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## VOC TEST REPORT

### BREEAM<sup>®</sup> NOR

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#### 1 Sample Information

Sample name	GRAFT Interior Paint FR-1
Batch no.	P360/034/01
Production date	13/05/2016
Product type	Paint
Sample reception	23/05/2016

#### 2 Brief Evaluation of the Results

Regulation or protocol	Conclusion	Version of regulation or protocol
BREEAM Norway	Pass	BREEAM-NOR New Construction 2016

Full details based on the testing and direct comparison with limit values is available in the following pages



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### 3 Applied Test Methods

#### 3.1 General Test References - Emission

Regulation, protocol or standard	Version	Reporting limit VOC [ $\mu\text{g}/\text{m}^3$ ]	Calculation of TVOC	Combined uncertainty <sup>a</sup> [RSD(%)]
CEN/TS 16516	October 2013	5	Toluene equivalents	22.5%
ISO 16000 -3 -6 -9 -11	2006-2011 depending on part	2	Toluene equivalents	22.5%
ASTM D5116	2010	-	-	-
BREEAM <sup>®</sup> NOR	BREEAM-NOR New Construction 2016	2	Toluene equivalents	22.5%

#### 3.2 General Test References – VOC content

Regulation, protocol or standard	Version	Reporting limit VOC [g/l]	Combined uncertainty <sup>a</sup> [RSD(%)]
ISO 11890-2	2013	1	20%
ASTM G6886	2012	1	20 %

#### 3.3 Specific Laboratory Sampling and Analyses

Procedure	External Method	Internal S.O.P.	Quantification limit / sampling volume	Analytical principle	Uncertainty <sup>a</sup> [RSD(%)]
Sample preparation	ISO 16000-11:2006, EN16402:2013, CDPH, AgBB/DIBt, EMICODE	71M549810	-	-	-
VOC emission chamber testing	ISO 16000-9:2006, CEN/TS 16516:2013	71M549811	-	Chamber and air control	-
Sampling of VOC	ISO 16000-6:2011, CEN/TS 16516:2013	71M549812	5 L	Tenax TA	-
Analysis of VOC	ISO 16000-6:2011, CEN/TS 16516:2013	71M542808B	1 $\mu\text{g}/\text{m}^3$	ATD-GC/MS	10%
Sampling of aldehydes	ISO 16000-3:2011, CEN/TS 16516:2013	71M549812	35 L	DNPH	-
Analysis of aldehydes	ISO 16000-3:2011, EN 717-1, CEN/TS 16516:2013	71M548400	3-6 $\mu\text{g}/\text{m}^3$	HPLC-UV	10%
Analysis of VOC content	ISO 11890-2: 2013, ASTM D6886-12	71M546002	50 mg/kg	GC/MS and GC/FID	10%

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

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## 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, $\eta$ [h <sup>-1</sup> ]	0.5	Test period	-
Relative humidity of supply air, RH [%]	50 ± 3	Area specific ventilation rate, q [m/h or m <sup>3</sup> /m <sup>2</sup> /h]	1.25
Temperature humidity of supply air, T [°C]	23 ± 1	Loading factor [m <sup>2</sup> /m <sup>3</sup> ]	1.0

### 4.2 Preparation of the Test Specimen – Chamber Test

The sample was homogenised and applied onto a glass plate.

Number of Layers	Application amount per layer, g/m <sup>2</sup>	Drying time, h
1	140	-

### 4.3 Picture of Sample – Chamber Test



### 4.4 Deviations from Referenced Protocols and Regulations

No deviations from the referenced test methods were observed.

## 5 Results

### 5.1 VOC Emission Test Results after 28 Days

	CAS No.	Retention time [min]	ID-Cat	Concentration [µg/m <sup>3</sup> ]	SER [µg/(m <sup>2</sup> *h)]
<b>VOC compounds</b> None determined					
<b>TVOC</b>				< 5	< 3
<b>VVOC compounds</b> None determined					
<b>TVVOC</b>				< 5	< 3
<b>SVOC compounds</b> None determined					
<b>TSVOC</b>				< 5	< 3
<b>Carcinogens</b>					
<b>Total carcinogens</b>				< 1	< 1
<b>Add. compounds</b>					
Formaldehyde	50-00-0		1	< 3	< 2

### 5.2 VOC Content Test Results

	CAS No.	Retention time [min]	ID-Cat	Content [g/l]
<b>VOC compounds</b> None determined	-	-	-	< 1

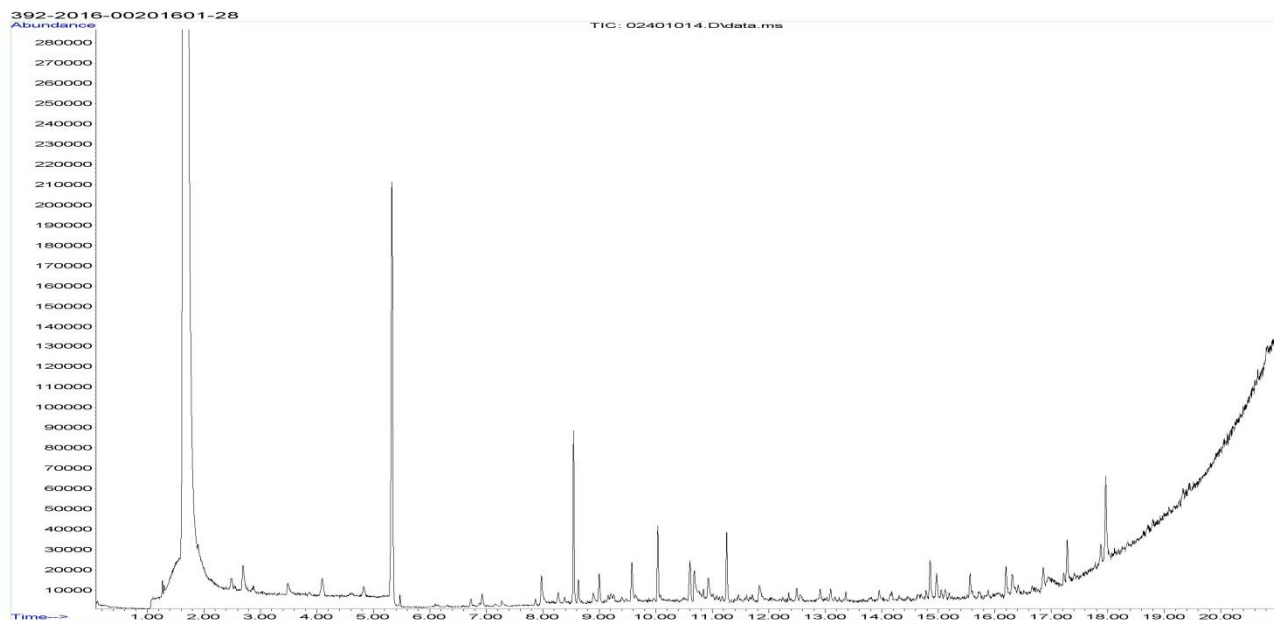
## 6 Summary and Evaluation of the Results

### 6.1 Comparison with BREEAM<sup>®</sup> NOR Limit Values

Parameter	Concentration $\mu\text{g}/(\text{m}^2\text{h})$	Limit Value $\mu\text{g}/(\text{m}^2\text{h})$
<b>TVOC</b>	< 3	$\leq 200$
<b>Formaldehyde</b>	< 2	$\leq 50$
<b>Total carcinogens</b>	< 1	$\leq 5$
<b>VOC content (g/l)</b>	< 1	< 50

## 7 Appendices

### 7.1 Chromatogram of VOC Emissions after 28 Days



## 7.2 How to Understand the Results

### 7.2.1 Acronyms Used in the Report

- < Means less than
- > Means bigger than (Tube/GC-MS overload)
- \* Not a part of our accreditation
- ⌘ Um(%) is given as 2x RSD%. 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 wooden panels and is thus removed.
- c The results have been corrected by the emission from wooden panels.
- d Very polar organic compounds are not suitable for reliable quantification using tenax TA adsorbent and HP-5 GC column. A high degree of uncertainty must be expected.

SER Specific emission rate.

### 7.2.2 Explanation of ID Category

#### Categories of Identity:

- 1: Identified and specifically calibrated
- 2: Identified by comparison with a mass spectrum obtained from library and supported by other information. Calibrated as toluene equivalent.
- 3: Identified by comparison with a mass spectrum obtained from a library. Calibrated as toluene equivalent.
- 4: Not identified, calibrated as toluene equivalent.



## 7.3 Qualitative Description of VOC Emission Test

### 7.3.1 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 (CEN/TS 16516, ISO 16000-9, internal method no.: 71M549811).

### 7.3.2 Expression of the Test Results

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

### 7.3.3 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) (CEN/TS 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).

### 7.3.4 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) (CEN/TS 16516, ISO 16000-6, internal methods no.: 71M549812 / 71M542808B).

All single substances that are listed with a LCI/NIK 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)
- 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 CEN/TS 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 CEN/TS 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).

### 7.3.5 Testing of Aldehydes

The presence of aldehydes after the specified duration of storage in the ventilated test chamber 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 (CEN/TS 16516, ISO 16000-3, VDI 3862 Blatt 3, internal methods no.: 71M549812 / 71M548400).

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.

### 7.3.6 VOC content

The determination is performed in conformity with ISO 11890-2 and the Commission Decision 2014/312/EU of 28 May 2014 establishing the ecological criteria for the award of the EU Ecolabel for indoor and outdoor paints and varnishes, with its most recent amendments and its most recent User Manual.

Analyses are performed with a slightly polar gas chromatographic column (HP-5). Mass spectrometric detector is used for identification and flame ionization detector is used for quantification. Identified VOCs are quantified with their authentic response factors, or with their relative response factors using 1,2-diethoxyethane as internal standard. Remaining unknown VOC peaks are quantified in diethyl adipate equivalents.

## 7.4 Quality Assurance

Before loading the test chamber, a blank check of the empty chamber is performed and compliance with background concentrations in accordance with CEN/TS 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.

## 7.5 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.

## 7.6 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/uncertainty](http://www.eurofins.dk/uncertainty).