REPORT

Contract no.:	1033/2021 - HC (Translation of the original report of 24.03.2022)	11.10.2023 HAE/BAK
Customer:	Theurl Timber Structures Gmbh Industriezone 1 9754 Steinfeld	
Subject:	Measurement of the emissions of VOC, formaldehyde and carbonyl compounds according to EN 16516 of a sample	
Date of contract:	06.12.2021	
Date of sample delivery:	21.12.2021	
Date/Period of service:	10.01. – 21.03.2022	
Period of validity:	--	
Pages:	12	
Enclosures:	Enclosure 1: Sampling Protocol	

1. Contract

On December 6th, 2021 Holzforschung Austria was commissioned with the testing of the VOC, formaldehyde and carbonyl compound emissions of a CLT sample according to ÖNORM EN 16516.

Contact person: Mr. Stefan Steinkasserer

1.1. Changes to report 1033/2021 of 21.03.2021

In section 3 “sample specification” the sample type in table 1 was corrected.
In section 5 “results” converted results for a q = 0.36 m³/hm² were added.
In section 6 “result interpretation” further comparisons of the results with orientation values/ecolabes were added.

2. Applied standards and guidelines

DIN ISO 16000-6 (2011): Indoor air — Part 6: Determination of volatile organic compounds in indoor and test chamber air by active sampling on Tenax TA sorbent, thermal desorption and gas chromatography using MS or MS-FID

ÖNORM EN ISO 16000-9 (2006 + Cor 1:2007): Indoor air — Part 9: Determination of the emission of volatile organic compounds from building products and furnishing — Emission test chamber method

ÖNORM EN ISO 16000-11 (2006): Indoor air — Part 11: Determination of the emission of volatile organic compounds from building products and furnishing — Sampling, storage of samples and preparation of test specimens

DIN ISO 16000-3 (2013): Indoor air — Part 3: Determination of formaldehyde and other carbonyl compounds in indoor and test chamber air — Active sampling method

ÖNORM EN 16516 (2021): Construction products - Assessment of release of dangerous substances - Determination of emissions into indoor air

Blue Angel, The German Ecolabel DE-UZ 76: Low-emission material Panel-Shaped Materials (Construction and Furnishing Panels for Interior Construction), Edition February 2016, Version 10

Committee for Health-related Evaluation of Building Products (Ausschuss zur gesundheitlichen Bewertung von Bauprodukten - AgBB) – June 2021; Requirements for the Indoor Air Quality in Buildings: Health-related Evaluation Procedure for Emissions of Volatile Organic Compounds (VVOC, VOC and SVOC) from Building Products (with list of LCI values)

3. Sample material

The sample was delivered to Holzforschung Austria on December 21st, 2021. The specimens were packed airtight.

The sample consisted of 2 specimens of a CLT sample made of spruce with the dimensions of 500 x 500 x 280 mm (L x W x H). The sample dimensions were chosen to achieve a chamber loading factor of 0.5 m^2/m^3.

Table 1 shows the properties of the received sample.

Table 1: Sample properties

HFA sample label	Product designation	Sample type	Batch no.	Dimensions [mm]	Production date
1033/2021	Theurl CLT Plus	spruce CLT-FIFI-C7-2I-ST 280mm	3200879	500 x 500 x 280	13.12.2022

4. Test methods

The sample was tested in one of the 1 m^3 emission chambers of Holzforschung Austria.

The specimens were already cut to the above shown dimensions on delivery, so that a loading factor of 0.5 m^2 emitting surface /m^3 of chamber volume, and therefore an area specific air flow rate of q=1 m^3/hm was reached.

The edges of one specimen was sealed according to EN 16516 with low emitting self-adhesive aluminium tape before placing the sample in the emission chamber (figure 1).

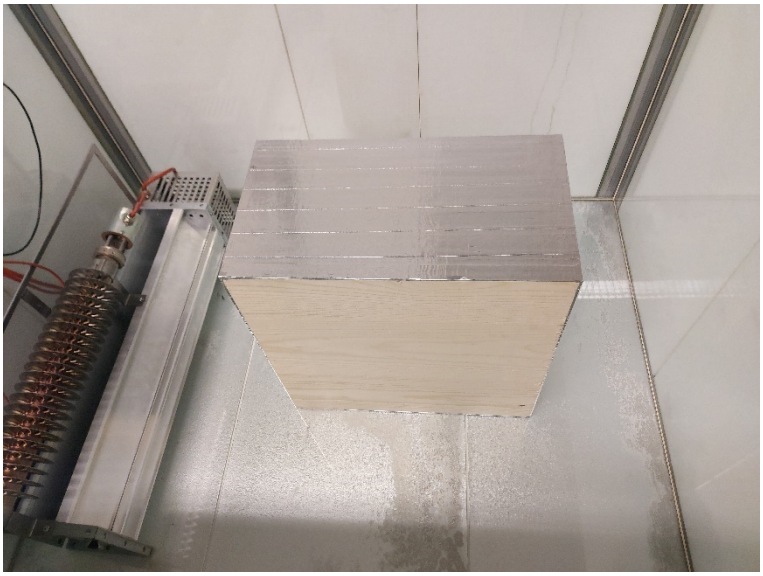

Figure 1: Sample 1033/2021 in the 1 m³ emission chamber

4.1. Emission chamber testing parameters

Table 2: Emission chamber testing parameters

Parameter	Value	Unit	Tolerance
Temperature	23	°C	± 1
Relative humidity	50	%	± 5
Air exchange rate	0.5	h^{-1}	± 0.015
Loading factor	0.5	m^2/m^3	
Area specific air flow rate q	1.0	m^3/hm^2	
Chamber volume	1	m^3	

Temperature and relative humidity conditions were met and recorded continuously during the entire test period.

4.2. Analysis of volatile organic compounds (VOC)

4.2.1. Sampling and analysis

For the sampling of VOC, a defined volume of emission chamber air is drawn through an adsorption tube filled with Tenax TA®, a porous polymer resin based on 2,6-diphenylene oxide. This material is suitable for the adsorption of volatile organic compounds of a chain length between C_6 (n-hexane) and C_{26} (hexacosane). According to the definitions of the WHO[1] this includes both VOC (volatile organic substances with boiling points between 50 °C and 250 °C) and SVOC (semi-volatile organic substances with boiling points between 250 °C and 390 °C).

Subsequent analysis of the Tenax TA®-Tubes is conducted according to ISO 16000-6 by use of a thermal desorption unit coupled to a gas chromatograph with mass spectrometric detection.

4.2.2. TD/GC/MS measurements

Because of a defect of the GC/MS system of Holzforschung Austria, the TD/GC/MS measurements and the qualitative and quantitative analysis of the substances absorbed on Tenax TA® was conducted at the Institut für Ökologie, Technik und Innovation GmbH (OETI, Wien) which is also accredited for EN 16516.

Substance specific quantification of individual compounds takes place by integrating the peak areas of target and qualifier ions. If VOC are found, which can not be quantified substance specifically, these are quantified as toluene equivalents.

4.3. Analysis of formaldehyde (and other carbonyl compounds)

4.3.1. Sampling on 2,4-Dinitrophenylhydrazine (DNPH) and analysis

A defined volume of emission chamber air is drawn through a cartridge containing DNPH. The principle of this procedure is based on the reaction of carbonyl groups with DNPH in acidic media, resulting in the formation of stable hydrazine-derivatives.

Subsequent analysis of the eluted compounds was conducted according to ISO 16000-3 by use of a high pressure liquid chromatography system with a diode array detector (absorption wavelength 360 nm).

4.3.2. Calibration

Commercially available standards were used to prepare a dilution series, which was analysed via the above described method. The calibration spans a range of approx. 1 - 610 µg/m³ for each substance.

[1] World Health Organization, WHO (1989) – Indoor Air Quality: Organic Pollutants. Euro reports and studies, 11. Copenhagen, Regional Office for Europe.

4.3.3. Qualitative analysis

Identification of the detected compounds is carried out by comparison of their retention times with those of commercially available standards and information regarding the retention times of the substances on the used Acclaim Carbonyl C18 column.

4.3.4. Quantitative analysis

Substance specific quantification of individual compounds takes place by integrating the peak areas of the substances. To check the detector sensitivity a reference standard mix is analysed before the start of each series of measurements.

5. Results

Categorization of VVOC, VOC and SVOC was performed according to EN 16516 and based on the AgBB guidelines with the following scheme:

- VVOC substances within a retention range of < C_6
- VOC substances within a retention range of C_6-C_{16}
- $TVOC_{spec}$ sum of VOC substances with concentrations ≥5 µg/m³ quantitation by substance specific calibration according to EN16516 and. AgBB
- TVOC sum of VOC substances with concentrations ≥5 µg/m³ quantitation via toluene equivalents according to EN16516
- SVOC substances within a retention range of C_{16}-C_{22}
- TSVOC sum of SVOC substances with concentrations ≥5 µg/m³

In compliance with the AgBB guidelines, acetic acid, though eluting before C_6, is also included in the TVOC.
Carcinogenic substances (CARC 1A and CARC 1B, according to regulation (EC) No 1272/2008) are reported and included in the results starting from a concentration of 1 µg/m³.

All results are mean values resulting from repeat determinations (n=2).

In addition, the substance specific R_i values are calculated in accordance with the German AgBB guidelines, using the directly measured concentration results and the list of the “lowest concentrations of interest” (LCI values).

$$R_i = \frac{c_i}{LCI_i}$$

R_i: substance specific R value
c_i: determined concentration in µg/m³
LCI_i: specific LCI value of the substance

For the assessment of the total emissions of the sample on day 28, all substance specific R_i-values are summed up to the actual R value.

$$R = \sum R_i$$

For these calculations the updated LCI values of the AgBB guidelines 2020 were used.

To enable the comparison of the results with the specifications of the Blue Angel Ecolabel DE-UZ 76 “Low-emission material Panel-Shaped Materials (Construction and Furnishing Panels for Interior Construction)” and the requirements of the German AgBB scheme the results were also converted to a loading of 1.4 m²/m³ (for use in walls and ceilings) and therefore for an area specific air flow rate q = 0.36 m³/hm in accordance with EN 16516.

5.1. Results of measurements of VOC, SVOC and Formaldehyde of sample 1033/2021 at q = 1 m³/hm²

Table 3: concentration results VOC, SVOC and Formaldehyde at q = 1 m³/hm²

Substance	CAS - No	Mean value Sample taking day 3		Mean value Sample taking day 28		Expanded uncertainty of the method
		Subst. spec. [µg/m³]	Toluene equiv. [µg/m³]	Subst. spec. [µg/m³]	Toluene equiv. [µg/m³]	
Heptane	142-82-5	10	7	< 5	< 5	± 40 %
alpha-Pinene	80-56-8	41	28	30	22	
beta-Pinene	127-91-3	46	16	36	13	
delta-3-Carene	88917-22-0	11	7	8	5	
Limonene	138-86-3	14	16	11	12	
Benzyl alcohol	100-51-6	8	< 5	6	< 5	
not identified substance[a]	---	7	7	< 5	< 5	
not identified substance[a]	---	8	8	< 5	< 5	
not identified substance[a,b]	---	< 5	< 5	7	7	
$TVOC_{spec}$		**145**	**---**	**91**	**---**	
TVOC		**---**	**89**	**---**	**52**	
TSVOC		**< 5**	**< 5**	**7**	**7**	
Formaldehyde	50-00-0	**8**		**2**		± 25 %
Acetaldehyde	75-07-0	**27**		**10**		

a quantified via toluene equivalents
b SVOC

5.2. Calculation of R value at q = 1 m³/hm²

Table 4: calculation of the R value at q = 1 m³/hm²

Substance	CAS - No	Mean value Sample taking day 28 Substance spec. [µg/m³]	LCI values [µg/m³]	R_i values
alpha-Pinene	80-56-8	30	2500	0.01
beta-Pinene	127-91-3	36	1400	0.03
delta-3-Carene	88917-22-0	8	1500	0.005
Limonene	138-86-3	11	5000	0.002
Benzyl alcohol	100-51-6	6	440	0.01
Formaldehyde	50-00-0	2	100	0.02
Acetaldehyde	75-07-0	10	300	0.03
Sum Ri values/R value				**0.1**

5.3. Results of measurements of VOC, SVOC and Formaldehyde of sample 1033/2021 converted to a q = 0,36 m³/hm²

Table 5: concentration results VOC, SVOC and Formaldehyde at q = 0,36 m³/hm²

Substance	CAS - No	Mean value Sample taking day 3		Mean value Sample taking day 28		Expanded uncertainty of the method
		Subst. spec. [µg/m³]	Toluene equiv. [µg/m³]	Subst. spec. [µg/m³]	Toluene equiv. [µg/m³]	
Heptane	142-82-5	28	20	< 5	< 5	± 40 %
alpha-Pinene	80-56-8	115	78	84	62	
beta-Pinene	127-91-3	129	45	101	36	
delta-3-Carene	88917-22-0	31	20	22	14	
Limonene	138-86-3	39	45	31	34	
Benzyl alcohol	100-51-6	22	< 5	17	< 5	
not identified substance[a]	---	20	20	< 5	< 5	
not identified substance[a]	---	22	22	< 5	< 5	
not identified substance[a,b]	---	< 5	< 5	20	20	
$TVOC_{spec}$		**406**	**---**	**255**	**---**	
TVOC		**---**	**250**	**---**	**146**	
TSVOC		**< 5**	**< 5**	**20**	**20**	
Formaldehyde	50-00-0	**21**		**6**		± 25 %
Acetaldehyde	75-07-0	**76**		**28**		

a quantified via toluene equivalents
b SVOC

5.4. Calculation of R value at q = 0,36 m³/hm²

Table 6: calculation of the R value at q=0,36 m³/hm²

Substance	CAS - No	Mean value Sample taking day 28 Substance spec. [µg/m³]	LCI values [µg/m³]	R_i values
alpha-Pinene	80-56-8	84	2500	0.03
beta-Pinene	127-91-3	101	1400	0.07
delta-3-Carene	88917-22-0	22	1500	0.01
Limonene	138-86-3	31	5000	0.006
Benzyl alcohol	100-51-6	17	440	0.04
Formaldehyde	50-00-0	6	100	0.06
Acetaldehyde	75-07-0	28	300	0.09
Sum Ri values/R value				**0.3**

6. Result interpretation

Table 7: Comparison of specifications of BauXund with results of sample 1033/2021 at q=1 m³/hm²

Category	Specifications BauXund day 28	Results day 28
TVOC (excl. Acetic acid)	≤ 300 µg/m³	91 µg/m³
TSVOC	≤ 100 µg/m³	7 µg/m³
Carcinogenic substances	≤ 1 µg/m³ not detectable	< 1 µg/m³
Acetic acid	≤ 600 µg/m³	< 5 µg/m³
Formaldehyde	≤ 0.05 ppm (= 60 µg/m³)	0.002 ppm (2 µg/m³)

Table 8: Comparison of specifications of Blue Angel DE-UZ 76 with results of sample 1033/2021 at q=0,36 m³/hm²

Category	Specifications DE-UZ 76 day 3	Results day 3	Specifications DE-UZ 76 day 28	Results day 28
TVOCspec	≤ 3.000 µg/m³	406 µg/m³	≤ 800 µg/m³ wood based panels ≤ 300 µg/m³ other panels	255 µg/m³
TSVOC	-	< 5 µg/m³	≤ 100 µg/m³	20 µg/m³
Carcinogenic substances	≤ 10 µg/m³ total	n.d.	≤ 1 µg/m³ per single value	n.d.
R value	-	-	≤ 1	0.3
Sum VOC with no LCI	-	42 µg/m³	≤ 100 µg/m³	< 5 µg/m³
Formaldehyde	-	21 µg/m³	≤ 80 µg/m³	6 µg/m³

n.d. not detectable

Table 9: Comparison of specifications of German AgBB scheme with results of sample 1033/2021 at q=0,36 m³/hm²

Category	Specifications AgBB day 3	Results day 3	Specifications AgBB day 28	Results day 28
TVOCspez (incl. SVOC with LCI)	≤ 10.000 µg/m³	406 µg/m³	≤ 1.000 µg/m³	255 µg/m³
TSVOC (SVOC with no LCI)	-	< 5 µg/m³	≤ 100 µg/m³	20 µg/m³
Carcinogenic substances	≤ 10 µg/m³ per single value	n.d.	≤ 1 µg/m³ per single value	n.d.
R value	-	-	≤ 1	0.3
Sum VOC with no LCI	-	42 µg/m³	≤ 100 µg/m³	< 5 µg/m³

n.d. not detectable

The results of the emission measurements of CLT sample 1033/2021 meet the specifications of BauXund (at q=1 m³/hm²) and also the specifications of Blue Angel DE-UZ 76 and the German AgBB scheme (at q= 0.36 m³/hm²).

7. Storage of samples

Samples will be kept in storage for a period of 3 months after completion of the measurements.

HOLZFORSCHUNG AUSTRIA

Mag. Elisabeth Habla
Authorisation to sign and technical execution

Wolfgang Hochschorner
Technical execution

This report was approved electronically in accordance with an internal HFA process by the designated authorized signatory, traceable and documented.

Accreditation is given for the following procedures.
It is not allowed to use included accreditation marks for own purposes.

Accreditation mark	Type of accreditation	Procedure/s
Akkreditierung Austria 0055 ISO/IEC 17025 T	testing	• DIN ISO 16000-6 • ÖNORM EN ISO 16000-9 • ÖNORM EN ISO 16000-11 • DIN ISO 16000-3 • ÖNORM EN 16516

The results and statements given in this document relate only to the tested materials as received, the present information and the state of the art at the time of investigation.

Publication in excerpts is only permitted with the written approval of Holzforschung Austria.

The conformity assessment of the results is subject to the shared-risk approach.

Enclosure 1

of report no. 1033/2021 - HC

HOLZ FORSCHUNG AUSTRIA

Probenahmebegleitblatt
Proben für Emissionsprüfungen

Hersteller am Probenahmeort (Firmenname, Adresse, Telefon)	Theurl Timber Structures Industriezone 1 A-8754 Steinfeld	**Produkthersteller (falls abweichend)** (Firmenname, Adresse, Telefon)	/ – " –
Probenehmer (Name, Firma, Telefon)	DI Stefan Steinbrenner 0664/88 84 1700 Theurl		

Produkt-bezeichnung	Theurl CLT Plus	**Probenart** (Materialart)	C7-21-ST Fichte
Typ/Serie	C7 280 mm	**Chargen-Nr.**	3200879
Artikel-Nr.	3001233374	**Produktions-datum**	13.12.2022

Probenahme			
Probenahme-datum/ Uhrzeit	13.12.2022 16:30	**Probengröße** (Länge x Breite x Höhe)	500 x 500 x 280 mm
Produkt-entnahme aus	☒ laufender Produktion ☐ Lagerbeständen ☐ sonstiges:		
bei Entnahme aus Lagerbeständen: Lagerung vor Entnahme/ Zuschnitt	☐ offen ☐ offen im Stapel: Entnahme von: ☐ Außenseite/oben ☐ Stapelinnerem ☐ verpackt Verpackungsmaterial: ungefähre Lagerbedingungen: Temp: _____ rel. Luftfeuchte: _____		
Zuschnitt	☐ kein Zuschnitt ☒ Zuschnitt aus Materialinnerem (alle Schnittkanten neu) ☐ Zuschnitt vom Materialrand aus		
Achtung: Die Proben sind unmittelbar nach der Entnahme/dem Zuschnitt gasdicht zu verpacken!			
Bemerkungen (mögl. Kontaminationen; Lösungsmittel-dämpfe etc.)	/		

Hiermit bestätigt die unterzeichnende Person die Richtigkeit der obrigen Daten. Die Probe wurde eigenhändig gemäß Probenahmeanleitung ausgewählt, gezogen und verpackt.

Datum, Ort Unterschrift (Stempel)	Steinfeld am 13.12.2022	THEURL AUSTRIAN PREMIUM TIMBER THEURL TIMBER STRUCTURES GMBH 9754 Steinfeld · Industriezone 1 · Tel.+43 4855 8411-500 ATU 73784489