STANDARD METHOD FOR THE TESTING AND EVALUATION OF VOLATILE ORGANIC CHEMICAL (VOC) EMISSIONS FROM INDOOR SOURCES USING ENVIRONMENTAL CHAMBERS VERSION 1.2-CALIFORNIA DEPARTMENT OF PUBLIC HEALTH (CDPH)

(Emission testing method for California Specification 01350)

Laboratory Report

1. Introduction

Middle East Testing Laboratory L.L.C (METS) were contacted by Berger Paints Emirates Ltd co (LLC) and requested to perform 14 days emission test as per CDPH Method.

Client	: Berger Paints Emirates Ltd co (LLC) Al Qouz Indl Area-1, Opp TCTI factory, P O Box: 27524 - Dubai, UAE
Report No	: MR-171024-320
Reporting Date	: 01/11/2024
Tested by	: SH
Date of Analysis	: 17/10/2024-01/11/2024
Issue No	: 01 (Re-Issue Date: NA)

2. Sample Information

Sample Description : Apcoflor HFP 120

3. Brief Evaluation of the Results:

	TVOC and Individual VOC's of Concern		Formaldehyde	
	Criterion	Compliance	Criterion	Compliance
MS-171024-323	TVOC: <0.5 mg/m^3	**PASS**	≤9.0µg/m^3	**PASS**
	Individual VOC: < Limit	**PASS**		

Details furnished in following pages

Prepared by

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4. Test Method

Standard Method for the Testing and Evaluation of VOC Emissions from Indoor Sources using Environmental Chambers, version 1.2 of January 2017 by the California Department of Public Health (CDPH Method).

For evaluation of test results the principle of shared risk is applied, i.e., for a max limit, a result Less than or equal to the limit complies and a result Greater than the limit does not comply.

5. Sample Preparation

The Apcoflor HFP 120 was mixed vigorously until it is fully homogenous and 280grams of paint was coated on a steel plate which has an area of 0.36 m^2

6. Test Procedure

Principle: To determine the specific emission rates of VOC's emitted from the tested specimen. The test was conducted in a small-scale environmental chamber at specified constant conditions of temperature, relative humidity, ventilation rate and product loading factor. The chamber is considered to be a constantly stirred tank reactor. As the air in the chamber is fully mixed, VOC concentrations measured at the chamber exhaust represents the air concentrations in the chamber. From the airflow rate into the chamber, the VOC concentration, and the exposed surface area of the specimen, an area-specific emission rate or emission factor is calculated using the steady-state form of the mass-balance model.

The specimens were placed in a separate conditioning container in a room with controlled climate conditions of temperature 23 ± 1°C and 50 ± 4 % RH. After 10 days ± 5 h of conditioning the specimens were placed in a 1 m^3 emission chamber of stainless steel. Air samplings, minimum duplicates, were carried out after 24, 48 and 96 hours in the chamber.

Conditions in the emission chamber

Chamber volume	: 1.0 m^3, stainless steel
Temperature	: 23 ± 1°C
Relative humidity	: 50 ± 4 % RH
Area of test specimen	: 0.36 m^2
Area specific air flow rate	: 2.0 m^3/m^2 h
Air exchange rate	: 1.0 h^{-1}
Air velocity at specimen surface	: 0.1 – 0.3 m/s

The air samples from the chamber were collected into a collection vessel containing sorbent materials. VOCs are determined by GC comparing the chromatographic retention time and mass spectrum of the unknown to the corresponding parameters for the pure compound analyzed on the same. Matching retention times and mass spectra provide positive, confirmed identifications.

The capillary column used is RXi-624 Sil MS – 30m x 0.32mm x 1.8µm. The mass/charge ratio is used for compound identification. The total volatile organic compounds (TVOC) mean compounds eluting between and including n-hexane to hexadecane, having boiling points in the range of about 60-250 °C. The emission rate of TVOC is quantified with known equivalent standard and includes all compounds ca ≥ 1 µg/m3 in the chamber. Minimum duplicate air samples were taken and the results are mean values. Sampled volumes are 3 to 8 L.

The samplings of formaldehyde and acetaldehyde were carried out with DNPH samplers. The samplers were analyzed 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 60 to 80 L.

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7. Results

The results in Table 1, 2 and 3 are expressed as concentrations in the test chamber and as area specific emission rates. Calculation of emission rate from chamber concentration:

$$SER_{I} = \frac{Conc\ X\ n}{L}$$

SER_I = area specific emission rate, in µg/m²h

Conc = concentration of a VOC in the chamber, in µg/m³

n = air exchange rate, in changes per hour

L = loading factor, in m²/m³ (area of sample/volume of chamber)

Test results of TVOC and formaldehyde after 24 hours and 48 hours

Table 1
Test results of Apcoflor HFP 120, after 24 h

Volatile organic compound	**CAS number**	**Retention time** (min)	**Concentration in the chamber** (µg/m3)	**Emission rate** (µg/m2h)
After 24 h:				
TVOC (C6 – C16)	--	5.9-40.1	< 20	< 50
Formaldehyde	50-00-0	--	< 1	< 1

Table 2
Test results of Apcoflor HFP 120, after 48 h

Volatile organic compound	**CAS number**	**Retention time** (min)	**Concentration in the chamber** (µg/m3)	**Emission rate** (µg/m2h)
After 48 h:				
TVOC (C6 – C16)	--	5.9-40.1	< 20	< 50
Formaldehyde	50-00-0	--	< 1	< 1

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Test results of TVOC and VOCs after 96 hours

Table 3
Test results of Apcoflor HFP 120, after 96 h

Volatile organic compound	**CAS number**	**Retention time** (min)	**Concentration in the chamber** (µg/m3)	**Emission rate** (µg/m2h)
TVOC (C6 – C16)	--	5.9-40.1	< 20	< 50
Identified substances:				
No substances identified	--	--	< 2	< 4
Volatile Carcinogens 1		5.9-40.1		
No substances identified	--	--	< 1	< 1
Substances outside TVOC:				
VVOC (< C6)		4.5 – 6.2		
No substances identified	--	--	< 2	< 4
SVOC (C16 – C22)		37.9 - 50.0		
No substances identified	--	--	< 2	< 4
Formaldehyde	50-00-0	--	< 1	< 1
Acetaldehyde	75-07-0	--	< 1	< 1

[1)] Volatile carcinogens = VOCs according to EU Regulation No 1272/2008 Annex VI, cat 1A and 1B

The emission results in Table 4 are expressed as area emission rates (in µg/m2h) and as concentrations in a standard private office and in a standard school classroom (in µg/m3). Calculation of concentration of VOC in the standard private office from emission rate:

$$C = (SER \times A) \div (n \times V)$$

C = concentration of VOC in the private office, in µg/m^3
SERa= area specific emission rate of the tested product, in µg/m^{2}h
A = surface area of the tested product, in m, here 33.4 m, (wall area)
n = air ventilation rate, in changes per hour, here 0.68 h-1
V = volume of a private office in m3, here 30.6 m3

In the standard private office, the floor area is 11.1 m2, the wall area is 33.4 m2, door & other millwork 1.89 m2 and wall base area 1.27 m2. In a standard school classroom, the floor area is 89.2 m2, the wall area is 94.6 m2, wall base area 9.68 m2, air ventilation rate 0.82 h-1 and the volume of the room is 231 m3. Wall area is used for the calculations

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Test results of the estimated concentrations in a standard private office and a standard school classroom scenario according to the target VOCs according to one-half of the CREL list (compound 1-35) and non-listed compounds:

Table 4
Estimated concentrations in a standard private office and a standard school classroom

No	Volatile organic compound	CAS number	Emission rate (µg/m2h)	Concentration in private office (µg/m3)	Concentration in school classroom (µg/m3)
1.	Acetaldehyde	75-07-0	ND	< 3	< 1
2.	Benzene	71-43-2	ND	<0.3	<0.3
3.	Carbon disulfide	75-15-0	ND	< 3	< 1
4.	Carbon tetrachloride	56-23-5	ND	< 3	< 1
5.	Chlorobenzene	108-90-7	ND	< 3	< 1
6	Chloroform	67-66-3	ND	< 3	< 1
7.	Dichlorobenzene (1,4-)	106-46-7	ND	< 3	< 1
8.	Dichloroethylene (1,1)	75-35-4	ND	< 3	< 1
9.	Dimethylformamide (N, N-)	68-12-2	ND	< 3	< 1
10.	Dioxane (1,4-)	123-91-1	ND	< 3	< 1
11.	Epichlorohydrin	106-89-8	ND	< 3	< 1
12.	Ethylbenzene	100-41-4	ND	< 3	< 1
13.	Ethylene glycol	107-21-1	ND	< 3	< 1
14.	Ethylene glycol mono ethyl ether	110-80-5	ND	< 3	< 1
15.	Ethylene glycol mono ethyl ether	111-15-9	ND	< 3	< 1
16.	Ethylene glycol monomethyl ether	109-86-4	ND	< 3	< 1
17.	Ethylene glycol monomethyl ether	110-49-6	ND	< 3	< 1
18.	Formaldehyde	50-00-0	ND	< 3	< 1
19.	n-Hexane	110-54-3	ND	< 3	< 1
20.	Iso-phorone	78-59-1	ND	< 3	< 1
21.	Isopropanol	67-63-0	ND	< 3	< 1
22.	Methyl chloroform	71-55-6	ND	< 3	< 1
23.	Methylene chloride	75-09-2	ND	< 3	< 1
24.	Methyl t-butyl ether	1634-04-4	ND	< 3	< 1
25.	Naphthalene	91-20-3	ND	< 3	< 1

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Table 4 Cont.

No	Volatile organic compound	CAS number	Emission rate (µg/m2h)	Concentration in private office (µg/m3)	Concentration in school classroom (µg/m3)
26.	Phenol	108-95-2	ND	**< 3**	**< 1**
27.	Propylene glycol monomethyl ether	107-98-2	ND	**< 3**	**< 1**
28.	Styrene	100-42-5	ND	**< 3**	**< 1**
29.	Tetrachloroethylene	127-18-4	ND	**< 3**	**< 1**
30.	Toluene	108-88-3	ND	**< 3**	**< 1**
31.	Trichloroethylene	79-01-6	ND	**< 3**	**< 1**
32.	Vinyl acetate	108-05-4	ND	**< 3**	**< 1**
33-35	Xylenes (m-, o-, p-)	108-38-3, 95-47-6, 106-42-3	ND	**< 3**	**< 1**
	TVOC (C6 – C16)	-	< 20	< 30	< 10
	SVOC (C16 – C22)	-	<2	<3	<1

ND = not detected (detection limit is approx. 2 µg/m2h)

Evaluation of the test results

The tested product Apcoflor HFP 120 complies with the requirements of the Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources using Environmental Chambers, version 1.2, 2017, by the California Department of Public Health.

The test results can be used to evaluate compliance with the indoor air emission requirements of LEEDv4 and BREEAM International (2016 & 2021), see Table 5 and 6. The sample is evaluated as floor product.

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Table 5.
Standard private office: Compliance with LEED v4 and BREEAM International (2016 & 2021)

	Concentration in private office (mg/m3)	**Maximum allowable conc.** (mg/m3)	**PASS / FAIL**
LEEDv4			
TVOC	**<0.010**	0.5 mg/m3 or less	**PASS**
		between 0.5 and 5.0 mg/m3	-
		5.0 mg/m3 or more	**-**
Acetaldehyde	**< 0.003**	0.070	**PASS**
Formaldehyde	**< 0.003**	0.009	**PASS**
Single VOC compounds found with defined CREL:	ND	According to list of CREL (see App 3)	**PASS**
BREEAM International (2016 & 2021)			
TVOC	**<0.010**	1.0 (emission criteria)	**PASS**
		0.3 (exemplary level emission criteria)	**PASS**
SVOC	**< 0.003**	0.1 (exemplary level emission criteria)	**PASS**
Carc cat 1A+1B	**< 0.001**	0.001	**PASS**
Formaldehyde	**< 0.003**	0.06 (emission criteria)	**PASS**
		0.01 (exemplary level emission criteria)	**PASS**

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Table 6.
Standard school classroom: Compliance with LEED v4 and BREEAM International (2016 & 2021)

	Concentration in private office (mg/m3)	**Maximum allowable conc.** (mg/m3)	**PASS / FAIL**
LEEDv4			
TVOC	**<0.010**	0.5 mg/m3 or less	**PASS**
		between 0.5 and 5.0 mg/m3	-
		5.0 mg/m3 or more	**-**
Acetaldehyde	**< 0.001**	0.070	**PASS**
Formaldehyde	**< 0.001**	0.009	**PASS**
Single VOC compounds found with defined CREL:	ND	According to list of CREL (see App 3)	**PASS**
BREEAM International (2016 & 2021)			
TVOC	**<0.010**	1.0 (emission criteria)	**PASS**
		0.3 (exemplary level emission criteria)	**PASS**
SVOC	**<0.001**	0.1 (exemplary level emission criteria)	**PASS**
Carc cat 1A+1B	**< 0.001**	0.001	**PASS**
Formaldehyde	**< 0.001**	0.06 (emission criteria)	**PASS**

Appendices:

1. Target CREL VOCs and their maximum allowable concentrations

The above test report shall not be reproduced (except in full) without the written approval of METS. When analysis is witnessed by us or carried out by sub contract labs, our responsibility is solely to ensure that the analysis is conducted to standard test methods in accordance with industry accepted practice.

For further clarification of reports, please contact qc@metslab.com

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APPENDIX I

Sl. No	Volatile organic compound	CAS number	Maximum allowable conc. (µg/m3)
1.	Acetaldehyde	75-07-0	**70**
2.	Benzene	71-43-2	**0.3**
3.	Carbon disulfide	75-15-0	**400**
4.	Carbon tetrachloride	56-23-5	**20**
5.	Chlorobenzene	108-90-7	**500**
6.	Chloroform	67-66-3	**150**
7.	Dichlorobenzene (1,4-)	106-46-7	**400**
8.	Dichloroethylene (1,1)	75-35-4	**35**
9.	Dimethylformamide (N, N-)	68-12-2	**40**
10.	Dioxane (1,4-)	123-91-1	**1500**
11.	Epichlorohydrin	106-89-8	**1.5**
12.	Ethylbenzene	100-41-4	**1000**
13.	Ethylene glycol	107-21-1	**200**
14.	Ethylene glycol mono ethyl ether	110-80-5	**35**
15.	Ethylene glycol mono ethyl ether acetate	111-15-9	**150**
16.	Ethylene glycol monomethyl ether	109-86-4	**30**
17.	Ethylene glycol monomethyl ether acetate	110-49-6	**45**
18.	Formaldehyde	50-00-0	**9**
19.	n-Hexane	110-54-3	**3500**
20.	Iso-phorone	78-59-1	**1000**
21.	Isopropanol	67-63-0	**3500**
22.	Methyl chloroform	71-55-6	**500**
23.	Methylene chloride	75-09-2	**200**
24.	Methyl t-butyl ether	1634-04-4	**4000**
25.	Naphthalene	91-20-3	**4.5**
26.	Phenol	108-95-2	**100**
27.	Propylene glycol monomethyl ether	107-98-2	**3500**
28.	Styrene	100-42-5	**450**
29.	Tetrachloroethylene	127-18-4	**17.5**
30.	Toluene	108-88-3	**150**
31.	Trichloroethylene	79-01-6	**300**
32.	Vinyl acetate	108-05-4	**100**
33-35	Xylenes (m-, o-, p-)	108-38-3, 95-47-6, 106-42-3	**350**

Target CREL VOCs and their maximum allowable concentrations.
Note: Traceability details of the sample not provided by client.
Test Location: Ajman

-End of Report-

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