

Test Report

Report No.: 890653-1-AB

Assignor:

Gregersensvej DK-2630 Taastrup Tel. +45 72 20 20 00 Fax +45 72 20 20 19

info@teknologisk.dk www.teknologisk.dk

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Material: FORM armchair. Sample information is given in Appendix 1.

Normann Copenhagen ApS

Østerbrogade 70

Denmark

2100 Copenhagen

- **Sampling:** The test material was sampled by the assignor and received in cardboard at the Danish Technological Institute 2019-11-22.
- **Method:** ANSI/BIFMA M7.1-2011 (R2016) Standard test method for determining VOC emissions from office furniture systems, components and seating.

Details of test methods are shown in Appendix 2.

- Period: The testing was carried out from 2019-11-22 to 2020-01-28.
- **Result:** The estimated building concentrations (C_{bldg}) of the tested furniture and limit of indoor air concentrations after 7 days (168 hours) are shown in the following table:

	Tested Seating	Emissions Limits*
	C _{bldg}	Seating C _{bldg}
TVOC _(toluene) (mg/m ³)	0.05	≤ 0.25
Formaldehyde (ppb)	Not detected	≤ 25
Total aldehydes (ppb)	Not detected	≤ 50
4-Phenylcyclohexene (mg/m ³)	Not detected	≤ 0.00325

* ANSI/BIFMA M7.1 Table A1.1.

Detailed results for emissions are shown in Appendix 3. Estimated building concentrations are shown in Appendix 4. The estimated building concentrations are below the allowable limits; hence the tested furniture is low-emitting according to LEED v4 for Interior Design and Construction, January 5, 2018.

- **Storage:** The test material will be picked up by the assignor after testing unless otherwise agreed.
- **Terms:** Accredited testing was carried out in compliance with international requirements (EN/ISO/IEC 17025:2005) and in compliance with Danish Technological Institute's General Terms and Conditions regarding Commissioned Work accepted by Danish Technological Institute. The test results apply to the tested products only. This report may be quoted in extract only if the laboratory has granted its written consent.

Date/place: 2020-01-28, Danish Technological Institute, Taastrup, Building and Construction

Digitally signed by: Helene Bendstrup Klinke Ph.-Direct: +45 72202173 E-mail: hbk@teknologisk.dk *Digitally signed by:* Johan Stefan Leitet Ph.-Direct: +45 72201292 E-mail: jle@teknologisk.dk

Signature:

Test responsible

Co-signatory



DANISH TECHNOLOGICAL

Sample information

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Material information given by assignor:

Chain of Custody form (CoC) ANSI BIFMA / CDPH 01350



Gegetsensvej DK 2600 Talstrup Tel. +45 72 20 20 00 Fan. +45 72 20 20 19

wieOtek nalogek zk www.teknologisk.ck

Company	Normann Copenhagen ApS	
Address	Østerbrogade 70, 2100 Copenhagen	
Country	Denmark	
Contact name	Søren Stryhn-Petersen	
Contact title	СТО	
Phone	+45 22844421	
E-mail	ssp@normann-copenhagen.com	

oumpie decimo	
Sample ID	FORM armchair, full upholstery with Oak legs. Fabric – Main Line flax 22 from Camira, Westminster blue.
Product category	Dining chairs and bar stools
Product name	FORM series & HYG series (dining and bar)
Manufacturers ID. no.	
Date manufactured	November 4th. 2019
Sample collection	Taken directly from manufacturer
Samples collection time and date	Shipped from manufacturer, production date – Nov. 4 ^{th.}
Sample collected by	
Number of sample pieces	1 pc. FORM armchair
Disposal of sample material after test:	□Scrap/discard Storage and pick-up

Shipping details Packed by Søren Stryhn-Petersen Shipping date November 14th 2019 Carrier Søren Stryhn-Petersen Air bill number Road delivery

IMPORTANT:

Please wrap samples in airtight plastic in protective cardboard box/pallet and enclose this chain of custody form.

Please send the sample to:

Danish Technological Institute Gregersensvej, Port 3K DK-2630 Taastrup Attn. Helene Bendstrup Klinke – Phone + 4572202173

Send electronic copy of test order form to: E-lab@dti.dk

Test laboratory			
Reception date & initials	2019/11/4 /	MHON	
Laboratory ID	890653-1		



Sample information

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normann

COPENHAGEN

Appendix 1 - ANSI BIFMA/CDPH 01350

November 5th. 2019

The test sample represents the following furniture with the following materials:

- 1) FORM seating series Dining chairs and bar stools
- 2) HYG seating series Dining chairs and bar stools

The FORM series comes in following versions.

FORM open (no armrest), with armrest and Bar-stool.



FORM chair series can be delivered with legs made of:

- Steel with powder coating
- Steel with Chrome
- Steel with PVD coating
- Solid oak wood
- Solid walnut wood
- Swivel legs in aluminium



Sample information

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The HYG series comes in following versions.

HYG dining and HYG bar-stool.



HYG chair series can be delivered with legs made of:

- Steel with powder coating
- Steel with Chrome
- Steel with PVD coating
- Solid oak wood
- Solid walnut wood
- Swivel legs in aluminium

All FORM and HYG chairs can be delivered as upholstery version. The upholstery version will consist of following materials:

- PP (Polypropylene) shell
- Fabric or leather
- Low emission HR or CMHR foam

Emission Testing

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Chamber testing:

The test material was unwrapped and placed in the chamber.

Photo of test material in the chamber:



Climate chamber Temperature Relative humidity Air velocity at the surface of the specimen Air change rate (n) Area change flow rate 24 m³ Polished stainless steel 23°C \pm 1°C 50% RH \pm 5% RH 0.1 – 0.3 m/s 0.52 h⁻¹ \pm 0.05 h⁻¹ 12.4 m³/h

The test material was tested in the emission chamber without prior conditioning.

The chamber testing was carried out from 2019-11-22 to 2019-11-29.

Air samples were taken from the climate chamber outlet air with calibrated pumps according to ISO 16000-6 on Tenax tubes (3 L and 4 L) and ISO 16000-3 on DNPH tubes (60 L)

Results Emissions

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The concentration approach was applied for emission testing.

The measured chamber concentrations are shown in Tables 1 and 2.

Results from the VOC analysis are shown in Table 1.

Method: 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/FID.

Analysis of the air sampled on Tenax was performed at the Wilhelm Klauditz Institut (WKI) under DAkkS accreditation number D-PL-11140-05-02. Report no. MAIC-2020-4749.

Table 1: Emission of volatile organic compounds (VOCs) between n-C6 and n-C16 measured by GC-MS $(\mu g/m^3)^*$

	72 hrs (3 days)				168 hrs (7 days)			
Chemical class/compound name	#1	#2	Mean	% diff	#1	#2	Mean	% diff
Aromatic hydrocarbons	< 2	< 2	< 2	0	< 2	< 2	< 2	0
Aliphatic hydrocarbons	< 2	< 2	< 2	0	< 2	< 2	< 2	0
Cycloalkanes	< 2	< 2	< 2	0	< 2	< 2	< 2	0
Terpenes								
Terpene (Toluene)	2	2	2	0	< 2	< 2	< 2	0
Terpene (Toluene)	3	3	3	0	< 2	< 2	< 2	0
Alcohols	< 2	< 2	< 2	0	< 2	< 2	< 2	0
Glycols/Glycol ethers	< 2	< 2	< 2	0	< 2	< 2	< 2	0
Aldehydes								
n-Decanal	2	< 2	< 2	>100	< 2	< 2	< 2	0
Ketones	< 2	< 2	< 2	0	< 2	< 2	< 2	0
Halocarbons	< 2	< 2	< 2	0	< 2	< 2	< 2	0
Acids								
Acetic acid	< 2	4	2	>100	< 2	< 2	< 2	0
2-Ethylhexanoic acid	3	2	2.5	40	< 2	2	< 2	>100
Esters								
n-Butyl acetate	3	< 2	1.5	>100	< 2	< 2	< 2	0
Benzoic acid, ester (Toluene)	2	< 2	< 2	>100	< 2	< 2	< 2	0
Others								
Hexamethylcyclotrisiloxane	4	4	4	0	< 2	4	2	>100
Butyrolactone	6	2	4	100	< 2	2	< 2	>100
2,5-Di-tert-butyl-1,4-benzoquinone (Toluene)	2	< 2	< 2	>100	< 2	< 2	< 2	0
Sums								
TVOC Toluene (ISO 16000-6)	161	141	151	13.2	90	120	105	28.6
Sum VOC (C6-C16)	27	17	22	45.5	< 2	8	4	>100

* Single substances/volatile compounds were quantified with pure reference standards, and in some cases the substances shown in subscript were used for the quantification.

< 2 Not found above reporting limit 2 µg/m³ Measured concentrations just above limit of quantification (LOQ) of approx. 1 µg/m³ result in higher standard deviation from mean value.

Results Emissions

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Definitions according to ISO 16000-6:

VOC (C6-C16):Volatile organic compounds, between hexane (C6) and hexadecane (C16)VVOC (<C6):</td>Very volatile organic compounds, eluting before hexane, not included in TVOCSVOC (>C16):Semi-volatile organic compounds, eluting after hexadecane, not included in TVOCTVOC:Total volatile organic compounds is the sum of all VOCs eluting between C6 and C16, quantified as toluene equivalents.

Results from aldehyde analysis are shown in Table 2.

Method: ISO 16000-3: 2011. Indoor Air – Part 3: Determination of formaldehyde and other carbonyl compounds – Active sampling method.

Analysis of the air sampled on DNPH was performed at the Danish Technological Institute under DANAK accreditation number 90. Report no. 905469.

Table 2: Emission of lower aldel	ydes (C1-C4)	by HPLC analysis	$(\mu g/m^3)$
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	72 hrs (3 days)			168 hrs (7 days)				
Compound name	#1	#2	Mean	% diff	#1	#2	Mean	% diff
Formaldehyde	< 2	< 2	< 2	0	< 2	< 2	< 2	0
Acetaldehyde	< 2	< 2	< 2	0	< 2	< 2	< 2	0
Propanal	< 2	< 2	< 2	0	< 2	< 2	< 2	0
Butanal	< 2	< 2	< 2	0	< 2	< 2	< 2	0
Acrolein	< 3	< 3	< 3	0	< 3	< 3	< 3	0

< 2 Not found above reporting limit 2 μ g/m³

Limit of detection (LOD) is 0.5 μ g/m³ (formaldehyde, acetaldehyde, butanal), 0.8 μ g/m³ (propanal) and 3.3 μ g/m³ (acrolein).

Measured concentrations just above limit of quantification (LOQ) result in higher standard deviation from mean value

Building Concentration

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Estimated indoor air concentrations in a building

The tested furniture is seating, hence the measured concentrations from chamber testing must be adjusted to a standard office scenario using the default ventilation rate of per seating unit: $Q=24.8 \text{ m}^3/\text{h}$.

According to Table 11.1 (ANSI/BIFMA M7.1) the standard office environment parameter "modelled air flow (Q)" for seating is 24.8 m³/h for both open plan working stations and private office work stations.

The chamber ventilation rate was $Q_{chamber} = 12.4 \text{ m}^3/\text{h}$, hence the measured chamber concentrations ($C_{chamber}$) in Tables 1 and 2 must be multiplied by a factor:

Q_{chamber}=12.4 m³/h

 $Q_{bldg} = 24.8 \text{ m}^3/\text{h}$

 $C_{bldg} \times Q_{bldg} = C_{chamber} \times Q_{chamber}$

 $C_{bldg} = \frac{12.4 \text{ m3/h}}{24.8 \text{ m3/h}} \text{ x } C_{chamber} = 0.50 \text{ x } C_{chamber}$

Estimated building concentrations are shown in Tables 4 and 5.

The building concentrations after 14 days (336 h) were calculated from the emission factors after 3 days (72 h) and 7 days (168 h) by the power-of-law model according to the formulas given in ANSI/BIFMA M7.1 chapter 11.2.

The estimated building concentrations were calculated, and results are shown in Tables 3 and 4.

Table 3: Estimated building concentrations C_{bldg} of volatile organic compounds (VOCs) between n-C6 and n-C16 measured by GC-MS (μ g/m³)

Chemical class/compound name		7	14
	days	days	days
Aromatic hydrocarbons	-	-	-
Aliphatic hydrocarbons	-	-	-
Cycloalkanes	-	-	-
Terpenes			
Terpene (Toluene)	1.0	-	-
Terpene (Toluene)	1.5	-	-
Alcohols	-	-	-
Glycols/Glycol ethers	-	-	-
Aldehydes			
n-Decanal	0.5	-	-
Ketones	-	-	-
Halocarbons	-	-	-
Acids			
Acetic acid	1.0	-	-
2-Ethylhexanoic acid	1.3	0.5	0.2
Esters			
n-Butyl acetate	0.8	-	-
Benzoic acid, ester (Toluene)	0.5	-	-
Others			
Hexamethylcyclotrisiloxane	2.0	1.0	0.6
Butyrolactone	2.0	0.5	0.2
2,5-Di-tert-butyl-1,4-benzoquinone (Toluene)	0.5	-	-
Sums			
TVOC Toluene (ISO 16000-6)	75.5	52.5	39.0
Sum VOC (C6-C16)	11.0	2.0	0.5

Building Concentration

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- Not detected

< 0.1 Not found above reporting limit 0.1 μ g/m³

Table 4: Estimated building concentrations C_{bldg} of lower aldehydes (C1-C4) by HPLC analysis (ppb)

Compound name	3 days	7 days	14 days
Formaldehyde	-	-	-
Acetaldehyde	-	-	-
Propanal	-	-	-
Butanal	-	-	-
Acrolein	-	-	-

- Not detected

< 0.1 Not found above reporting limit 0.1 μ g/m³

According to ANSI/BIFMA M7.1 Table A1.1 and ANSI/BIFMA X7.1 Standard for Formaldehyde and TVOC Emissions from Low-emitting Office Furniture and Seating Table A1.1, the evaluation of indoor air concentrations from furniture in a building must meet the criteria limits for giving LEED EQ Credit 4.5 Low-Emitting Materials, Systems Furniture and Seating. The results are shown in Table 5.

Higher aldehydes analysed by GC-MS VOC analysis (Table 3) were converted to ppm and included in the sum of total aldehydes (Table 5).

Table 5: Estimated building concentrations of tested furniture and limit of indoor airconcentrations after 7 days.

	Tested Seating	Emissions Limits*
	C _{bldg}	Seating C _{bldg}
TVOC _(toluene) (mg/m ³)	0.05	≤ 0.25
Formaldehyde (ppb)	-	≤ 25
Total aldehydes (ppb)	-	≤ 50
4-Phenylcyclohexene (mg/m ³)	-	≤ 0.00325

* ANSI/BIFMA M7.1 Table A1.1.

The building concentrations are below the maximum allowable limit after 7 days, and hence is low emitting furniture and compliant with LEED v4 for interior design and construction.

The estimated building concentrations according to the above ANSI/BIFMA office furniture calculations of volatile compounds in air after 3, 7 and 14 days, respectively are shown Table 6 with reference to CDPH 01350 table 4-1, where the allowable concentration limit CREL (Chronic Reference Exposure Level) are stated for evaluation of the 14 days (336 hrs) building concentrations.

Note: CDPH01350 evaluation is only relevant for classroom furniture according to LEED v4.

Building Concentration

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Table 6: Estimated building concentrations of tested furniture at 3, 7 and 14 days of target CREL VOCs from Proposition 65 and Table 4-1 in CDPH 01350*.

Compound Name	CAS No.	C (3 d)	C (7 d)	C (14 d)	Allowable C _(14 d) **
		(µg/m³)	(µg/m³)	(µg/m³)	(µg/m³)
Acetaldehyde	000075-07-0	-	-	-	70
Benzene	000071-43-2	-	-	-	1.5
Carbon disulfide	000075-15-0	-	-	-	400
Carbon tetrachloride	000056-23-5	-	-	-	20
Chlorobenzene	000108-90-7	-	-	-	500
Chloroform	000067-66-3	-	-	-	150
Dichlorobenzene (1.4-)	000106-46-7	-	-	-	400
Dichloroethylene (1.1)	000075-35-4	-	-	-	35
Dimethylformamide (N.N-)	000068-12-2	-	-	-	40
Dioxane (1.4-)	000123-91-1	-	-	-	1500
Epichlorohydrin	000106-89-8	-	-	-	1.5
Ethylbenzene	000100-41-4	-	-	-	1000
Ethylene glycol	000107-21-1	-	-	-	200
Ethylene glycol monoethyl ether	000110-80-5	-	-	-	35
Ethylene glycol monoethyl ether acetate	000111-15-9	-	-	_	150
Ethylene glycol monomethyl ether	000109-86-4	-	-	_	30
Ethylene glycol monomethyl ether acetate	000110-49-6	-	-	-	45
Formaldehyde	000050-00-0	-	-	-	9
Hexane (n-)	000110-54-3	-	-	-	3500
Isophorone	000078-59-1	-	-	-	1000
Isopropanol	000067-63-0	-	-	-	3500
Methyl chloroform	000071-55-6	-	-	-	500
Methylene chloride	001634-04-4	-	-	-	200
Methyl t-butyl ether	000075-09-2	-	-	-	4000
Naphthalene	000091-20-3	-	-	-	4.5
Phenol	000108-95-2	-	-	-	100
Propylene glycol monomethyl ether	000107-98-2	-	-	-	3500
Styrene	000100-42-5	-	-	-	450
Tetrachloroethylene	000127-18-4	-	-	-	17.5
Toluene	000108-88-3	-	-	-	150
Trichloroethylene	000079-01-6	-	-	-	300
Vinyl acetate	000108-05-4	-	-	_	100
	000106-42-3	-	-	_	
xyienes, technical mixture	000108-38-3	-	-	_	350
(0.111.P)	000095-47-6	-	-	-	

- Not detected

*CDPH 01350 (2017) Standard method for the testing and evaluation of volatile organic chemical emissions from indoor sources using environmental chambers. Version 1.2.

**All maximum allowable concentrations are one-half the corresponding CREL adopted by Office of Environmental Health Hazard Assessment (OEHHA) agency of California Environmental Protection Agency (CalEPA).

Results from Table 6 show the building concentrations of target CREL VOCs are below the maximum allowable limit after 14 days.