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REPRESENTATIVE TESTING of OBERON VOC EMISSION PERFORMANCE

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1 Introduction

There has been performed VOC emission testing according to ISO 16000-3 -6- 9 -11 and CEN/TS 16516 of several table components which the client use in production of tables. There was also tested a complete table according to the mentioned standards and ANSI/BIFMA and ASTM D5116. The table range is build up in a similar way with possibility of choosing different materials for the table top or the structural components. Eurofins Product Testing A/S has, together with the client, defined worst case samples of the different materials and set up a test program to be able to make conclusions on the VOC emission performance of the entire range.

The table tops are present in several design and materials choices which can be seen in the table here below:

Materials	Design variants
Melamine faced chipboard (MFC)	Oak, Beech, Birch, Walnut, Black, Light grey, White
Veneer	Oak, Beech, Birch
High pressure laminate (HPL)	Beech, Birch, Light Grey, White
Powder coated metal	Silver Grey, White, Black

Table 1: Available materials for production of the table range

2 Short conclusion

The complete table (Oberon) showed low emissions and passed all requirements in ANSI/BIFMA, Indoor Air Comfort GOLD and M1. From the emissions seen from the individual tested components, it is evaluated that Oberon furniture made from the tested materials will pass the requirements in ANSI/BIFMA, Indoor Air Comfort GOLD and M1.


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Table of contents

1	Introduction	1
2	Short conclusion	1
3	Tested Products and Components	2
4	Applied Test Methods	3
4.1	General Test References	3
4.2	Specific Laboratory Sampling and Analyses (depending on specific test)	3
5	Test Parameters and Sample Preparation	4
5.1	VOC Emission Chamber Test Parameters	4
5.2	Example of Picture of Sample (392-2016-00175501)	4
5.3	Example of Picture of Sample (392-2016-00202102)	5
5.4	Example of Picture of Sample (392-2016-00472303)	5
6	Analytical Results	6
7	Evaluation of VOC emission	6
7.1	Comparison with Limit Values of ANSI/BIFMA (392-2016-00472303 (Oberon))	7
7.2	Comparison with Limit Values of Indoor Air Comfort GOLD® (392-2016-00472303 (Oberon))	7
7.3	Comparison with M1 Limit Values (392-2016-00472303 (Oberon))	8

3 Tested Products and Components

There has been performed VOC emission testing on 4 different table tops with at least one of each material type, 3 different metal coatings and a full test of an assembled piece of furniture. The performed tests and materials have been listed here below.

Sample Number	Sample Name	Material	Colour
392-2016-00175501	MFC Vit 8017/Egger	MFC	White
392-2016-00175502	HPL Vit 8017_Swedspan	HPL	White
392-2016-00175503	Faner Björk 59339796_Swedspan, Mack faner	Veneer	Beech
392-2016-00175504	MFC Gråvit 3540_Pleiderer	MFC	Light Grey
392-2016-00202101	Metall Grå PulverlackTiger coatings 05990106 Sodik Silber 3 GLME	PCM	Silver Grey
392-2016-00202102	Metall Svart PulverlackAkzo Nobel Interpon 700 EN849L	PCM	Black
392-2016-00202103	Metall Vit Pulverlack/Jotun Corro Coat MX-8385 1021188	PCM	White
392-2016-00472303	Oberon work table sit/stand	Complete table	White top / White

The results are only valid for the tested sample(s).

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4 Applied Test Methods

Most tests were performed as 3 day VOC testing with sampling according to ISO 16000-3 and ISO 16000-6 to establish the emission of these types. There was in the end performed full ANSI/BIFMA, Indoor Air Comfort GOLD and M1 test on a complete table piece.

4.1 General Test References

Regulation, protocol or standard	Version	Reporting limit VOC [$\mu\text{g}/\text{m}^3$]	Calculation of TVOC	Combined uncertainty \pm [RSD(%)]
CEN/TS 16516	October 2013	5	Toluene equivalents	22 %
ISO 16000 -3 -6 -9 -11	2006-2011 depending on part	2	Toluene equivalents	22 %
ASTM D5116	2010	-	-	-
ANSI/BIFMA	ANSI/BIFMA M7.1-2011	2	Toluene equivalents	22 %
CDPH	CDPH/EHLB/Standard Method V1.1. (February 2010)	2	Toluene equivalents	22%

4.2 Specific Laboratory Sampling and Analyses (depending on specific test)

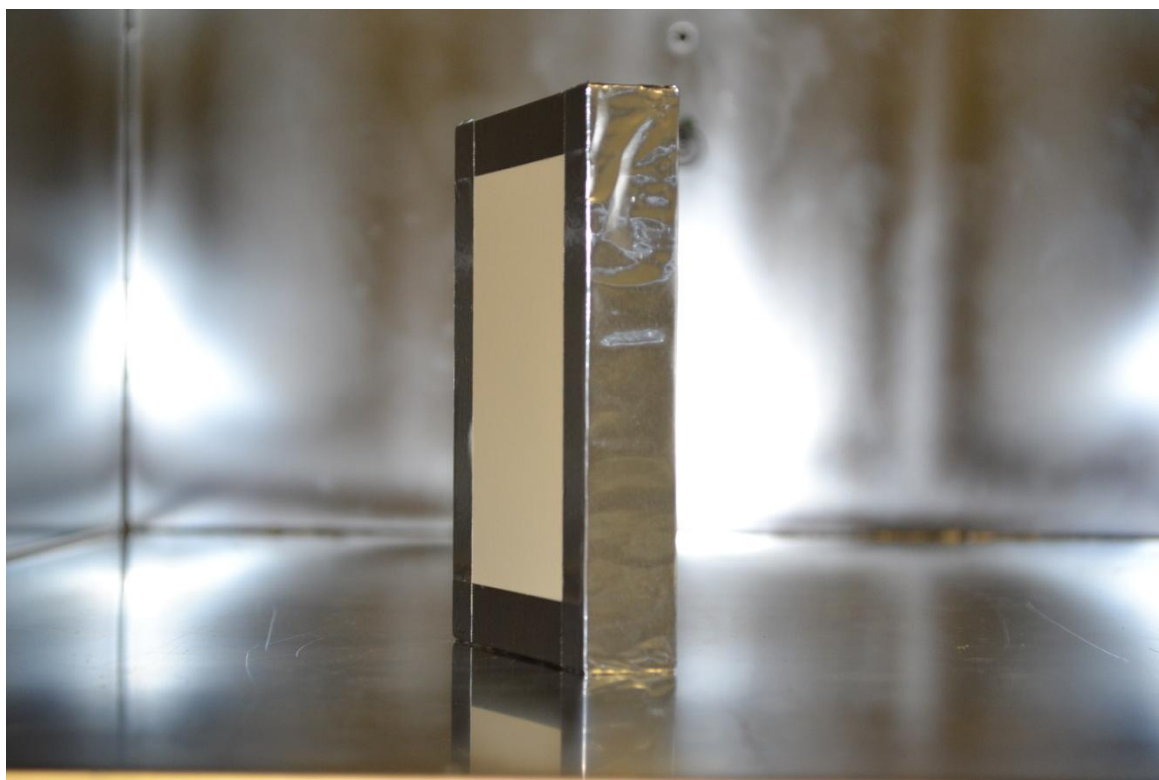
Procedure	External Method	Internal S.O.P.	Quantification limit	Analytical principle	Uncertainty \pm [RSD(%)]
Sample preparation	ISO 16000-11:2006, EN16402:2013,	71M549810	-	-	-
VOC emission chamber testing	ISO 16000-9:2006, CEN/TS 16516:2013	71M549811	-	Chamber and air control	-
Sampling of VOC	ISO 16000-6:2011, CEN/TS 16516:2013	71M549812	5 L	Tenax TA	-
Analysis of VOC	ISO 16000-6:2011, CEN/TS 16516:2013	71M542808B	1 $\mu\text{g}/\text{m}^3$	ATD-GC/MS	10%
Sampling of aldehydes	ISO 16000-3:2011, CEN/TS 16516:2013	71M549812	35 L	DNPH	-
Analysis of aldehydes	ISO 16000-3:2011, EN 717-1, CEN/TS 16516:2013	71M548400	3-6 $\mu\text{g}/\text{m}^3$	HPLC-UV	10%

5 Test Parameters and Sample Preparation

5.1 VOC Emission Chamber Test Parameters

Parameter	Value	Parameter	Value
Chamber volume, V[L]	119 or 3000	Preconditioning period	-
Air Change rate, $n[h^{-1}]$	0.5	Test period	2016
Relative humidity of supply air, RH [%]	50 ± 3	Area specific ventilation rate, q [m/h or m ³ /m ² /h]	5 or 1.25 or unit loading
Temperature of supply air, T [°C]	23 ± 1	Loading factor [m ² /m ³]	0.1 or 0.4 or unit loading

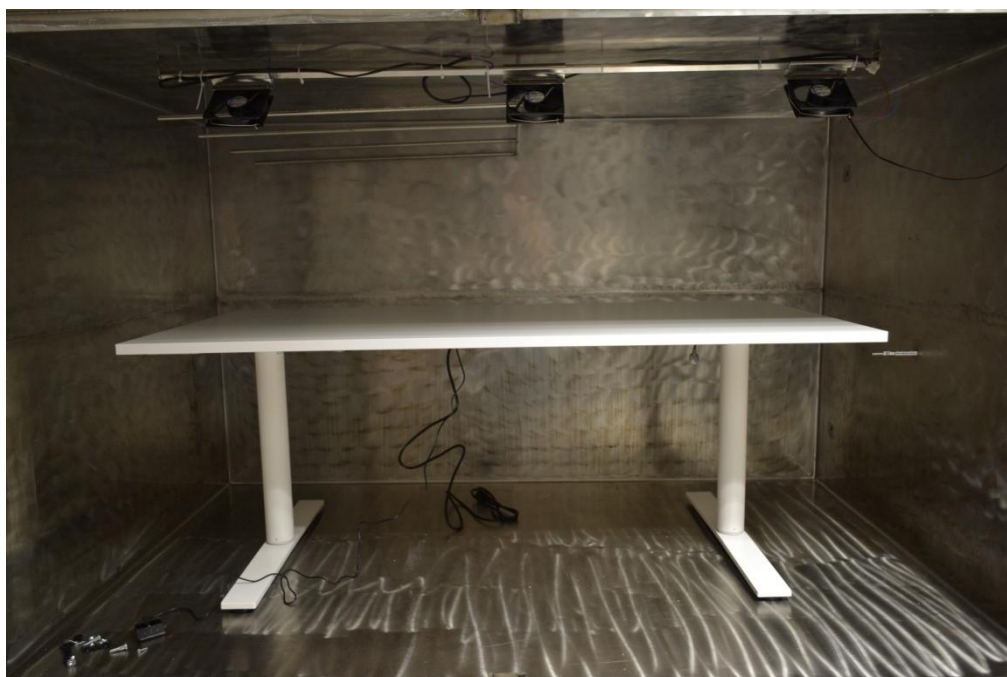
5.2 Example of Picture of Sample (392-2016-00175501)



5.3 Example of Picture of Sample (392-2016-00202102)



5.4 Example of Picture of Sample (392-2016-00472303)



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392-2016-00467700

Page 5 of 8

6 Analytical Results

There detected results after 3 days have been listed in table 2 here below. For more information regarding the specific testing, please see the individual test report.

Sample Number	Material	Colour	3d TVOC $\mu\text{g}/\text{m}^3$	3 day FA $\mu\text{g}/\text{m}^3$	Chamber size m^3	Loading factor m^2/m^3
392-2016-00175501	MFC	White	7.2	< 3	0.12	0.1
392-2016-00175502	HPL	White	25	8.4	0.12	0.1
392-2016-00175503	Veneer	Beech	4.3	7.3	0.12	0.1
392-2016-00175504	MFC	Light Grey	2.7	< 3	0.12	0.1
392-2016-00202101	PCM	Silver Grey	< 2	< 3	0.12	0.4
392-2016-00202102	PCM	Black	< 2	< 3	0.12	0.4
392-2016-00202103	PCM	White	< 2	< 3	0.12	0.4
392-2016-00472303 (Oberon)	Complete Table	White top / White legs	< 5	3.7	3	1 unit

Table 2: Results from the testing of the various components and the complete table. TVOC is the total of volatile components measured (VOC) and FA is an abbreviation for formaldehyde emissions.

7 Evaluation of VOC emission

The VOC and formaldehyde emissions were in general low from both the individual components and the finished table.

There was detected formaldehyde emission from both HPL and Veneer table tops tested worst case with a loading of $0.1 \text{ m}^2/\text{m}^2$, which is equivalent of $\frac{1}{4}$ of the floor area in the European reference room. The measured emission from the complete table of formaldehyde was lower because one table was calculated into the reference room, which is a smaller loading.

The VOC emissions from the HPL was worst case table top material, and the main components measured were hexanal and pinene in concentrations around $5 \mu\text{g}/\text{m}^3$. There was not detected any VOC emission from the complete table in the measurement after 3 days (calculated as 1 table in the European reference room).

The ANSI/BIFMA measurement of the complete table shows an extrapolated results after 14 days in the office room as being a TVOC of $3.6 \mu\text{g}/\text{m}^3$, and the only component with defined CREL was phenol in a concentration of $0.5 \mu\text{g}/\text{m}^3$ which is 100 times below the limit value. Formaldehyde was present in the office after 14 days at $3.6 \mu\text{g}/\text{m}^3$ which is below the defined limit value in ANSI/BIFMA.

The complete table also passes both Indoor Air Comfort GOLD and M1 limit values.

7.1 Comparison with Limit Values of ANSI/BIFMA (392-2016-00472303 (Oberon))

Parameter	Results after 7 days	
	Concentration mg/m ³	Limit values Systems Furniture mg/m ³
TVOC	0.066	< 0.5
Formaldehyde	36 ppb	< 50 ppb
Total aldehydes (other)	6.6 ppb	< 100 ppb
4-Phenylcyclohexene	< 0.002	< 0.0065
Individual compounds with CHREL-value after 14 days	complies	

7.2 Comparison with Limit Values of Indoor Air Comfort GOLD® (392-2016-00472303 (Oberon))

	Test after 3 days		Test after 28 days	
	Concentration µg/m ³	Limit value µg/m ³	Concentration µg/m ³	Limit value µg/m ³
TVOC (CEN/TS 16516)	< 5	≤ 1000	< 5	≤ 100
TSVOC	< 5	-	< 5	≤ 50
R _D -value (NIK) (dimensionless)	0.037	-	0.031	≤ 1
R _B -value (LCI) (dimensionless)	0.037	-	0.031	≤ 1
Total VOC without NIK or CLI	< 5	-	< 5	≤ 40
Total Carcinogens	< 1	≤ 10	-	-
Any individual carcinogens	-	-	< 1	≤ 1
CMR Substances (according to French CMR regulation)	-	-	< 1	≤ 1
Formaldehyde	3.7	-	3.1	≤ 10
Acetaldehyde	< 3	-	< 3	≤ 200

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7.3 Comparison with M1 Limit Values (392-2016-00472303 (Oberon))

Parameter	Area specific emission rate mg/(m ² h)	Limit Value mg/(m ² h)
TVOC	0.022	≤ 0.2
Formaldehyde	0.038	≤ 0.05
Ammonia	< 0.02	≤ 0.03
Total carcinogens	< 0.002	≤ 0.005
Odour	0.4	≥ 0.0