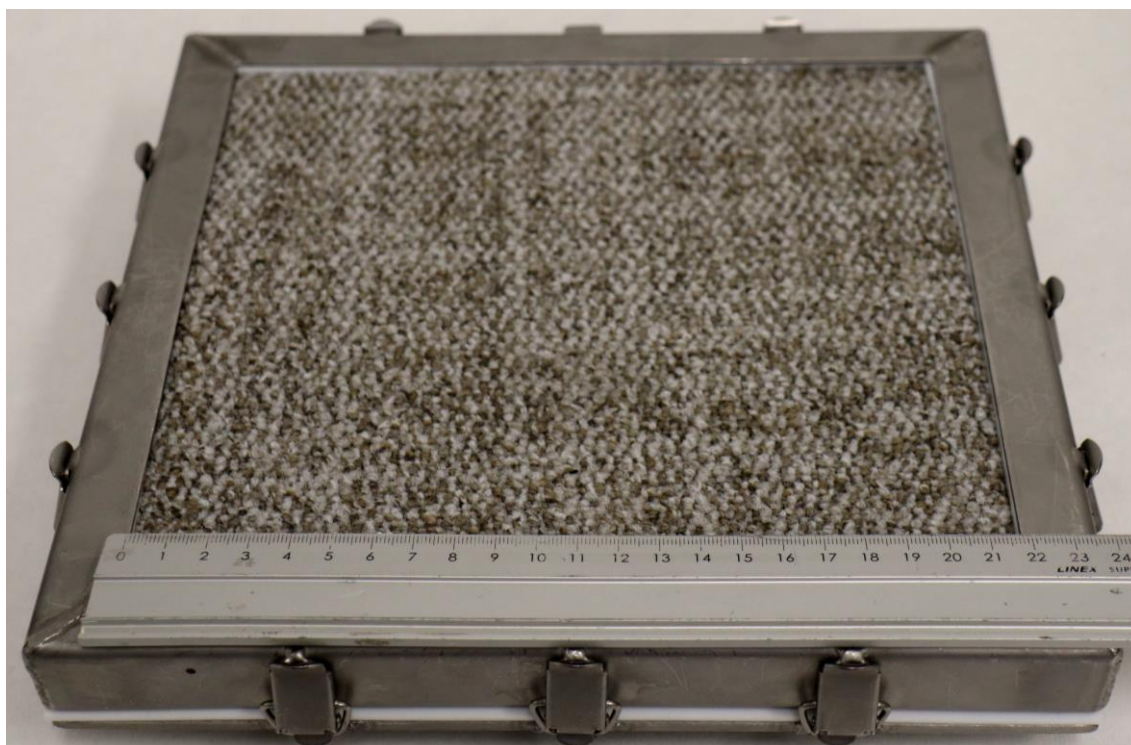
### 4.1 VOC Emission Chamber Test Parameters

Parameter	Value	Parameter	Value
Chamber volume, V[L]	119	Preconditioning period	-
Air change rate, n[h <sup>-1</sup> ]	0.5	Chamber test period	24/05/2023 - 21/06/2023
Area specific ventilation rate, q [m/h or m <sup>3</sup> /m <sup>2</sup> /h]	1.25	Analytical test period	24/05/2023 - 26/06/2023
Air Velocity [m/s]	0.1	Loading factor [m <sup>2</sup> /m <sup>3</sup> ]	0.4
Temperature of supply air, T [°C]	23 ± 1	Test scenario	Flooring or ceiling
Relative humidity of supply air, RH [%]	50 ± 3		

### 4.2 Preparation of the Test Specimen

Edges and back were covered with aluminium foil and the sample was mounted into a frame in accordance with JIS A 1901.

### 4.3 Picture of Sample



#### 4.4 Deviations from Referenced Protocols and Regulations

No deviations from the referenced test methods were observed.

#### 4.5 Air Samplings from the Test Chamber

Sampling media	Day (yyyy-mm-dd)	Time (hh:mm)	Volume [L]
26 Day-Rin, Nalophan sampling bag	2023-06-19	13:33 - 13:34	0.80
27 Day, Nalophan sampling bag	2023-06-20	10:30 - 10:30	0
28 Day, H <sub>2</sub> SO <sub>4</sub> silicagel	2023-06-21	08:23 - 12:47	110
28 Day-Res, H <sub>2</sub> SO <sub>4</sub> silicagel	2023-06-21	08:24 - 12:48	100
28 Day, DNPH silicagel	2023-06-21	12:49 - 14:39	36
28 Day-Res, DNPH silicagel	2023-06-21	12:49 - 14:40	39
28 Day, Tenax TA	2023-06-21	12:50 - 13:50	5.2
28 Day-Res, Tenax TA	2023-06-21	13:50 - 14:40	2.2

## 5 Results

### 5.1 VOC Emission Test Results after 28 Days

	CAS No.	Retention time [min]	ID- Cat	Specific Conc. [µg/m³]	Toluene eq. [µg/m³]	Toluene SER [µg/(m²·h)]	SER [µg/(m²·h)]	EU-LCI [µg/m³]
<b>VOC compounds</b>								
Caprolactam *	105-60-2	11.86	1	41	15	19		300
<b>TVOC</b>				41	15	19		
<b>VVOC compounds</b>								
None determined								
<b>TVVOC</b>				< 5	< 5	< 7		
<b>SVOC compounds</b>								
None determined								
<b>TSVOC</b>				< 5	< 5	< 7		
<b>CMR</b>								
None determined								
<b>Total CMR</b>				< 1	< 1		< 2	
<b>Aldehydes</b>								
Formaldehyde	50-00-0		1	< 3			< 4	100
Acetaldehyde	75-07-0		1	< 3			< 4	300
Propionaldehyde	123-38-6		1	< 3			< 4	650
Butyraldehyde	123-72-8		1	< 3			< 4	650
Acrolein *	107-02-8		1	< 5			< 7	14
2-Butenal *	123-73-9		1	< 5			< 7	5
Glutaraldehyde *	111-30-8		1	< 5			< 7	
Octanal *	124-13-0		1	< 5			< 7	900
Nonanal *	124-19-6		1	8.6			11	900
Decanal *	112-31-2		1	< 5			< 7	900
<b>Add. compounds</b>								
Ammonia	7664-41-7		1	26			33	

The results are only valid for the tested sample(s).

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## 5.2 Sensory Testing

	Acceptance		Acceptance
<b>Participant 1</b>	0.80	<b>Participant 11</b>	1.00
<b>Participant 2</b>	-0.40	<b>Participant 12</b>	0.90
<b>Participant 3</b>	0.75	<b>Participant 13</b>	0.90
<b>Participant 4</b>	1.00	<b>Participant 14</b>	-0.80
<b>Participant 5</b>	0.25	<b>Participant 15</b>	1.00
<b>Participant 6</b>	0.85	<b>Participant 16</b>	1.00
<b>Participant 7</b>	-0.35	<b>Participant 17</b>	0.55
<b>Participant 8</b>	-0.65	<b>Participant 18</b>	0.55
<b>Participant 9</b>	0.90	<b>Participant 19</b>	0.55
<b>Participant 10</b>	1.00	<b>Participant 20</b>	1.00
<b>Final Results</b>			
Average assessment	0.5		
90% confidence interval	0.3 - 0.8		
Standard deviation	0.6		

## 6 Summary and Evaluation of the Results

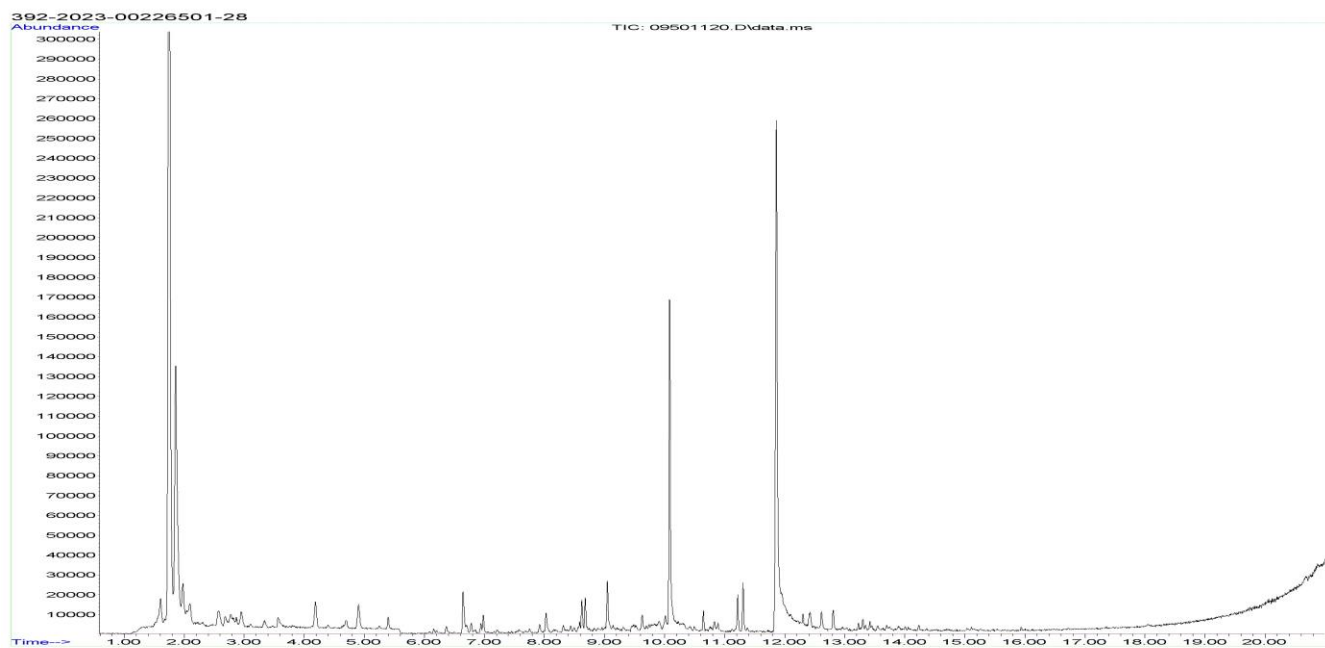
### 6.1 Comparison with M1 Limit Values

Parameter	Area specific emission rate mg/(m <sup>2</sup> h)	Limit Value mg/(m <sup>2</sup> h)
<b>TVOC</b>	0.019	≤ 0.2
<b>Formaldehyde</b>	< 0.004	≤ 0.05
<b>Ammonia</b>	0.033	≤ 0.03
<b>Total CMR [mg/m<sup>3</sup>]</b>	< 0.001	≤ 0.001
<b>Odour (dimensionless)</b>	0.5	≥ 0.0
<b>Single VOCs with EU-LCI</b>	Complies	≤ EU-LCI



## 7 Appendices

### 7.1 Chromatogram of VOC Emissions after 28 Days



## 7.2 Sampling Report

Combined Sampling Report and Chain of Custody	
<b>Name of applicant:</b> Mikael Taberman, Forbo Flooring AB, August Barks gata 26, 421 32 Västra Frölunda, Sweden, +318892000 (name, company, phone)	
Product information	
<b>Name of the product:</b> Tessera serie Union (Accord, Harmony & Infused)	<b>Product type:</b> Textile flooring
<b>Batch N°:</b> 229785	<b>Article N°:</b>
<b>Model / Program / Series:</b>	<b>Manufacture:</b> Forbo Flooring AB, August Barks gata 26, 421 32 Västra Frölunda, Sweden (Company, Address, Stamp)
Production & Sampling information	
<b>Production Date:</b> 2023-04-26 <b>Time:</b>	<b>Sampling Date:</b> den 5 maj 2023 <b>Time:</b>
<b>Place of sampling</b> (if deviating from the manufacture)	<b>Sample is taken from:</b> <input type="checkbox"/> ongoing production <input type="checkbox"/> stocks <input checked="" type="checkbox"/> retained sample
	<b>Number of samples:</b> 4 tiles
<b>Person in charge of sampling:</b> (Name, company, telephone)	<b>Signature of sample collector:</b> 
<b>Where has the product been stored prior to sampling?</b> <input checked="" type="checkbox"/> production <input type="checkbox"/> store <input type="checkbox"/> miscellaneous	<b>How has the product been stored prior to sampling?</b> <input type="checkbox"/> open <input type="checkbox"/> in the stack <input checked="" type="checkbox"/> wrapped up
<b>Place of storage:</b>	<b>Packing material:</b>
<b>Specifics</b> (possible negative influences by air contamination where sample was taken, by petrol emissions, by solvent emissions from production; any other uncertainties, questions, etc).	
Cut edges (identification of cut edges when present and identification of new surfaces and surface to be exposed in the emission test):	
Confirmation from the applicant	
Herewith the signer confirms the correctness of the data given above. The sample was selected, drawn and packed personally in accordance with the instructions for the taking of samples.	

The results are only valid for the tested sample(s).

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## 7.3 How to Understand the Results

### 7.3.1 Acronyms Used in the Report

<	Means less than
>	Means bigger than
*	Not a part of our accreditation
α	Please see section regarding uncertainty in the Appendices
§	Deviation from method. Please see deviation section
a	The method is not optimal for very volatile compounds. For these substances smaller results and a higher measurement uncertainty cannot be ruled out
b	The component originates from the substrate and is thus removed
c	The results have been corrected by the emission from the substrate
d	Very polar organic compounds are not suitable for reliable quantification using Tenax TA adsorbent and HP-5ms GC column. A high degree of uncertainty must be expected
e	The component may be overestimated due to contribution from the system
SER	Specific Emission Rate

### 7.3.2 Explanation of ID Category

#### Categories of Identity:

- 1: Identified by comparison with a mass spectrum obtained from library and supported by other information and quantified through specific calibration.
- 2: Identified by comparison with a mass spectrum obtained from library and supported by other information. Quantified as toluene equivalent.
- 3: Identified with a lower match by comparison with a mass spectrum obtained from a library. Quantified as toluene equivalent.
- 4: Not identified, quantified as toluene equivalent.

## 7.4 Applied LCI and NIK Values

### 7.4.1 LCI/NIK Values for Compounds found after 28 Day Measurements

Compound	CAS No.	EU-LCI [µg/m³]
Caprolactam *	105-60-2	300
Nonanal *	124-19-6	900

## 7.5 Description of VOC Emission Test

### 7.5.1 Test Chamber

The test chamber is made of stainless steel. A multi-step air clean-up is performed before loading the chamber, and a blank check of the empty chamber is performed.

The chamber operation parameters are as described in the test method section. (EN 16516, ISO 16000-9, internal method no.: 71M549811).

The recovery rates in the climate test chamber have been investigated using toluene and n-dodecane. The mean recovery rates of toluene and n-dodecane were concluded to be between 95 % and 100 % depending on the chamber size. These values comply with the criteria of a minimum mean recovery rate of 80 % stated in the 16000-9 test method.

Air sampling from the test chamber is carried out in a clean test chamber room at ambient air pressure and  $23 \pm 1$  °C.

### 7.5.2 Expression of the Test Results

All test results are calculated as specific emission rate, and as extrapolated air concentration in the European Reference Room (EN 16516, AgBB, EMICODE, M1 and Indoor Air Comfort).

### 7.5.3 Testing of Carcinogenic VOCs

The emission of carcinogens (EU Categories C1A and C1B, as per European law) is tested by drawing sample air from the test chamber outlet through Tenax TA tubes after the specified duration of storage in the ventilated test chamber. Analysis is performed by ATD-GC/MS (automated thermal desorption coupled with gas chromatography and mass spectroscopy using 30 m HP-5 (slightly polar) column with 0.25 mm ID and 0.25 µm film, Agilent) (EN 16516, ISO 16000-6, internal methods no.: 71M549812 / 71M542808B).

All identified carcinogenic VOCs are listed; if a carcinogenic VOC is not listed then it has not been detected. Quantification is performed using the TIC signal and authentic response factors, or the relative response factors relative to toluene for the individual compounds.

This test only covers substances that can be adsorbed on Tenax TA and can be thermally desorbed. If other emissions occur, then these substances cannot be detected (or with limited reliability only).

### 7.5.4 Testing of VOC, SVOC and VVOC

The emissions of volatile organic compounds are tested by drawing sample air from the test chamber outlet through Tenax TA tubes after the specified duration of storage in the ventilated test chamber. Analysis is performed by ATD-GC/MS using HP-5 column (30 m, 0.25mm ID, 0.25µm film) (EN 16516, ISO 16000-6, internal methods no.: 71M549812 / 71M542808B).

All single substances that are listed with a LC1/N1K value in the latest publications (hereafter referred to as target compounds) are identified if present. All other appearing VOCs are identified as far as possible. Quantification of target compounds is done using the TIC signal and authentic response factors, or the relative response factors relative to toluene. For certain compound groups, which differ significantly in chemistry from toluene, quantification is performed relative to a representative member of the group for more accurate and precise results. This can include quantification of for example glycols and acids. In addition to that, all results are also expressed in toluene equivalents. All non-target compounds, as well as all non-identified substances, are quantified in toluene equivalents.

The results of the individual substances are calculated in three groups depending on their retention time when analyzing using a non-polar column (HP-1):

- Volatile Organic Compounds (VOC) are defined as: All substances eluting between and including n-hexane (n-C6) and n-hexadecane (n-C16)

The results are only valid for the tested sample(s).

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- Semi-Volatile Organic Compounds (SVOC) are defined as: All substances eluting after n-hexadecane (n-C16) and before and including n-docosane (n-C22)
- Very Volatile Organic Compounds (VVOC) are defined as: All substances eluting before n-hexane (n-C6).

Total Volatile Organic Compounds (TVOC) is calculated by summation of all individual VOCs with a concentration  $\geq 5 \mu\text{g}/\text{m}^3$ . The TVOC can be expressed either in toluene equivalents as defined in EN 16516 and similar to ISO 16000-6, or as the sum of concentrations using specific or relative response factors. In the case of summation of concentrations using authentic or relative response factors, the toluene equivalent is applied to all non-target and non-identified VOCs before summing up. Compounds regarded as VOC in line with the above definition but elute before n-C6 or after n-C16 on the HP-5 column are treated as VOC, and are thus added to the TVOC.

Total Semi-Volatile Organic Compounds (TSVOC) is calculated by the summation of all individual SVOCs expressed in toluene equivalents with a concentration  $\geq 5 \mu\text{g}/\text{m}^3$ , as defined in EN 16516. VOCs that are regarded as VOC in line with the above definition, but elute after n-C16 in this test, are not added to the TSVOC.

Total Very Volatile Organic Compounds (TVVOC) is calculated by the summation of all individual VVOCs with a concentration  $\geq 5 \mu\text{g}/\text{m}^3$  and expressed in toluene equivalents. VOCs that are regarded as VOC in line with the above definition, but elute before n-C6 in this test, are not added to the TVVOC.

This test only covers substances which can be adsorbed on Tenax TA and can be thermally desorbed. If emissions of substances outside these specifications occur then these substances cannot be detected (or with limited reliability only).

### 7.5.5 Testing of Aldehydes

The presence of aldehydes is tested by drawing air samples from the test chamber outlet through DNPH-coated silicagel tubes after the specified duration of storage in the ventilated test chamber. Analysis is performed by solvent desorption and subsequently by HPLC and UV-/diode array detection.

The absence of formaldehyde and other aldehydes is stated if UV detector response at the specific wavelength is lacking at the specific retention time in the chromatogram. Otherwise it is checked whether the reporting limit is exceeded. In this case the identity is finally checked by comparing full scan sample UV spectra with full scan standard UV spectra.

Conversions of specific aldehydes from  $\mu\text{g}/\text{m}^3$  to ppm are done by the ideal gas law using a temperature of 23 degree Celsius and standard atmospheric pressure.

### 7.5.6 Testing of Ammonia

The presence of ammonia was tested by drawing air samples from the chamber outlet through silicagel tubes coated with sulphuric acid after 28 days. Analysis was done by solvent desorption and UV/VIS spectroscopy (internal methods: 71M549812 / 71M544430).

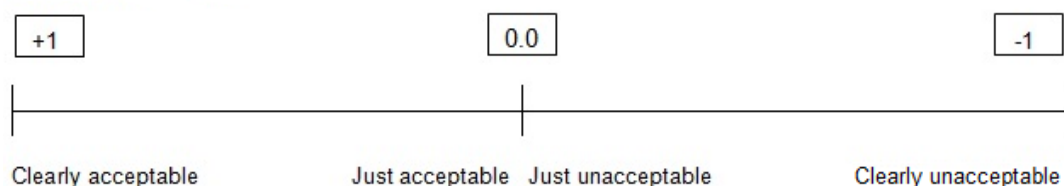
The absence of ammonia was stated if the signal was lacking at the specific wavelength. Otherwise it was checked whether the detection limit was exceeded.

### 7.5.7 Sensory Testing

The sensory testing was done after 28 days storage under controlled conditions in the testing chamber. The test panel assessed the odour first of the room air and then give the odour rating once for each chamber. The judgement was based on the odour impression after 2-3 inhalations. The odour was rated immediately on a continuous scale with values between +1 (clearly acceptable) and -1 (clearly unacceptable), with just

acceptable = +0.1 and just unacceptable = -0.1. The scale was read with an accuracy of  $\pm 0.1$ . The result was calculated as the average of the assessments from the odour rating of the panel. Only panel members rating clean moistened air as acceptable ( $> 0.8$ ) were considered in the calculation.

Sensory Acceptance:



## 7.6 Quality Assurance

Before loading the test chamber, a blank check of the empty chamber is performed and compliance with background concentrations in accordance with EN 16516 / ISO 16000-9 is determined.

Air sampling at the chamber outlet and subsequent analysis is performed in duplicate. Relative humidity, temperature and air change rate in the chambers is logged every 5 minutes and checked daily. A double determination is performed on random samples at a regular interval and results are registered in a control chart to ensure the uncertainty and reproducibility of the method.

The stability of the analytical system is checked by a general function test of device and column, and by use of control charts for monitoring the response of individual substances prior to each analytical sequence.

## 7.7 Accreditation

The testing methods described above are accredited on line with EN ISO/IEC 17025 by DANAK (no. 522). This accreditation is valid worldwide due to mutual approvals of the national accreditation bodies (ILAC/IAF, see also [www.eurofins.com/galten.aspx#accreditation](http://www.eurofins.com/galten.aspx#accreditation)).

Not all parameters are covered by this accreditation. The accreditation does not cover parameters marked with an asterisk (\*), however analysis of these parameters is conducted at the same level of quality as for the accredited parameters.

## 7.8 Uncertainty of the Test Method

The relative standard deviation of the overall analysis is 22%. The expanded uncertainty  $U_m$  equals 2 x RSD. For further information please visit [www.eurofins.dk/product-testing/uncertainty/](http://www.eurofins.dk/product-testing/uncertainty/).

## 7.9 Decision Rules

Eurofins Product Testing A/S, declare statement of conformity based on the "Binary Statement for Simple Acceptance Rule" described in ILAC's "Guidelines on decision Rules and Statements of Conformity" ILAC-G8:09/2019.

This means that results above the detection limit are always reported with two significant digits. Results are evaluated with the same number of significant digits as the corresponding limit values, and conformity is based on results being less than or equal to limit values.

For limit values with more than two significant digits, the third digit will be used to confirm whether a result is below or equal to the limit value. It will always be indicated in the evaluation table if this expanded evaluation

is performed.

For further information, please visit [www.eurofins.dk/product-testing/om-os/beslutningsregler/](http://www.eurofins.dk/product-testing/om-os/beslutningsregler/)

### 7.10 Version History

Report date	Report number	Modification
29/06/2023	392-2023-00226501_I_EN	Current version