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## Emission measurements

(2 appendices)

### Object

One sample of a table top was delivered to SP. The sample was taken from the stockroom, manufacturing date ca 2-3 weeks ago.

Sample marking:	<b>Quickly-991</b> 140 x 60 x 2.5 cm
Packaging:	Container of cardboard, table top well wrapped in plastic foil
Date of arrival:	2012-05-11

### Work requested

Emission measurements according to ANSI/BIFMA M7.1-2011 *Standard Test Method for Determining VOC Emissions From Office Furniture Systems, Components and Seating*, with air samples taken from the test chamber at the 72<sup>nd</sup> and 168<sup>th</sup> hour regarding volatile organic compounds (VOC), formaldehyde and aldehydes. Evaluation according to ANSI/BIFMA X7.1-2011, the emission factors from the tested product are compared with the maximum emissions factors for an Open Plan Office Environment presented in Table A1.2 of ANSI/BIFMA X7.1-2011.

### Method

The test sample was stored in the shipping container in a room with controlled climate conditions of  $23 \pm 2$  °C and  $50 \pm 10$  % RH until start of the test.

The test sample was placed in the test chamber 2012-05-18.

Test conditions in chamber:

Chamber volume:	22.0 m <sup>3</sup>
Temperature:	$23 \pm 0.5$ °C
Relative humidity:	$50 \pm 3$ % RH
Air exchange rate:	0.33 h <sup>-1</sup>
Approx area of sample:	1.1 m <sup>2</sup>
Area specific air flow rate:	4.3 m <sup>3</sup> /m <sup>2</sup> h.
Loading:	0.045 unit/m <sup>3</sup> (1 table top/chamber volume)
Air samplings day 3:	2012-05-21
Air samplings day 7:	2012-05-25

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Tenax TA was used as adsorption medium for VOC. The Tenax tubes were thermally desorbed and analysed in accordance to ISO 16000-6:2004 (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/FID), accredited SP method 0601. This means an analysis in a gas chromatograph and detection with a flame ionisation detector (FID) and mass selective detector (MS). The FID signals are used for compound quantification. The TVOC is quantified in toluene equivalents and includes all compounds  $\geq 1 \mu\text{g}/\text{m}^3$ . The mass selective detector is used for identification of single compounds, quantified in compound specific amounts when possible, otherwise in toluene equivalents.

The samplings of Formaldehyde and Acetaldehyde were carried out with DNPH samplers. The samplers were analysed according to ISO 16000-3:2001 -Indoor air--Part 3:Determination of formaldehyde and other carbonyl compounds – Active sampling method, accredited SP method 2302. This means analysis on a liquid chromatograph with absorbance detector. The other aldehydes (Propanal, Butanal, Pentanal, Hexanal, Heptanal, Octanal, Nonanal and Benzaldehyde) were analyzed by GC-MS/FID by sampling on Tenax TA.

## Results

The results of the emission tests are summarized on the following pages in accordance with the BIFMA M7.1-2011 guidelines for reporting:

**Table 1.**  
**Chamber concentrations of VOCs between n-C<sub>6</sub> and n-C<sub>16</sub> measured by GC-MS/FID ( $\mu\text{g}/\text{m}^3$ )**

Volatile organic compound	CAS	RT (min)	ID	72 <sup>nd</sup> hour				168 <sup>th</sup> hour			
				# 1	# 2	Mean	% diff	# 1	# 2	Mean	% diff
<b>Aromatic Hydrocarbons</b>											
Toluene	108-88-3	9.7	A	< 2	< 2	< 2	--	< 2	< 2	< 2	--
<b>Alcohols</b>											
1-Propanol, 2-methyl-	78-83-1	5.8	B	2	3	2	15	2	2	2	15
<b>Aldehydes</b>											
Hexanal	66-25-1	10.7	A	< 2	< 2	< 2	--	< 2	< 2	< 2	--
<b>Others</b>											
Formamide, N,N-dimethyl-	68-12-2	10.2	B	< 2	< 2	< 2	--	< 2	< 2	< 2	--
<b>TVOC</b>	--	5.0-36	B	10	11	11	8	< 10	< 10	< 10	--

Sorbent tube and media: Stainless steel tube with Tenax-TA; Sampling volumes: 6 – 13 L  
ID: A = quantified compound specific, B = quantified in toluene equivalents

Only VOC-compounds with a concentration higher than  $2 \mu\text{g}/\text{m}^3$  are listed in the table.  
Quantification limit for TVOC is  $10 \mu\text{g}/\text{m}^3$ .

**Table 2.**  
**Chamber concentrations of Formaldehyde, Acetaldehyde and Total Aldehydes by HPLC and GC-MS/FID Analysis ( $\mu\text{g}/\text{m}^3$ )**

Volatile organic compound	72 <sup>nd</sup> hour				168 <sup>th</sup> hour			
	# 1	# 2	Mean	% diff	# 1	# 2	Mean	% diff
<b>Formaldehyde</b>	13	13	<b>13</b>	5	9	10	<b>10</b>	10
<b>Acetaldehyde</b>	1.7	< 0.9	< <b>1</b>	--	< 0.9	< 0.9	< <b>0.9</b>	--
<b>Total Aldehydes</b>	15	15	<b>15</b>	2	9	12	<b>11</b>	15

Sampling cartridges: silica gel coated with DNPH; Sampling volumes: 60 – 110 L  
Total aldehydes are defined as the sum of all normal-between n-C<sub>1</sub> and n-C<sub>9</sub>-aldehydes plus benzaldehyde.

The results in table 3 are expressed as area specific emission rates. The emission factors are calculated by:

$$SER_A = \frac{Conc \times n}{L}$$

$SER_A$  = area specific emission rate, in  $\mu\text{g}/\text{m}^2 \times \text{h}$   
 Conc = concentration of a VOC in the chamber, in  $\mu\text{g}/\text{m}^3$   
 n = air exchange rate in the chamber, in changes per hour  
 L = loading factor, in  $\text{m}^2/\text{m}^3$  (area of sample/volume of chamber)

**Table 3.**  
**Calculated Emission Factors for Identified VOCs, TVOC, Formaldehyd, Acetaldehyde and Total Aldehydes ( $\mu\text{g}/\text{m}^2\text{h}$ )**

Volatile organic compound	Emission factor	
	72 <sup>nd</sup> hour (3 days)	168 <sup>th</sup> hour (7 days)
TVOC <sub>Toluene</sub>	47	< <b>43</b>
Formaldehyde	56	<b>41</b>
Acetaldehyde	4	<b>5</b>
Total Aldehydes ( $\mu\text{mol}/\text{m}^2\text{h}$ )	2	<b>1</b>
4-Phenylcyclohexene	< 2	< <b>2</b>
Individual VOC:		
Toluene	3	<b>4</b>
1-Propanol, 2-methyl-	10	<b>9</b>
Hexanal	5	< <b>2</b>
Formamide, N,N-dimethyl-	6	<b>4</b>

Background of TVOC in the empty chamber was  $7 \mu\text{g}/\text{m}^3$ . The background value is subtracted.  
Measurement uncertainty: TVOC 15 % (rel), formaldehyde and acetaldehyde 30 % (rel).

See Appendix 1 for gas chromatograms (FID spectra).

Appendix 2 is a photo of the test specimen in the emission chamber.

## Evaluation of Test Results

The data obtained from the emissions testing of an individual furniture component is compared to the ANSI/BIFMA X7.1-2011 *Standard for Formaldehyde and TVOC Emissions of Low-emitting Office Furniture and Seatin*. The following criteria from ANSI/BIFMA X7.1-2011 must be met at the seven-day time point specified in the ANSI/BIFMA M7.1-2011.

**Table 4.**  
**Workstation or Individual Furniture Components Maximum Emission Factors**  
(according to ANSI/BIFMA, X7.1-2011 Table A1.2)

Volatile organic compound	ANSI/BIFMA M7.1 Open Plan Office Environment
Formaldehyde ( $\mu\text{g}/\text{m}^2\text{h}$ )	42.3
TVOC ( $\mu\text{g}/\text{m}^2\text{h}$ )	345
Total Aldehydes ( $\mu\text{mol}/\text{m}^2\text{h}$ )	2.8
4-Phenylcyclohexene ( $\mu\text{g}/\text{m}^2\text{h}$ )	4.5

**Table 5.**  
**Comparison of Emission Factors for the tested product Quickly-991 and Maximum Emission Factors** (ANSI/BIFMA X7.1-2011)

Volatile organic compound	Maximum Emission Factors Open Plan Office Environment	Emission Factors for <u>Quickly-991</u>	Pass / Fail Result
Formaldehyde ( $\mu\text{g}/\text{m}^2\text{h}$ )	42.3	40.9	<b>PASS</b>
TVOC ( $\mu\text{g}/\text{m}^2\text{h}$ )	345	< 43	<b>PASS</b>
Total Aldehydes ( $\mu\text{mol}/\text{m}^2\text{h}$ )	2.8	1.4	<b>PASS</b>
4-Phenylcyclohexene ( $\mu\text{g}/\text{m}^2\text{h}$ )	4.5	< 2	<b>PASS</b>

## Summary of test results

The emission factors for the tested product **Quickly -991** are in compliance with all the criterias of maximum emission factors from ANSI/BIFMA X7.1-2011.

## SP Technical Research Institute of Sweden Chemistry and Materials - Organic Analytical Chemistry

Performed by

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## Appendices

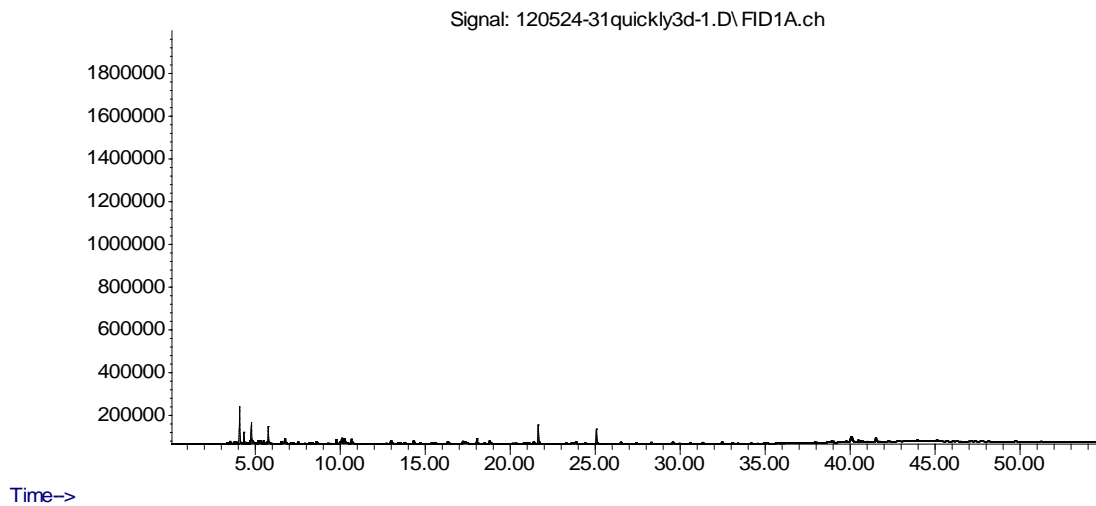
1. Gas chromatograms
2. Photo of test sample in the chamber

## Appendix 1

### Gas Chromatograms

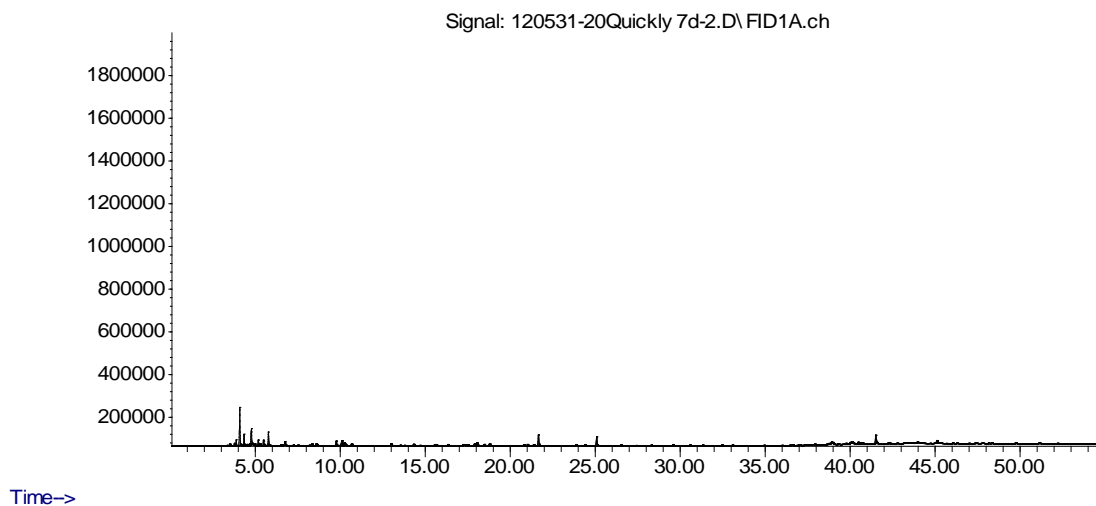
**Quickly-991**, after 3 days:

Abundance



**Quickly-991**, after 7 days:

Abundance



VOCs between n-C<sub>6</sub> and n-C<sub>16</sub>, means compounds eluting between 5.0 and 36 minutes.

The compound at 4.2 min is a contamination from the analysis system

## Appendix 2

### Photo of test specimen in the emission chamber

