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# VOC EMISSION TEST REPORT

# M1

21 June 2018

## 1 Sample Information

| | |
|---|---|
| Sample name | Trælim D2 Inde 490 |
| Batch no. | 81401107 |
| Production date | 05/04/2018 |
| Product type | Adhesive |
| Sample reception | 01/05/2018 |

## 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

Paul Santner
Consultant

Thomas Bjerring
Consultant

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# 3 Applied Test Methods

## 3.1 General Test References

| Regulation, protocol or standard | Version | Reporting limit VOC [µg/m³] | Calculation of TVOC | Combined uncertainty¤ [RSD(%)] |
|---|---|---|---|---|
| EN 16516 | October 2017 | 5 | Toluene equivalents | 22% |
| ISO 16000 -3 -6 -9 -11 | 2006-2011 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¤ [RSD(%)] |
|---|---|---|---|---|---|
| Sample preparation | ISO 16000-11:2006, EN16402:2013, CDPH, AgBB/DIBt, EMICODE | 71M549810 | - | - | - |
| Emission chamber testing | ISO 16000-9:2006, EN 16516:2017 | 71M549811 | - | Chamber and air control | - |
| Sampling of VOC | ISO 16000-6:2011, EN 16516:2017 | 71M549812 | 5 L | Tenax TA | - |
| Analysis of VOC | ISO 16000-6:2011, EN 16516:2017 | 71M542808B | 1 µg/m³ | ATD-GC/MS | 10% |
| Sampling of aldehydes | ISO 16000-3:2011, EN 16516:2017 | 71M549812 | 35 L | DNPH | - |
| Analysis of aldehydes | ISO 16000-3:2011, EN 717-1, EN 16516:2017 | 71M548400 | 3-6 µg/m³ | HPLC-UV | 10% |
| Sampling of Ammonia | NIOSH 6015:1994 | 71M549812 | 100 L | $H_2SO_4$ coated Silicagel | - |
| Analysis of Ammonia | NIOSH 6015:1994 | 71M544430 | 10 µg/m³ | Spectrofotometry | 10% |
| Odour/sensory testing* | ISO 16000-28:2012 | 71M549822 | - | Odour panel | 10% |

# 4 Test Parameters, Sample Preparation and Deviations

## 4.1 VOC Emission Chamber Test Parameters

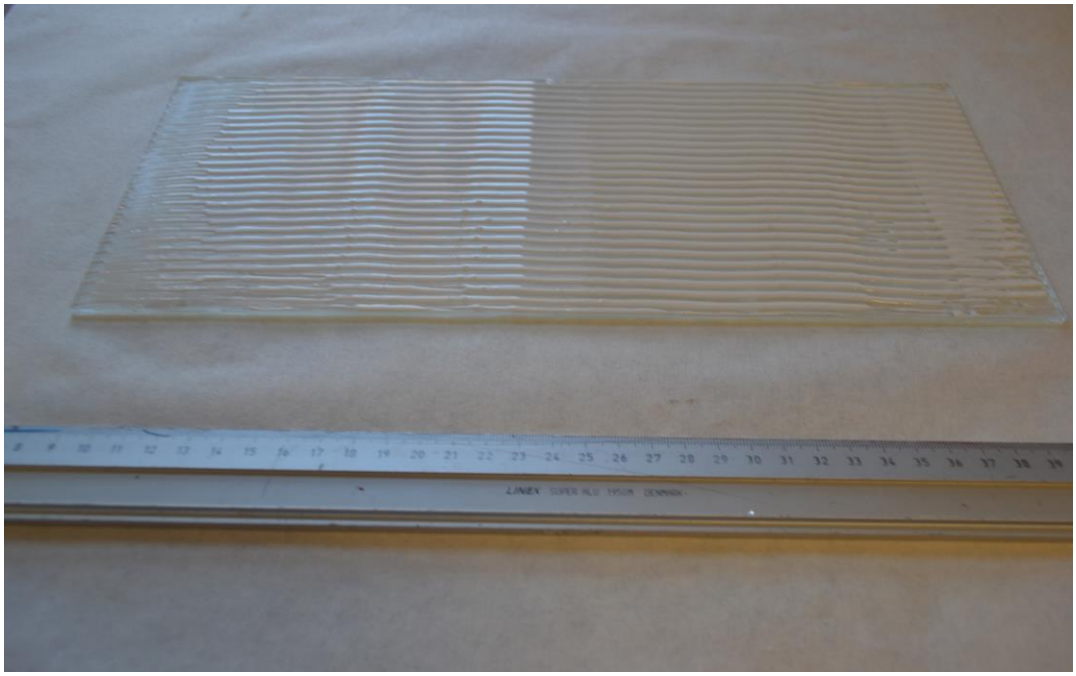
| Parameter | Value | Parameter | Value |
|---|---|---|---|
| Chamber volume, V[L] | 119 | Preconditioning period | - |
| Air Change rate, n[$h^{-1}$] | 0.5 | Test period | 15/05/2018 - 12/06/2018 |
| Relative humidity of supply air, RH [%] | 50 ± 3 | Area specific ventilation rate, q [m/h or $m^3/m^2/h$] | 1.25 |
| Temperature of supply air, T [°C] | 23 ± 1 | Loading factor [$m^2/m^3$] | 0.4 |
| | | Test scenario | Flooring or ceiling |

## 4.2 Preparation of the Test Specimen

The sample was homogenised, applied onto a glass plate and structured with a notched trowel.

| Application amount, $g/m^2$ | Trowel |
|---|---|
| 200 | TKB B1 |

## 4.3 Picture of Sample



## 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 | Specific Conc. [µg/m³] | Toluene eq. [µg/m³] | Toluene SER [µg/(m²·h)] | EU-LCI [µg/m³] |
|---|---|---|---|---|---|---|---|
| **VOC compounds** | | | | | | | |
| None determined | | | | | | | |
| **TVOC** | | | | < 5 | < 5 | < 7 | |
| **VVOC compounds** | | | | | | | |
| None determined | | | | | | | |
| **TVVOC** | | | | < 5 | < 5 | < 7 | |
| **SVOC compounds** | | | | | | | |
| None determined | | | | | | | |
| **TSVOC** | | | | < 5 | < 5 | < 7 | |
| **CMR substances** | | | | | | | |
| None determined | | | | | | | |
| **Total CMR** | | | | < 1 | < 1 | < 2 | |
| **Aldehydes** | | | | | | | |
| Formaldehyde | 50-00-0 | | 1 | < 3 | | < 4 | 100 |
| Acetaldehyde | 75-07-0 | | 1 | < 3 | | < 4 | 1200 |
| Propionaldehyde | 123-38-6 | | 1 | < 3 | | < 4 | |
| Butyraldehyde | 123-72-8 | | 1 | < 3 | | < 4 | 650 |
| 2-butenal | 123-73-9 | | 1 | < 5 | | < 7 | 5 |
| Glutaraldehyde | 111-30-8 | | 1 | < 5 | | < 7 | |
| **Add. compounds** | | | | | | | |
| Ammonia | 7664-41-7 | | 1 | < 10 | | < 20 | |

## 5.2 Sensory Testing

| | Acceptance | | Acceptance |
|---|---|---|---|
| Participant 1 | 0.15 | Participant 9 | 1.0 |
| Participant 2 | 0.90 | Participant 10 | 0.95 |
| Participant 3 | 0.50 | Participant 11 | -1.0 |
| Participant 4 | 0.70 | Participant 12 | 1.0 |
| Participant 5 | 0.75 | Participant 13 | 0.9 |
| Participant 6 | 0.85 | Participant 14 | 1.0 |
| Participant 7 | 0.85 | Participant 15 | 0.95 |
| Participant 8 | 0.90 | Participant 16 | 1.0 |
| **Final Results** | | | |
| Average assessment | 0.7 | | |
| 90% confidence interval | 0.5 - 0.9 | | |
| Standard deviation | 0.5 | | |

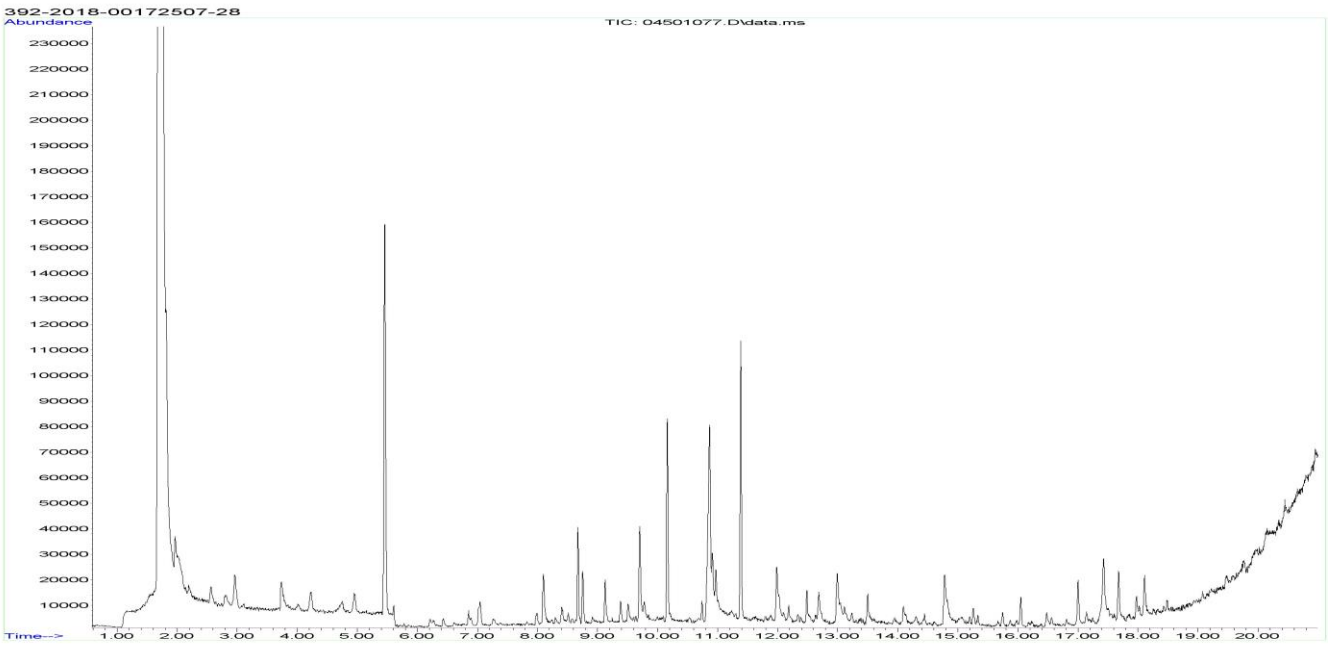
# 6 Summary and Evaluation of the Results

## 6.1 Comparison with M1 Limit Values

| Parameter | Area specific emission rate<br>mg/(m²h) | Limit Value<br>mg/(m²h) |
|---|---|---|
| **TVOC** | < 0.007 | < 0.2 |
| **Formaldehyde** | < 0.004 | < 0.05 |
| **Ammonia** | < 0.02 | < 0.03 |
| **Total CMR** | < 0.002 | < 0.005 |
| **Odour (dimensionless)** | 0.7 | ≥ 0.0 |
| **Single VOCs with EU-LCI** | Complies | ≤ EU-LCI |

# 7 Appendices

## 7.1 Chromatogram of VOC Emissions after 28 Days



## 7.2 Sampling Report

### EN 16516 Sampling Report

| | | | |
|---|---|---|---|
| **Name of applicant:** (name, company, phone): | Robert Pedersen<br>Dana Lim A/S<br>Københavnsvej 220<br>DK-4600 Køge<br><br>+45 56 64 00 72 | **Producer** (If different from company's name at place of sampling): | |
| **Production plant, where sampling takes place** | Køge | **Sampler *** (Please mark): | Robert Pedersen |
| | | (name, company, phone): | |
| **Name of the product:** | Trælim D2 Inde 490 | **Type of product** | Wood glue |
| **Model / Program / Series:** | | **Batch N°:** | 81401107 |
| **Article N°:** | 2044 | **Date of batch production:** | 05.04.2018 |
| **Sample was taken from** | ☐ ongoing production<br>☒ stocks<br>☐ retained sample | **Date of sampling:**<br><br>**Time of sampling:** | 20.04.2018 |
| **Where had the product been stored prior to sampling?**<br><br>**Place of storage:** | ☐ production<br>☒ store<br>☐ miscellaneous<br><br>Warehouse | **How had the product been stored prior to sampling?**<br><br>**Packing material:** | ☐ open<br>☒ in the stack<br>☐ wrapped up<br><br>PE-HD |
| **Specifics** (possible negative influences by air contamination where sample was taken, by petrol emissions, by solvent emissions from production; any other uncertainties, questions, etc). | | No | |
| Cut edges (identification of cut edges when present and identification of new surfaces and surface to be exposed in the emission test): | | | |
| **Confirmation**<br>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. | | | |
| **Date:** 25.04.2018 | **Signature:** Robert Pedersen<br>(Stamp) | DANA LIM A/S<br>Københavnsvej 220<br>4600 Køge<br>Tlf.: 56 64 00 70<br>Fax: 56 64 00 90 | |

## 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

¤ 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.

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 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.

## 7.4 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] |
|---|---|---|
| None determined | - | - |

## 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).

### 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 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 ≥ 5 µg/m³. 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 ≥ 5 µg/m³, 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 ≥ 5 µg/m³ 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.

### 7.5.6 Testing of Ammonia

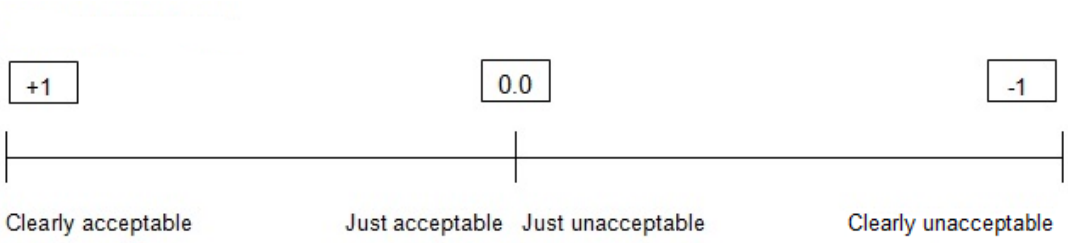
The presence of ammonia was tested by drawing air samples from the chamber outlet through silicagel tubes coated with sulphuric acid after 28 days. Analysis was done by solvent desorption and UV/VIS spectroscopy (internal methods: 71M549812 / 71M544430).

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 ± 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.

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 Um equals 2 x RSD. For further information please visit www.eurofins.dk/uncertainty.