

Setra Trävaror AB

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## Emission measurements after 28 days

(2 appendices)

### Object

One sample of cross laminated timber was delivered to RISE..

Product name:	<b>Cross laminated timber</b>
Production date:	2021-10-15
Size of sample:	500 x 500 x 140 mm
Date of sampling:	2021-10-15
Date of arrival to RISE:	2021-10-22

### Assignment

Emission measurement according to ISO 16000-9:2006 (Indoor air – Part 9: Determination of the emission of volatile organic compounds from building products and furnishing – Emission test chamber method), after 28 days regarding volatile organic compounds (VOC and VVOC/SVOC), carcinogenic substances (VOC-substances, EU Regulation No 1272/2008 Annex VI, cat 1A and 1B), formaldehyde and acetaldehyde (ISO 16000-3:2011). Evaluation according to EN 16516:2017 (EU-LCI values).

### Method

The test was started 2021-10-22 by unwrapping the test sample. All cut edges were sealed with aluminium tape. Open surface area was 0.5 m<sup>2</sup>. The specimen was placed in a room with controlled climate conditions of 23 ± 2 °C and 50 ± 5 % RH.

The test specimen was placed into the emission chamber three days prior to air samplings. Air samplings after 28 days of conditioning were carried out on 2021-11-19.

Test conditions in the chamber:

Chamber volume:	1.0 m <sup>3</sup>
Temperature:	23 ± 0.5 °C
Relative humidity:	50 ± 3 % RH
Surface area of test specimen:	0.5 m <sup>2</sup>
Air exchange rate:	0.5 h <sup>-1</sup>
Area specific air flow rate:	1.0 m <sup>3</sup> /m <sup>2</sup> h
Air velocity at specimen surface:	0.1 – 0.3 m/s

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Tenax TA was used as adsorption medium for VOC. The tubes were thermally desorbed and analysed in accordance to RISE method 0601, similar to ISO 16000-6:2011 (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). This means an analysis in a gas chromatograph and detection with a flame ionisation detector (FID) and mass selective detector (MS). The capillary column used is coated with 5% phenyl/ 95 % methylpolysiloxane. The FID signals are used for compound quantification. The total volatile organic compounds (TVOC) means compounds eluting between and including n-hexane to hexadecane, having boiling points in the range of about 70-260 °C. Minimum duplicate air samples were taken and the results are mean values. Sampled volumes are 2.4 to 6.3 L.

Tenax TA was also used as adsorption medium for testing of volatile carcinogenic compounds according to EU Regulation No 1272/2008 Annex VI, cat 1A and 1B), (exclusive formaldehyde), 1 µg/m<sup>3</sup> and above.

The samplings of aldehydes were carried out with DNPH samplers. The samplers were analysed according to SP method 2302, similar to ISO 16000-3:2011 (Indoor air - Part 3: Determination of formaldehyde and other carbonyl compounds – Active sampling method). This means analysis on a liquid chromatograph with absorbance detector. Duplicate air samples were taken and the results are mean values. Sampled volumes were 64 L.

## Results

The results relate only to the items tested.

The results in Table 1 are expressed as area specific emission rates and as concentrations in a reference room (according to EN 16516:2017). The reference room has a base area of 3 m x 4 m and a height of 2.5 m, with an air exchange rate of 0.5 h<sup>-1</sup>. The wall area is 31.4 m<sup>2</sup>, floor area is 12 m<sup>2</sup>, small area, like a door, is 1.6 m<sup>2</sup> and very small area, like sealant, is 0.2 m<sup>2</sup>. Wall area is used for the calculation of the concentrations.

Calculation of the concentration from the emission rate:

$$C = \frac{E_a \times A}{n \times V}$$

C = concentration of VOC in the reference room, in µg/m<sup>3</sup>

E<sub>a</sub> = area specific emission rate, in µg/m<sup>2</sup>h

A = surface area of product in reference room, in m<sup>2</sup>

n = air exchange rate, in changes per hour, here 0.5 h<sup>-1</sup>

V = volume of the reference room, in m<sup>3</sup>, here 30 m<sup>3</sup>

**Table 1.**  
Emission results of **Cross laminated timber** after 28 days

Volatile organic compounds	CAS number	Retention time (min)	ID <sup>1</sup>	Emission rate ( $\mu\text{g}/\text{m}^2\text{h}$ )	Concentration in reference room ( $\mu\text{g}/\text{m}^3$ )	LCI <sub>i</sub> ( $\mu\text{g}/\text{m}^3$ )	R <sub>i</sub> ( $c_i/\text{LCI}_i$ )
<b>TVOC (C<sub>6</sub> – C<sub>16</sub>)</b>	--	6.2 – 38	B	33	69	--	--
<b>Volatile Carcinogens<sup>2</sup></b>		6.2 – 38					
No substances detected	--	--	B	< 1	< 1	--	--
<b>VOC with LCI<sup>3</sup></b>		6.2 – 38					
Acetic acid (VVOC)	64-19-7	5.6	A	7	14	1200	0.01
Pentanal	110-62-3	8.6	A	6	12	800	0.02
Hexanal	66-25-1	11.9	A	14	29	900	0.03
$\alpha$ -Pinene	80-56-8	17.4	A	13	27	2500	0.01
$\beta$ -Pinene	127-91-3	19.2	A	3	7	1400	< 0.01
Limonene	138-86-3	20.0	A	3	6	5000	< 0.01
<b><math>\Sigma</math> VOC with LCI</b>	--	--	A	46	95	--	
<b>VOC without LCI<sup>4</sup></b>							
No substances detected	--	--	B	< 2	< 5	--	--
<b><math>\Sigma</math> VOC without LCI</b>	--	--	B	< 2	< 5	--	--
<b>SVOC (C<sub>16</sub> – C<sub>22</sub>)<sup>5</sup></b>		38 - 51					
No substances detected	--	--	B	< 2	< 5	--	--
<b><math>\Sigma</math> SVOC</b>	--	--	B	< 2	< 5	--	--
<b>VVOC (&lt; C<sub>6</sub>)<sup>6</sup></b>		4.5 – 6.2					
Formaldehyde <sup>7</sup>	50-00-0	--	A	3	5	100	0.05
Acetaldehyde <sup>7</sup>	75-07-0	--	A	9	18	300	0.06
<b><math>\Sigma</math> VVOC</b>	--	--	A	12	23	--	--
<b>R = <math>\Sigma C_i / \text{LCI}_i</math><sup>8</sup></b>	--	--	--	--	--	--	0.18

<sup>1)</sup> ID: A = quantified compound specific, B = quantified as toluene-equivalent

<sup>2)</sup> Volatile carcinogens = VOCs according to EU Regulation No 1272/2008 Annex VI, cat 1A and 1B

<sup>3)</sup> VOC with LCI = identified VOC-compound with LCI-value according to EU-LCI, December 2020

<sup>4)</sup> VOC without LCI = VOC-compound without LCI-value or not identified.

<sup>5)</sup> SVOC = semi-volatile organic compounds, as defined in ISO 16000-6 (not part of accreditation)

<sup>6)</sup> VVOC = very volatile organic compounds, as defined in ISO 16000-6 (not part of accreditation)

<sup>7)</sup> VVOC-aldehydes measured with DNPH samplers (ISO 16000-3)

<sup>8)</sup> All VVOC, VOC, SVOC and carcinogens with LCI

Only VOC-compounds with an emission rate higher than  $2 \mu\text{g}/\text{m}^2\text{h}$  are listed in Table 1, carcinogenic compounds  $\geq 1 \mu\text{g}/\text{m}^2\text{h}$ . Only the compounds with a concentration in the reference room  $> 5 \mu\text{g}/\text{m}^3$  are evaluated based on LCI (= lowest concentration of interest).

TVOC expressed in  $\mu\text{g}/\text{m}^3$  and  $\mu\text{g}/\text{m}^2\text{h}$  is the sum of all individual substances with concentrations  $\geq 5 \mu\text{g}/\text{m}^3$  (in toluene equivalents) in the reference room.

Quantification limit for TVOC is  $10 \mu\text{g}/\text{m}^2\text{h}$ . Measurement uncertainty for VOC is 15 % (rel) and for formaldehyde 30 % (rel). Background of TVOC in the empty chamber was below  $20 \mu\text{g}/\text{m}^3$  and is subtracted.

See Appendix 1 for a gas chromatogram (FID spectra) and Appendix 2 for a photo of the test specimen.

## Summary of the test results

The test results are summarized in Table 2.

**Table 2.**

Summary of the emission results after 28 days of **Cross laminated timber**

Compounds	Emission rate ( $\mu\text{g}/\text{m}^2\text{h}$ )	Concentration in reference room (wall scenario) ( $\mu\text{g}/\text{m}^3$ )
TVOC	33	69
$\Sigma$ Carcinogenic VOCs	< 1	< 1
$\Sigma$ VOC with LCI	46	95
$\Sigma$ VOC without LCI	< 2	< 5
$\Sigma$ VVOC	< 2	< 5
Formaldehyde	3	5
$\Sigma$ SVOC	< 2	< 5
$R = \Sigma C_i / LCI_i$	0.18	

The emission result of **formaldehyde** ( $3 \mu\text{g}/\text{m}^2\text{h}$ ) can be converted into a concentration according to EN 717-1:2004 (Wood-based panels – Determination of formaldehyde release – Part 1: Formaldehyde emission by the chamber method).

In EN 717-1 the area specific air flow rate is  $1 \text{ m}^3/\text{m}^2\text{h}$ , this means that the concentration equals the emission rate. After adjustment of measuring at different relative humidity (division by 1.09 (ASTM E 1333-14)) the emission of formaldehyde of the tested product expressed as **concentration according to EN 717-1 is  $0.003 \text{ mg}/\text{m}^3$  (670 h\*)**. \*) The duration of the test in hours.

## Evaluation of the test results

Byggvarubedömningen has criteria regarding Emissions to indoor environment. The emissions are to be measured according to a standard method such as ISO 16000-9 after 28 days regarding VOC and formaldehyde. The requirements for the *Recommended class* is that the requirements to one of the following systems are being met: Emicode EC1, Emicode EC1<sup>PLUS</sup>, Blue Angel, M1 (RTS) or GUT.

The results of the tested sample are compared to M1.

Decision rule: When comparing the measured results and requirement level, the average value of the measured results has been compared with the requirement level. No account is taken to the measurement uncertainty.

**Table 3.**

The test results of **Cross laminated timber** compared to the relevant requirements in M1

Compounds	Requirement M1 (mg/m <sup>2</sup> h)	Test Results (mg/m <sup>2</sup> h)	Pass / Fail
TVOC	< 0.2	<b>0.033</b>	<b>PASS</b>
Formaldehyde	< 0.05	<b>0.003</b>	<b>PASS</b>
CMR 1A+1B	< 0.001	<b>&lt; 0.001</b>	<b>PASS</b>
Single VOC (µg/m <sup>3</sup> )	≤ EU-LCI	≤ EU-LCI	<b>PASS</b>
Ammonia	< 0.03	not measured	--
Odour	≥ 0.0	not measured	--

The test results are in compliance with the tested requirements of M1 and meet the requirements for the *Recommended class*.

## **RISE Research Institutes of Sweden AB** **Chemistry and Applied Mechanics - Chemical Product Safety**

Performed by

Examined by

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## Appendices

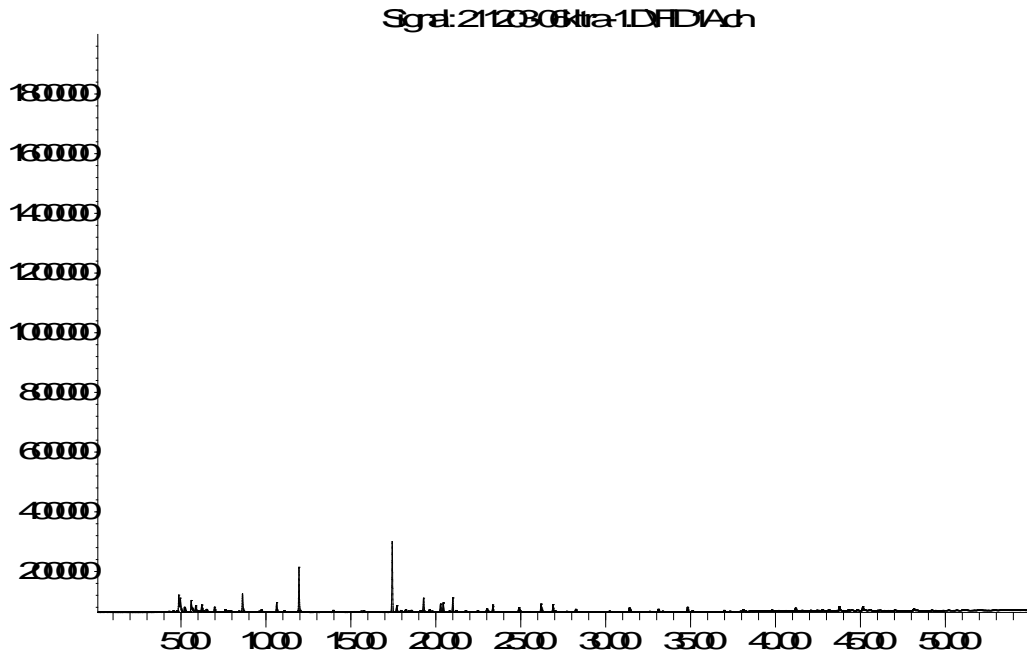
1. Gas Chromatogram
2. Photo of the test specimen

Appendix 1

Gas chromatogram

Cross laminated timber, after 28 days:

Abundance

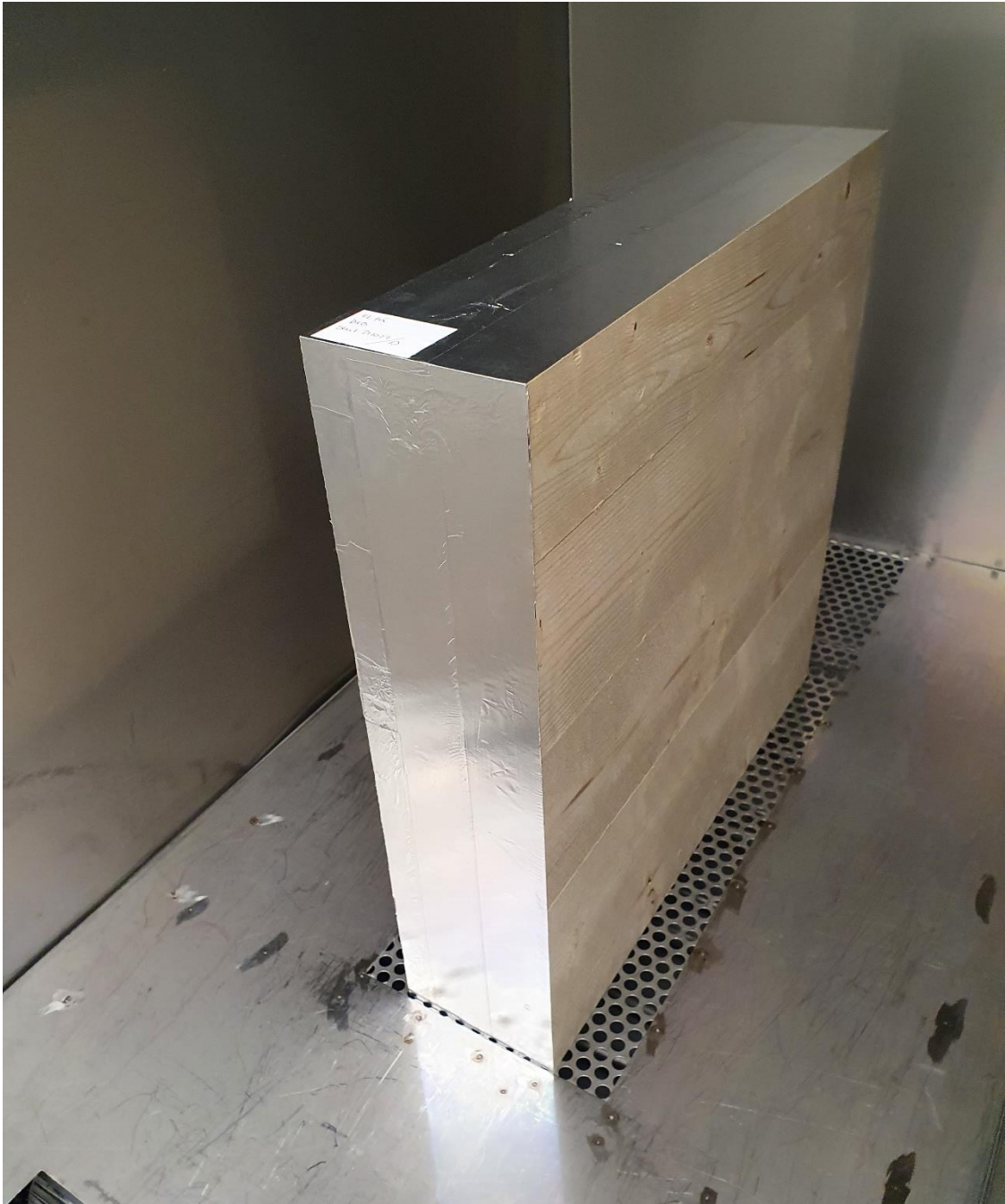


Time >

TVOC between C<sub>6</sub> and C<sub>16</sub>, means compounds eluting between 6.2 and 38 minutes.

## Appendix 2

## Photo of the test specimen

**Cross laminated timber**