

4701-022S-1A-RT

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PROJECT

**Indoor air quality evaluation following the requirements of
CDPH/EHLB/Standard Method V1.2
as written in Section 2 page 5 of NALFA UL 01-2015**

File # 4766-022S-1A-RT

Presented to:

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INTRODUCTION

Mr. Sennik from *DMX Plastics Limited* mandated the *CTT Group* to analyse their dimple sheet product to determine the volatile organic compounds (VOCs) for the NALFA UL 01-2015 specification. The specimens to be tested are shown in Figure 1.

The product was received by the CTT Group as packaged and shipped by the customer. The package was visually inspected and then stored in a controlled environment. Just prior to start testing, the product was unpackaged, sized for the required loading, and placed into a rack inside the environmental chamber. Immediately, the testing started according to the specified protocol.

Table 1 presents the general information of the sample.

Table 1 General information of the sample

Sample	DMX Dimple Sheet
Model	1-Step 2.0
Manufacturing date	December 9 th , 2019
Date received	December 11 th 2019
Test date	January 10 th , 2020 - January 24 th , 2020
Test Method	CDPH-CA Section 01350 Version 1.2

1. IDENTIFICATION OF SAMPLE

Figure 1 shows the photo of the specimens placed in two different extraction chambers for duplicate analysis.

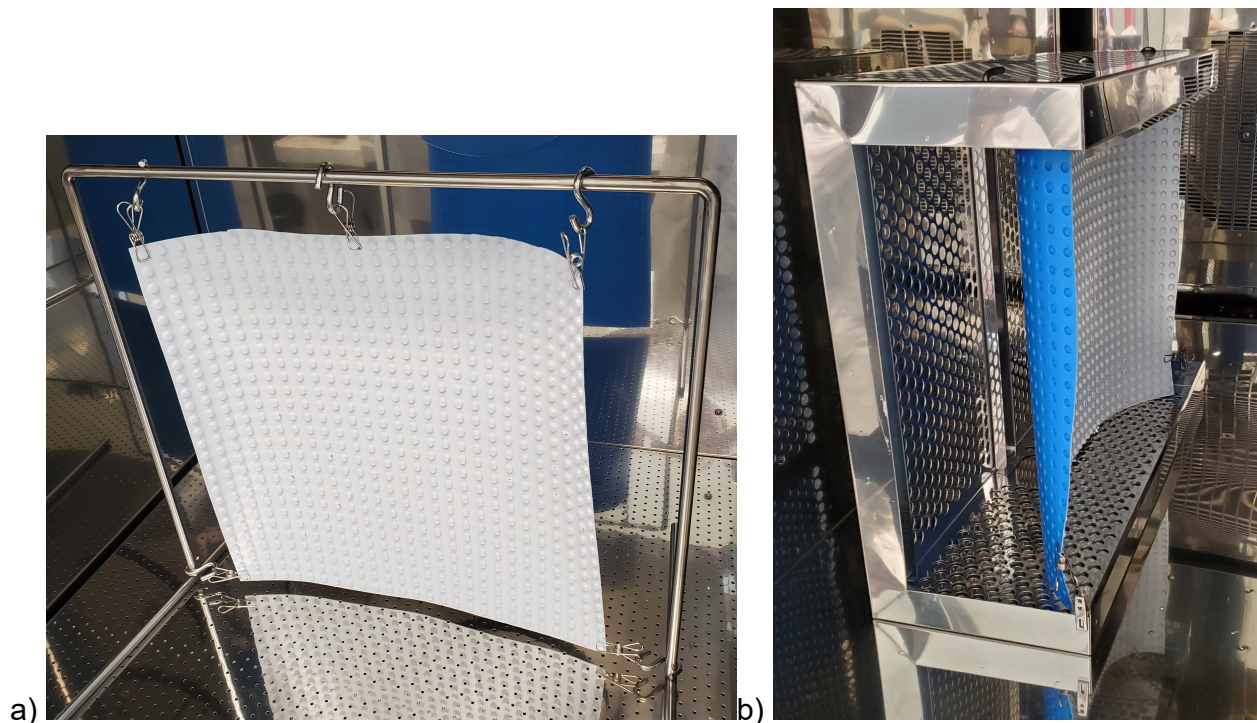


Figure 1: Photos of specimens in the environmental chambers; a) 0.722m³ chamber and b) 0.917 m³ chamber

2. CHARACTERIZATION METHODS

In order to evaluate the volatile organic compounds, the NALFA UL 01-2015 asks to follow the general guide ASTM D5116-17 *Standard Guide for Small-Scale Environmental Chamber Determinations of Organic Emissions from Indoor Materials/Products* for the equipment used. The test conditions are specified in the CDPH-CA Section 01350 Version 1.2: *Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources using Environmental Chambers*.

Accordingly, the specimens were placed in an environmental chamber in order for the volatile organic compounds (VOCs) to be extracted by air under controlled conditions of temperature, relative humidity, and airflow rate.

At specific intervals, the air carrying the VOCs was taken through a sampling port by using absorbent tubes. Subsequently, the absorbed VOCs were analysed by the chromatography technique. The table 2 shows the operating conditions of the extraction.

Table 2 Operating conditions of the extraction process

Sample		0.917m ² chamber	0.722m ² chamber
Product area exposed ¹ , m ²		0.700	0.499
Chamber volume, m ³		0.917	0.722
Product loading ratio ¹ , m ² /m ³		1.12	1.018
Test chamber conditions	Air exchange rate, h ⁻¹	1	1
	Inlet air flow rate, m ³ /h	0.917	0.722
	Temperature, °C	23 ± 1	23 ± 1
	Relative humidity, %	50 ± 5	50 ± 5

¹ As per client request, the product area exposed is calculated from area coverage and not actual exposed area. The product loading ratio is calculated with actual calculated value of area exposed.

3. RESULTS AND DISCUSSIONS

The samples were monitored for the emissions of total VOC (TVOC), individual VOC, formaldehyde and other aldehydes over the 336 hours test period.

The CDPH-CA Section 01350 test started by conditioning the samples for 10 days following by sampling at 24, 48 and 96 hours. The results were compared to 1/2 (one-half) the current Chronic Reference Exposure Levels (CRELs), as adopted from the California OEHHA list [1].

Table 3 shows the concentrations of individual VOC in comparison with the half of the regulated levels. Table 4 shows the TVOC and Formaldehyde concentration at the 24, 48, and 96 hours after 10 days of conditioning.

Since no compound was measured over the quantification level, the following tables asked by the method could not be produced. Those tables are the *“Ten most abundant VOCs and/or aldehydes at the 96 hours following 10 days of conditioning”* and *“Predicted air concentrations at 96 hours following 10 days of conditioning”*.

Table 3 Concentrations of individual regulated VOC at 96 hours following 10 days of conditioning

Comparison of data to method requirement at 96 hours following 10 days of conditioning					
Compound	CAS #	1/2 CREL (µg/m³)	Chamber concentration (µg/m³)	Emission factor (µg/m²*hr)⁺⁺	Meets 1/2 CREL? (Classroom/Office)
1,1,1-Trichloroethane	71-55-6	500	BQL	BQL	Yes
1,1-Dichloroethene	75-35-4	35	BQL	BQL	Yes
1,4-Dichlorobenzene	106-46-7	400	BQL	BQL	Yes
Acetaldehyde	75-07-0	70	BQL	BQL	Yes
Benzene	71-43-2	1.5	BQL	BQL	Yes
Carbon disulfide	75-15-0	400	BQL	BQL	Yes
Carbon tetrachloride	56-23-5	20	BQL	BQL	Yes
Chlorobenzene	108-90-7	500	BQL	BQL	Yes
Chloroform	67-66-3	150	BQL	BQL	Yes
Epichlorohydrin	106-89-8	1.5	BQL	BQL	Yes
Ethylbenzene	100-41-4	1000	BQL	BQL	Yes
Ethylene glycol	107-21-1	200	BQL	BQL	Yes
Ethylene glycol monoethyl ether	110-80-5	35	BQL	BQL	Yes
Ethylene glycol monomethyl ether	109-86-4	30	BQL	BQL	Yes
Ethylene glycol monomethyl ether acetate	110-49-6	45	BQL	BQL	Yes
Formaldehyde	50-00-0	9***	BQL	BQL	Yes
Glycol monoethyl ether acetate	111-15-9	150	BQL	BQL	Yes
Isophorone	78-59-1	1000	BQL	BQL	Yes
Isopropanol	67-63-0	3500	BQL	BQL	Yes
Methyl t-Butyl Ether	1634-04-4	4000	BQL	BQL	Yes
Methylene Chloride	75-09-2	200	BQL	BQL	Yes
N,N-Dimethylformamide	68-12-2	40	BQL	BQL	Yes
Naphthalene	91-20-3	4.5	BQL	BQL	Yes

n-Hexane	110-54-3	3500	BQL	BQL	Yes
p-Dioxane	123-91-1	1500	BQL	BQL	Yes
Phenol	108-95-2	100	BQL	BQL	Yes
Propylene glycol monomethyl ether	107-98-2	3500	BQL	BQL	Yes
Styrene	100-42-5	450	BQL	BQL	Yes
Tetrachloroethene	127-18-4	17.5	BQL	BQL	Yes
Toluene	108-88-3	150	BQL	BQL	Yes
Trichloroethylene	79-01-6	300	BQL	BQL	Yes
Vinyl acetate	108-05-4	100	BQL	BQL	Yes
Xylenes (m-, o-, p-)	1330-20-7	350	BQL	BQL	Yes

BQL denotes below quantifiable level of 2.0 µg/m³ at chamber concentration and 5µg/m²*hr for the emission factor.

*** Formaldehyde measurement is performed with the DNPH derivatization/HPLC-UV method. The guidance value is as per CA standard method.

** Emission factor is calculated from the chamber concentration (CC), the chamber air exchange rate (NC), the chamber volume (VC), and the product area exposed in the chamber (AC) as $EF = (CC*VC*NC)/AC$.

Table 4 TVOC and Formaldehyde chamber concentration and Emission factors at 24, 48, and 96 hours after 10 days of conditioning

Chamber concentration and Emission factors for TVOC and Formaldehyde at 24, 48, and 96 hours following 10 days of conditioning		
Elapsed Exposure hour after 10 days conditioning	Chamber Concentration (µg/m³)	Emission Factor (µg/m²*hr)
TVOC ⁺		
24	BQL	BQL
48	BQL	BQL
96	BQL	BQL
Formaldehyde		
24	BQL	BQL
48	BQL	BQL
96	BQL	BQL

⁺TVOC is defined as the sum of the VOCs that elute between the n-hexane (C₆) and n-hexadecane (C₁₆) on a non-polar capillary GC column quantified based on a toluene response factor.

4. CONCLUSION

DMX Plastics Limited mandated the *CTT Group* to analyse their dimple sheet identified as 1-Step 2.0.

The analysis was carried out for the specification NALFA UL 01-2015. The analytical method and specification levels used for the results were used from the CDPH-CA Section 01350 *Standard Method for the testing and Evaluation of Volatile Organic Chemical Emissions from indoor sources using Environmental chamber* Version 1.2 and OEHHA Acute, 8 hour and Chronic Reference Exposure Level (REL) (see references) with the guidance of ASTM D5116-17 *Standard Guide for Small-Scale Environmental Chamber Determinations of Organic Emissions from Indoor Materials/Products*.

The product is compliant to NALFA UL 01-2015 Section #2 Section #7, Indoor Air Quality (CA01350) as no VOC and/or aldehydes were detected over the quantification level.

5. REFERENCES

1. OEHHA Acute, 8-hour and Chronic Reference Exposure Level (REL) Summary

[HTTPS://OEHHA.CA.GOV/AIR/GENERAL-INFO/OEHHA-ACUTE-8-HOUR-AND-CHRONIC-REFERENCE-EXPOSURE-LEVEL-REL-SUMMARY](https://oehha.ca.gov/air/general-info/oehha-acute-8-hour-and-chronic-reference-exposure-level-rel-summary)

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