Electronic Supplementary Material (ESI) for Analytical Methods.

Supplementary Information for

On-site monitoring of occupational exposure to volatile organic compounds by a portable comprehensive 2-dimensional gas chromatography device

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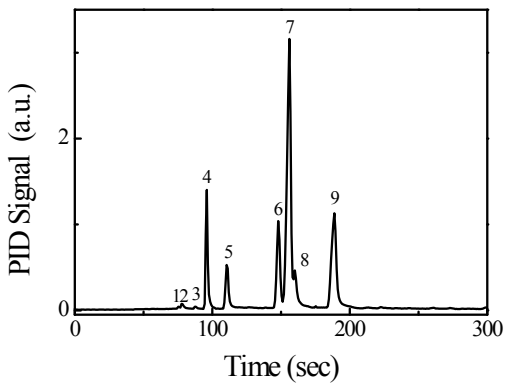

Figure S1 [1]D chromatogram recorded by μPID1 during spraying of Electrostatic semi-gloss enamel clear base V260-88 at Booth 2 (sampling 5 min).

Table S1 Comparison of Occupational Safety and Health Administration (OSHA) permissible exposure limits (PELs), National Institute for Occupational Safety and Health (NIOSH) recommended exposure limits (RELs), and American Conference of Governmental Industrial Hygienists (ACGIH) threshold limit values (TLVs). PELs are 8-hour time weighted averages (TWAs) unless otherwise indicated. (C): Ceiling limit, (STEL): Short Term Exposure Limit

Chemicals	**OSHA PEL**	**NIOSH REL**	**ACGIH TLV**	**Health Factors[1]**
Xylene	100 ppm 435 mg/m^3	100 ppm 435 mg/m^3 (STEL) 150 ppm 655 mg/m^3	100 ppm 435 mg/m^3 (STEL) 150 ppm 655 mg/m^3	Liver enlargement, narcosis, mild anemia, eye, nose, and throat irritation, reversible kidney, liver damage, dizziness, drowsiness
n-butylacetate	150 ppm 710 mg/m^3	150 ppm 710 mg/m^3 (STEL) 200 ppm 950 mg/m^3	50 ppm 236 mg/m^3 (STEL) 150 ppm 710 mg/m^3	Narcosis, eye and mucous membrane irritation, headache, dizziness, confusion,
t-butylacetate	200 ppm 950 mg/m^3	200 ppm 950 mg/m^3	50 ppm 236 mg/m^3 (STEL) 150 ppm 710 mg/m^3	Itching, inflamed eyes, irritated upper respiratory system, headaches, narcosis, dermatitis
Ethylbenzene	100 ppm 435 mg/m^3	100 ppm 435 mg/m^3 (STEL) 125 ppm 545 mg/m^3	20 ppm 87 mg/m^3	Eye, skin, and throat irritation, weakness, dizziness, drowsiness, unconsciousness, depression of the central nervous system, narcosis,

				edema, hemorrhage of lung tissue, hearing loss (cochlear impairment), kidney damage, upper respiratory tract irritation
n-butanol	100 ppm 300 mg/m^3	50 ppm 150 mg/m^3	20 ppm 60 mg/m^3	Eye, skin, nose, and upper respiratory irritation, corneal inflammation, blurred vision, Headache, dizziness, drowsiness
Toluene	200 ppm 750 mg/m^3 (C) 300 1125 mg/m^3	100 ppm 370 mg/m^3 (STEL) 150 ppm 562 mg/m^3	20 ppm 74 mg/m^3	Central nervous system depression, fatigue, headache, confusion, paresthesia, dizziness, muscular incoordination, irritation of the eyes, mucous membranes, upper respiratory tract, weakness, drowsiness, unconsciousness, female reproductive system damage, pregnancy loss
Isobutyl alcohol	100 ppm 300 mg/m^3	50 ppm 150 mg/m^3	50 ppm 150 mg/m^3	Eye, throat irritation, headaches, dizziness, drowsiness, eye redness, pain, blurred vision, skin irritation, cracking,

				dermatitis, nausea, vomiting, diarrhea
Methyl *n*-amyl ketone	100 ppm 465 mg/m^3	100 ppm 465 mg/m^3	50 ppm 232 mg/m^3	Narcosis, mucous membrane irritation, eye and skin irritation
2-propanol	400 ppm 980 mg/m^3	400 ppm 980 mg/m^3 (STEL) 500 ppm 1225 mg/m^3	200 ppm 491 mg/m^3 (STEL) 400 ppm 984 mg/m^3	Narcosis, mild eye, nose, and throat irritation, drowsiness, headache, incoordination, central nervous system effects (changes in postural sway)

Table S2 The most frequently used paint, sealer, top-coat, and primer at the Spray and Paint Shop of the University of Michigan.

	Type	**Product name**	**Manufacturer**	**Ingredients**
1	Enamel Paint	Electrostatic semi-gloss enamel clear base V260-88	Benjamin Moore & Co.	Limestone, Short oil alkyd resin, Xylene, *t*-butyl acetate, 2-pentanone, Kaolin, Ethylbenzene, 2-butoxyethanol, Methyl ethyl ketoxime
2	Clear Sealer	Level sealer C117 029	M. L. Campbell	*n*-butylacetate, Polyester, Butylated melamine-formaldehyde polymer, 2-methyl-1-propanol, Ethanol, *n*-butanol, Methyl *n*-Amyl ketone, 2-propanol, ethylbenzene
3	Clear Top-coat	Magnamax C148 14 Satin-35	M. L. Campbell	n-butyl acetate, Soya alkyd polymer, Ethanol, Cellulose nitrate, 2-propanol, *n*-butanol, Ethyl acetate, Acetone, 1-methoxy-2-propanol acetate, 2-methyl-1-propanol
4	Top-coat + Sealer	Magavar 1M.4304 Satin	Benjamin Moore & Co.	n-butyl acetate, Alkyd resin, Butylated urea-formaldehyde resin, Isobutyl alcohol, Ethanol, Methoxyisopropyl acetate, Acetone, VM&P naphtha, Toluene, Isopropyl alcohol, Methyl ethyl ketoxime, 2-butoxyethanol
5	Metal primer	Kem Kromik Universal Metal Primer B50NZ6	The Sherwin-Williams Co.	Calcium carbonate, Ceramic, Alkyd polymer, Xylene, Calcium borosilicate, Iron oxide, 1,2,4-trimethylbenzene, Toluene, Talc, 1,3,5-triethylbenzene, Ethylbenzene Light aromatic hydrocarbons

Table S3 List of VOCs detected during spraying Paint 1, 2, 3, 4, and 5

VOCs	**Paint 1**	**Paint 2**	**Paint 3**	**Paint 4 and 5**
1	Methyl ethyl ketone	2-propanol	Unknown	Isobutylalcohol
2	Unknown	Isobutanol	2-propanol	Unknown
3	Methyl propyl ketone	*n*-butanol	Ethylacetate	*n*-butylacetate
4	*t*-butylacetate	Methyl isobutyl ketone	*n*-butanol	Methyl propyl ketone
5	Toluene	Toluene	Unknown	Ethylbenzene
6	Ethylbenzene	*n*-butylacetate	Toluene	*m*-xylene
7	*m*-xylene	Ethylbenzene	*n*-butylacetate	unknown
8	Unknown	*m*-xylene	Unknown	*o*-xylene
9	*o*-xylene	unknown	1-methoxy-2-propanol acetate	unknown
10		Methyl *n*-amyl ketone		1,3,5-trimethylbenzene
11		Unknown		1,2,4-trimethylbenzene
12		Ethyl-3-ethoxypropionate		unknown
13		1,2,4-trimethylbenzene		
14		unknown		

Table S4 Comparison of the concentration concentrations of (a) *n*-butyl acetate, (b) *n*-butanol, (c) methyl *n*-amyl ketone, and (d) isobutanol obtained with the portable 2-D GC device and charcoal tube/GC-MS by OSHA ORG-07 method during the first spraying, the first drying, the second spraying, the second drying and the third spraying of Level sealer C117 029, at 0, 20, 50, 70, and 130 min, respectively.

Chemicals	**Time (min)**	**2-D GC (mg/m^3)**	**Tube1/GC-MS (mg/m^3)** **Tube2/GC-MS (mg/m^3)**	**Averaged GC-MS (mg/m^3)**	**Difference (%)** **Difference (%)**	**Averaged difference (%)**
n-butyl acetate	0	207.6	330	293.4	-37.0	-29.2
			256.8		-19.1	
	20	26.5	21	21.8	26.2	21.6
			22.6		17.2	
	50	218.7	410	472.1	-46.6	-53.6
			534.2		-59.0	
	70	12.3	12	14.2	3.3	-12.8
			16.4		-24.5	
	130	211.2	180	233.8	17.3	-9.6
			287.6		-26.5	
Methyl *n*-amyl ketone	0	33.1	32	27.8	3.5	19.0
			23.6		40.1	
	20	4.55	4.1	4.0	11.0	12.3
			4.0		13.6	
	50	44.5	41	47.2	8.5	-5.7
			53.4		-16.6	
	70	2.4	3.4	3.7	-26.9	-32.9
			4.0		-37.9	
	130	22.7	15	17.7	51.8	28.1
			20.5		10.8	
n-butanol	0	113.9	140	118.8	-18.6	-4.1
			97.6		16.7	
	20	13.9	11	11.6	26.4	19.2
			12.3		12.8	
	50	124.3	130	157.4	-4.3	-21.0
			184.9		-32.7	
	70	4.3	7.5	7.8	-42.0	44.6
			8.2		-47.1	
	130	86.5	65	74.6	33.1	15.9
			84.2		2.69	
isobutanol	0	112.8	130	113.8	-13.1	-0.8
			97.6		15.6	

	20	7.7	8.1	8.4	-4.8	-8.4
			8.7		-11.7	
	50	122.3	130	157.4	-5.8	-22.3
			184.9		-33.8	
	70	5.1	5.5	5.9	-6.5	-13.4
			6.3		-19.3	
	130	62.2	66	81.8	-5.6	-23.8
			97.6		-36.2	

1. https://www.osha.gov/dsg/annotated-pels/.