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# VOC EMISSION TEST REPORT

# Certipur US

26 January 2024

## 1 Sample Information

| | |
|---|---|
| Sample name | FY-002 |
| Batch no. | FY-002 |
| Stated production date | 07/12/2023 |
| Sampling date | 09/12/2023 |
| Foam type | Slabstock flexible PU foam |
| Foam group | Conventional polyether foam |
| Sample reception | 22/12/2023 |

## 2 Brief Evaluation of the Results

| Regulation or protocol | Conclusion | Version of regulation or protocol |
|---|---|---|
| CertiPUR US § | Pass | CertiPUR-US Label for Slabstock Flexible Polyurethane Foam for Use in Furniture and Bedding, Alliance for Flexible Polyurethane Foam, Inc, version May 1, 2023. |

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
§ See section 4.4 on deviations

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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 | 2017 + A1:2020 | 5 | Toluene equivalents | 22% |
| ISO 16000 -3 -6 -9 -11 | 2006-2021 depending on part | 2 | Toluene equivalents | 22% |
| ASTM D5116-10 | 2010 | - | - | - |
| CertiPUR US | May 1, 2023 | 2 | Toluene equivalents | 22% |

## 3.2 Specific Laboratory Sampling and Analyses

| Procedure | External Method | Internal S.O.P. | Quantification limit/ Sampling volume | Analytical principle | Uncertainty¤ [RSD(%)] |
|---|---|---|---|---|---|
| Sample preparation | ISO 16000-11:2006, EN 16516:2017+A1:2020, AgBB:2021 | 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 µg/m³ | ATD-GC/MS | 10% |
| Sampling of aldehydes | ISO 16000-3:2011, EN 16516:2017+A1:2020 | 71M549812 | 35 L | DNPH | - |
| Analysis of aldehydes | ISO 16000-3:2011, EN 16516:2017+A1:2020 | 71M548400 | 3-6 µg/m³ | HPLC-UV | 10% |
| Analysis of tributyltin ¥ | - | GLS OC 600 | 12 ppb | GC/MS | 10 - 15% |
| Analysis of 8 phthalates (*) | CPSC-CH-C1001-09.3 | 71M542650 | 5-30 ppm | GC/MS | 15% |
| Analysis of TDA and MDA* | - | 71M549029 | 0.5 ppm | LC-MS | 10 – 15% |
| Analysis of heavy metals Δ | CPSC-CH-E1002-08_3 | - | 0.1 – 2 ppm | ICP/MS | 20% |
| Analysis of flame-retardants ¥ | - | GLS OC 200 | 0.05 – 1.8 µg/g | GC/MS | 10 – 15% |

¥ Performed externally, ISO 17025 accredited laboratory and accredited test (DAkkS D-PL-14629-01-00)
Δ Performed externally by ISO 17025 accredited laboratory. Test is accredited for some parameters (DANAK no. 168)

# 4 Test Parameters, Sample Preparation and Deviations

## 4.1 VOC Emission Chamber Test Parameters

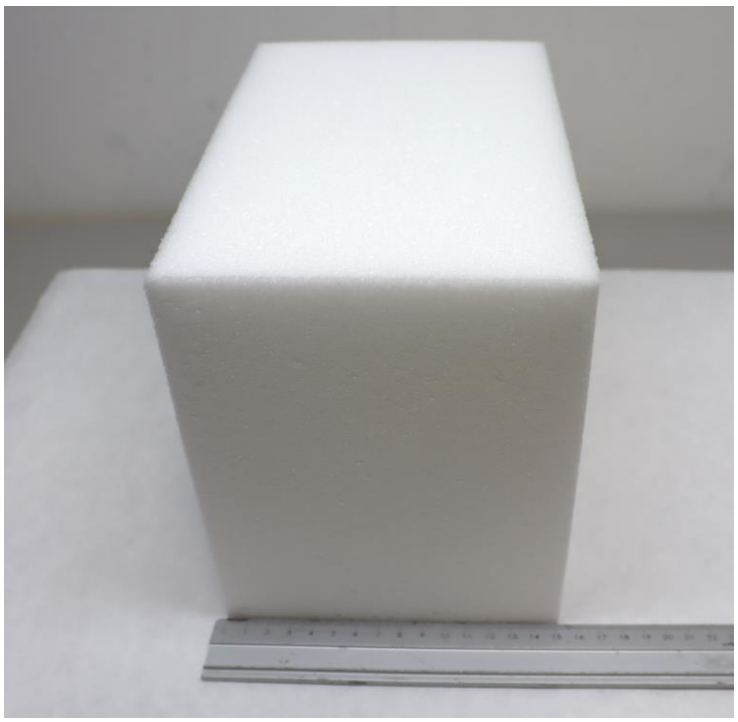
| Parameters | Value | Sample Conditions | Value |
|---|---|---|---|
| Chamber volume, V[L] | 225 | Date and time of unpacking and start of sample preparation | 10/01/2024 - 09:46 |
| Air change rate, n[$h^{-1}$] | 0.5 | Preconditioning period | - |
| Air Velocity [m/s] | 0.1 | Chamber test period | 10/01/2024 - 13/01/2024 |
| Area specific ventilation rate, q [m/h or $m^3/m^2/h$] | 0.57 | Analytical test period | 10/01/2024 - 24/01/2024 |
| Relative humidity of supply air, RH [%] | 50 ± 3 | Exposed sample area [$m^2$] | 0.19 |
| Temperature of supply air, T [°C] | 23 ± 1 | Loading factor [$m^2/m^3$] | 0.87 ** |
| Background concentration of TVOC [µg/$m^3$] | < 20 | | |

** The results have been recalculated to a loading factor of 0.4 $m^2/m^3$.

## 4.2 Preparation of the Test Specimen

One piece of a sample with dimensions of 25*20*15 cm were placed in the test chamber with the side facing down measuring 15*25 cm.

## 4.3 Picture of Sample



## 4.4 Deviations from Referenced Protocols and Regulations

Only piece of one foam was tested in the chamber and not two as defined in the standard.

## 4.5 Air Samplings from the Test Chamber

| Sampling media | Day (yyyy-mm-dd) | Time (hh:mm) | Volume [L] |
|---|---|---|---|
| **3 Day, DNPH silicagel** | 2024-01-13 | 09:11 - 11:00 | 36 |
| **3 Day-Res, DNPH silicagel** | 2024-01-13 | 09:11 - 11:00 | 37 |
| **3 Day, Tenax TA** | 2024-01-13 | 09:12 - 10:10 | 5.1 |
| **3 Day-Res, Tenax TA** | 2024-01-13 | 10:11 - 11:01 | 2.2 |

# 5 Results

## 5.1 VOC Emission Test Results after 3 Days

| | CAS No. | Retention time [min] | ID-Cat | Specific Conc. [µg/m³] | Toluene eq. [µg/m³] | Specific SER [µg/(m²·h)] |
|---|---|---|---|---|---|---|
| **VOC compounds** | | | | | | |
| 1,4-Diazabicyclo[2.2.2]octane * | 280-57-9 | 8.78 | 2 | 60 | 60 | 75 |
| 2-Ethylhexanoic acid [d] * | 149-57-5 | 10.19 | 1 | 12 | 7.8 | 15 |
| Decamethylcyclopentasiloxane * | 541-02-6 | 10.58 | 1 | 4.8 | 7.8 | 6.0 |
| Dodecamethylcyclohexasiloxane * | 540-97-6 | 12.46 | 1 | 5.0 | 5.1 | 6.3 |
| Not identified * | | 14.12 | 4 | 1.0 | 1.0 | 1.3 |
| **TVOC** | | | | 83 | 81 | 100 |
| **VVOC compounds** | | | | | | |
| None determined | | | | | | |
| **TVVOC** | | | | < 1 | < 1 | < 1 |
| **SVOC compounds** | | | | | | |
| None determined | | | | | | |
| **TSVOC** | | | | < 1 | < 1 | < 1 |
| **Carcinogens** | | | | | | |
| **Total carcinogens** | | | | < 1 | < 1 | < 1 |

## 5.2 Formaldehyde Emission Test Result after 3 Days

| | CAS No. | Specific Conc. [µg/m³] | Concentration [PPM] | Specific SER [µg/(m²·h)] |
|---|---|---|---|---|
| Formaldehyde | 50-00-0 | < 3 | < 0.003 | < 4 |

Calculation of ppm is done with a formaldehyde conversion factor; 1 ppm = 1.236 mg/m3 at 1 bar and 23 °C.

## 5.3 Test Results of the Extractable Compounds

| | CAS No. | Concentration |
|---|---|---|
| **Tinorganic Compounds** | | |
| Tributyltin (TBT) | 688-73-3 | < 0.1 ppm |
| **Phthalates** | | |
| Diisononyl phthalate (DINP) | 28553-12-0 | < 30 ppm |
| Di-2-ethylhexyl phthalate (DEHP) | 117-81-7 | < 5 ppm |
| Butylbenzyl phthalate (BBP) | 85-68-7 | < 5 ppm |
| Di-butyl phthalate (DBP) | 84-74-2 | < 5 ppm |
| Di-n-hexyl phthalate (DnHP) * | 84-75-3 | < 0.5 ppm |
| Diisobutyl phthalate (DIBP) | 84-69-5 | < 5 ppm |
| Di-n-pentyl phthalate (DPENP) * | 131-18-0 | < 5 ppm |
| Dicyclohexyl phthalate (DCHP) * | 84-61-7 | < 0.5 ppm |
| **TDA and MDA** | | |
| 2,4-Toluenediamine (TDA) * | 95-80-7 | < 0.5 ppm |
| 4,4-Diaminodiphenylmethane (MDA) * | 101-77-9 | < 0.5 ppm |
| **Heavy Metals** | | |
| Antimony (Sb) * | 7440-36-0 | < 0.5 ppm |
| Arsenic (As) * | 7440-38-2 | < 0.5 ppm |
| Barium (Ba) * | 7440-39-3 | < 2 ppm |
| Lead (Pb) | 7439-92-1 | < 1 ppm |
| Cadmium (Cd) | 7440-43-9 | < 0.1 ppm |
| Chromium total (Cr) * | 7440-47-3 | < 1 ppm |
| Mercury (Hg) * | 7439-97-6 | < 0.1 ppm |
| Selenium (Se) * | 7782-49-2 | < 1 ppm |
| **Flame-Retardants** | | |
| Pentabromodiphenyl ether | 32534-81-9 | < 0.001 wt% |
| Octabromodiphenyl ether | 32536-52-0 | < 0.001 wt% |
| Decabromodiphenyl ether | 1163-19-5 | < 0.001 wt% |

# 6 Summary and Evaluation of the Results

## 6.1 Comparison with Limit Values of CertiPUR US

### 6.1.1 VOC Emission Limit Values

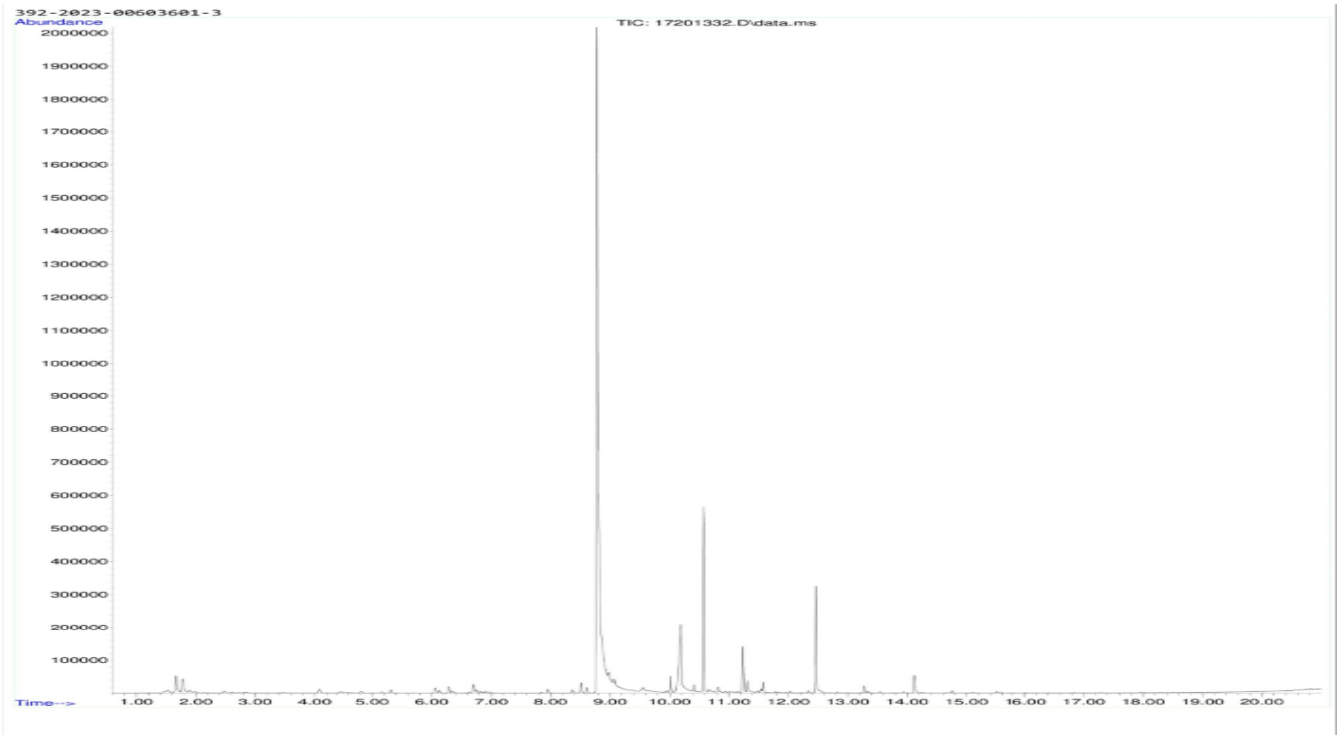
| | CAS No. | Concentration mg/m³ | Limit value mg/m³ |
|---|---|---|---|
| **Total TVOC ($C_6$-$C_{16}$)** | | 0.080 | < 0.5 |
| Benzene | 71-43-2 | < 0.001 | < 0.5 |
| Toluene | 108-88-3 | < 0.001 | < 0.5 |
| Styrene | 100-42-5 | < 0.001 | < 0.3 |
| Vinylcyclohexene * | 100-40-3 | < 0.001 | < LOD |
| 4-Phenylcyclohexene | 4994-16-5 | < 0.001 | < LOD |
| 2-Ethylhexanoic acid * | 149-57-5 | < 0.001 | < 0.005 |
| Aromatic hydrocarbons | - | < 0.001 | < 0.5 |
| Formaldehyde | 50-00-0 | < 0.003 | < 0.1 |

### 6.1.2 Limit Values of Extractable Compounds

| | Concentration | Limit value |
|---|---|---|
| Antimony (Sb) | < 1 ppm | 60 ppm |
| Arsenic (As) | < 0.5 ppm | 25 ppm |
| Barium | < 2 ppm | 1000 ppm |
| Lead (Pb) | < 1 ppm | 90 ppm |
| Cadmium (Cd) | < 0.1 ppm | 75 ppm |
| Chromium total (Cr) | < 1 ppm | 60 ppm |
| Mercury (Hg) | < 0.2 ppm | 60 ppm |
| Selenium (Se). | < 1 ppm | 500 ppm |
| Tributyltin (TBT) | < 0.1 ppm | 0.5 ppm |
| Sum of 8 phthalates | < 0.009 wt % | ≤ 0.01 wt % |
| 2,4 Toluenediamine (TDA) | < 0.5 ppm | ≤ 5.0 ppm |
| 4,4’ Diaminodiphenylmethane (MDA) | < 0.5 ppm | ≤ 5.0 ppm |
| Sum of TDA (2,4) and MDA (4,4’) | < 0.5 ppm | ≤ 5.0 ppm |
| Pentabromodiphenyl ether | < 0.001 wt% | ≤ 0.01 wt % |
| Octabromodiphenyl ether | < 0.001 wt% | ≤ 0.01 wt % |
| Decabromodiphenyl ether | < 0.001 wt% | ≤ 0.01 wt % |

# 7 Appendices

## 7.1 Chromatogram of VOC Emissions after 3 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 |
| ¤ | 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 substrate. |
| 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. |
| LOD | Limit of detection. |

### 7.2.2 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.

## 7.3 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 (EN 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 (EN 16516, AgBB, EMICODE, M1 and Indoor Air Comfort).

### 7.3.3 Testing of VOC

The emissions of volatile organic compounds after 3 days were tested by drawing air samples from the chamber outlet through Tenax TA tubes (main tube and backup tube) after 3 days of storage in the ventilated test chamber. Analyses were 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).

Calculation of the TVOC (Total Volatile Organic Compounds) was done by addition of the results of all substances between $C_6$ and $C_{16}$ as toluene equivalent, as defined in ISO 16000-6.

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).

### 7.3.4 Testing of formaldehyde

The presence of formaldehyde 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 (EN 16516, ISO 16000-3, VDI 3862 Blatt 3, internal methods no.: 71M549812 / 71M548400).

The absence of formaldehyde 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.

## 7.4 Qualitative Description of Testing of Extractable Compounds

### 7.4.1 Testing of Tinorganic Compounds

The sample was cut (in pieces of 5mm x 5 mm x 5 mm) and extracted for 1 hour with a methanol buffer in an ultrasonic bath at room temperature. After extraction the alkyltin species were derivatised by adding sodium tetraethylborate solution in n-hexane. The sample was then submitted to a second extraction procedure. Both hexane extracts were combined and further used to determine the organo tin compounds by gas chromatography with mass selective detection in SIM modus.

### 7.4.2 Testing of Phthalates

Approximately 5 g of sample was extracted with dichloromethane for 2 hours on a horizontal shaking table and afterwards unmoved during a minimum period of 16 hours. A part of the evaporated extract was

analysed directly at combined gas chromatography and mass spectrometry (GC/MS). The content was calculated to relevant phthalate standards i.e. the components that were identified at the analysis.

### 7.4.3 Testing of TDA and MDA

The sample was cut into cubes of approximately 5 mm x 5 mm x 5 mm and extracted for 1 hour with a 1% solution of acetic acid in water. The extraction was performed on a horizontal shaking table. The extract was neutralised by addition of 1 M sodium hydroxide and analysed by liquid chromatography mass spectrometry (LC-MS) using positive mode electro spray ionisation.

### 7.4.4 Testing of Heavy Metals

A representative subsample is made from the sample, and weighed into a digestion vessel for microwave digestion. The digestion is made according to CPSC-CH-E1002-08_3. The digested sample is measured on ICP/MS for the metals requested.

### 7.4.5 Testing of Flame-retardants

The sample was cut into cubes of approximately 5 mm x 5 mm x 5 mm and extracted for analysis of flame-retardants according to SOP QMA504-333. The analysis was performed by LRMS for the specific flame-retardants.

### 7.4.6 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.

## 7.5 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).

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

## 7.7 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/

For further information please visit www.eurofins.dk/product-testing/om-os/beslutningsregler/

## 7.8 Version History

| Report date | Report number | Modification |
|---|---|---|
| 26/01/2024 | 392-2023-00603601_S_EN | Current version |