

Evaluation of New 3M[™] Organic Vapor Monitors 3501+/3511+

1. Background

Sampler Validation consists of lab tests designed to demonstrate that a Sampler functions as claimed. Since the scope of the claim includes a range of environmental conditions that may exist in the environments sampled, exposure conditions are varied so that each reader may consult the data herein to determine the suitability of a Sampler for a particular application. Protocols published by NIOSH(a), ANSI/ISEA(b), ASTM(c), CEN(d) have been consulted in selecting the tests performed in these studies.

(a) Cassinelli, M.E., Hull, R.D, Crable, J.V., and Teass, A.W., "Protocol for the Evaluation of Passive Monitors," in Diffusive Sampling, Royal Society of Chemistry, London, England, 1987, pp. 190-202.

(b) ANSI/ISEA 104-1998 (R2015)

(c) ASTM D6246-98

(d) EN 838:1996

2. Facilities, Equipment & Apparatus

Facilities in a chemical challenge laboratory were used including laboratory benches and sinks, fume hoods, exposure chambers, lab ware, pumps, chemical reagents, and safety devices. Extraction and analysis of test and reference samplers were conducted in Assay Technology's AIHA-accredited industrial hygiene test labs including benches, sinks, hoods, etc. as well as gas chromatographs. In some cases, test and reference samplers were presented with "natural" exposures in a field environment and analyzed by other accredited Labs.

3. Plan of Study

In the chemical challenge lab, dynamic (flowing and continuously renewed) test atmospheres were typically generated by controlled vaporization of liquid analytes metered into a flowing stream (with heating when required) from the Miller-Nelson HCS 401 or 501 Atmosphere Generator at a controlled flow rate, temperature, and relative humidity.

The atmosphere generated was conducted through inert tubing into an exposure chamber which featured an inert inner compartment in which generated vapors flow by each set of samplers at the same time (Fig 1). The desired linear flow velocity at the sampler's face was developed by a DC motor driven fan installed in the inner compartment and near to the samplers. Reference samplers were typically active samplers in which the front end penetrated the test chamber while the back end was connected to a critical orifice air sampler external to the exposure chamber.

After exposures, all samplers were capped and submitted to an accredited IH lab which extracted samplers and performed the analysis. Typically, results were analyzed by direct comparison of test samplers to reference samplers.

Dynamic atmospheres generated under variable environmental conditions were designed to challenge the samplers as suggested in the referenced test protocols to demonstrate sampler performance under the challenge conditions.

3.1 Nominal Uptake (Sampling) Rate Determination

Constant concentrations of several analytes were generated and presented to several test and reference samplers concomitantly during a fixed duration. This test was repeated for several groups each containing multiple analytes at different exposure concentrations and times deemed appropriate for the particular analyte. Replicate results for each analyte at multiple concentrations were assessed to determine average uptake (sampling) rate.

3.2 Air Velocity/Sampler Orientation

A constant concentration of analyte was generated and presented to several test and reference samplers as in Section 3.1. The tests were repeated at high and low values of air velocity and different orientations, after which the amounts recovered from test and reference samplers were compared to assess any differences due to air velocity or orientation.

3.3 Effect on Uptake (Sampling) Rate of Temperature & Relative Humidity

A constant concentration of selected volatile analytes was generated and presented to several test and reference samplers as in Section 3.1 with temperature and humidity controlled at extreme values. The amount of analyte recovered from the sampler groups exposed at different extreme temperatures and humidity were compared with charcoal tubes subject to the same exposure to assess the effects of temperature and %RH on sampling rate.

Fig 1 Test Chamber Used for L aboratory Evaluation of Samplers



Results Are Summarized in Following Tables.

Table 3.1.1 Typical Uptake (Sampling) Rate Determination

Analyte	Target	Sampl'g	Sampler	Amount			Found		Sampling
	Concn	Time	Tested	Qty	Tube		Badge		Rate
	(µg/L)	(min)			(µg/L)	(<u>+</u>)	(µg)	(<u>+</u>)	(L/min)
	504	120	3501+/3511+	5	3/6	9%	3440	5%	0.083
Acetone	252	120	3501+/3511+	5	167	1%	1840	3%	0.085
						270	Average	=	0.087
	1			_					
Benzene	64	120	3501+/3511+	5	34	8%	274	6%	0.0678
	32	120	3501+/3511+	5	1/	1%	138	3%	0.0692
							Average	=	0.0685
Dereblereethylene	251	120	3501+/3511+	5	245	7%	1520	6%	0.0518
Perchioroethylene	129	120	3501+/3511+	5	117	3%	764	3%	0.0542
							Average	=	0.0530
	503	120	3501+/3511+	5	477	9%	3280	7%	0.0573
Cyclohexane	251	120	3501+/3511+	5	232	2%	1700	4%	0.0612
							Average	=	0.0592
	126	120	3501+/3511+	5	116	8%	880	6%	0.0631
1,2-Dichloroethane	65	120	3501+/3511+	5	57	5%	452	3%	0.0051
	00	120	0001.70011.	3	57	370	Average	=	0.0648
				_					
Methylene Chloride	63	120	3501+/3511+	5	78	10%	534	4%	0.0569
	31	120	3501+/3511+	5	39	1%	322	3%	0.0690
							Average	=	0.0629
Chloroform	127	120	3501+/3511+	5	105	9%	740	6%	0.0585
Chioroform	63	120	3501+/3511+	5	51	1%	384	4%	0.0626
							Average	=	0.0606
	313	120	3501+/3511+	5	247	9%	1900	6%	0.0642
Tetrahydrofuran	156	120	3501+/3511+	5	121	3%	976	3%	0.0674
			,		1		Average	=	0.0658
	212	120	2501+/2511+	Ę	267	Q0/	1040	6%	0.0605
Toluene	158	120	3501+/2511+	5	127	070 3%	1940 QQ/I	3%	0.0005
	130	120	3301 7 3311+	5	132	370	Average	=	0.0614
					1	_	Average	_	0.0014
Xylenes	252	120	3501+/3511+	5	213	9%	1380	6%	0.0540
	126	120	3501+/3511+	5	103	3%	688	3%	0.0555
			_			_	Average	=	0.0548

Table 3.1.2 Typical Uptake (Sampling) Rate Determination

Analyte	Target	Sampl'g	Sampler		An	nount	Found	Amount Found				
	Concn	Time	Tested	Qty	Tube		Badge		Rate			
	(µg/L)	(min)			(µg/L)	(+)	(μg)	(+)	(L/min)			
	207	120	2501 / 2511 /		225	00/	2040	40/	0.052			
1,1,1-Trichloroethane	387	120	3501+/3511+	5	325	8%	2040	4%	0.052			
	196	120	3501+/3511+	5	159	3%	1080	4%	0.057			
							Average	_	0.0545			
1 1- Dioxane	72	120	3501+/3511+	5	61	8%	394	4%	0.054			
1,4- Dioxalle	36	120	3501+/3511+	5	21	8%	202	2%	0.082			
							Average	=	0.0677			
	264	120	3501+/3511+	5	164	8%	1720	5%	0.087			
1- Butanol	133	120	3501+/3511+	5	60	24%	786	3%	0.109			
	100						Average	=	0.0983			
								_				
2- Butoxyethanol	68	120	3501+/3511+	5	27	3%	206	3%	0.063			
	34	120	3501+/3511+	5	12	23%	100	0%	0.068			
							Average	=	0.0658			
	67	120	3501+/3511+	5	50	8%	414	5%	0.069			
Acetonitrile	34	120	3501+/3511+	5	24	1%	248	2%	0.085			
							Average	=	0.0769			
	222	120	2504 - /2544 -		207	70/	1740	50/	0.054			
Heptane	332	120	3501+/3511+	5	287	1.20/	1740	5%	0.051			
	164	120	3501+/3511+	5	137	13%	930	2%	0.057			
							Average	=	0.0530			
Isopropyl Alcohol	531	120	3501+/3511+	5	454	9%	3780	6%	0.069			
торгоруг Агсоног	265	120	3501+/3511+	5	227	2%	1980	2%	0.073			
							Average	=	0.0710			
	398	120	3501+/3511+	5	195	10%	2440	4%	0 105			
Methyl Ethyl Ketone	198	120	3501+/3511+	5	84	2%	1260	4%	0.105			
	190	120	5561.75511.	3	01	270	Average	=	0.1150			
					,	_	/ Weituge	_	012200			
Methyl Methacrylate	135	120	3501+/3511+	5	70	7%	618	4%	0.074			
	66	120	3501+/3511+	5	25	10%	238	10%	0.079			
		_					Average	=	0.0767			
	68	120	3501+/3511+	5	41	3%	224	4%	0.045			
Naphthalene	31	120	3501+/3511+	5	23	16%	136	14%	0.048			
			·				Average	=	0.0467			

Table 3.1.3 Typical Uptake (Sampling) Rate Determination

Analyte	Target	Sampling	Sampler	Amoun			Found	Sampling	
	Concn	Time	Tested	Qty	Tube		Badge		Rate
	(µg/L)	(min)			(µg/L)	(+)	(µg)	(+)	(L/min)
	06	120	2501+/2511+	E	72	Nom	516	E%/	0.060
Cyclohexanone	48	120	3501+/3511+	5	36	Nom	252	3%	0.000
	-10	120	5501755111	5	50	Nom	Average	=	0.050
	1		. í		1			_	
Ethvl Acetate	490	120	3501+/3511+	5	522	5%	4080	5%	0.065
	245	120	3501+/3511+	5	261	2%	1980	2%	0.063
							Average	=	0.0642
Ether University of	69	120	3501+/3511+	5	73	1%	496	4%	0.057
Ethylbenzene	35	120	3501+/3511+	5	35	8%	238	5%	0.056
							Average	=	0.0564
	483	120	3501+/3511+	5	380	4%	2700	5%	0.059
Hexane	241	120	3501+/3511+	5	190	1%	1380	3%	0.060
			,	-			Average	=	0.0598
				_					
Isobutyl Alcohol	103	120	3501+/3511+	5	8/	4%	/20	5%	0.069
	52	120	3501+/3511+	5	43	1%	352	4%	0.069
							Average	=	0.0689
Hexope (MIRK)	246	120	3501+/3511+	5	223	3%	1680	5%	0.063
HEXOTE (MIDK)	123	120	3501+/3511+	5	109	4%	800	4%	0.061
							Average	=	0.0621
N,N-Dimethyl	123	120	3501+/3511+	5	103	6%	790	6%	0.064
Formamide	61	120	3501+/3511+	5	51	7%	352	4%	0.057
							Average	=	0.0606
Propylene Glycol Methyl	207	120	3501+/3511+	5	221	1%	1/20	3%	0.054
Fther Acetate	149	120	3501+/3511+	5	107	8%	682	4%	0.054
Ether / toetate	110	120	5501.75511.	5	107	0/0	Average	=	0.0535
		· · · · · ·				_	Arenage		
t-Butyl Acetate	195	120	3501+/3511+	5	193	3%	1360	11%	0.059
	97	120	3501+/3511+	5	96	4%	630	4%	0.055
							Average	=	0.0567
Trichlorgethulerer	296	120	3501+/3511+	5	235	3%	1700	4%	0.060
irichioroethylene	148	120	3501+/3511+	5	116	3%	814	4%	0.058
							Average	=	0.0593

Table 3.2 Air Velocity/Sampler Orientation

Analyte(s)	Target	Air	Sampler	Sampler		Amount	Found	Comparison
Tested	Concn	Velocity	Oriented	Tested	Qty	Ave	(<u>+</u>)	to Tube
	(ppm)	(cm/sec)				(ppm)	(%)	(%)
1,1-dichloro-2,2,2-trifluoroethane	8	153	perpendicular	C Tube	3	6.36	5%	100%
			perpendicular	Monitor	6	6.28	10%	99%
			parallel	Monitor	5	6.50	5%	102%
			perpendicular	C Tube	5	53.6	9%	100%
1,1-dichloro-2,2,2-trifluoroethane	60	19	perpendicular	Monitor	6	58.1	4%	109%
			parallel	Monitor	5	54.1	5%	101%

Table 3.3 Effect on Uptake (Sampling) Rate of Temperature & Relative Humidity

Analyte(s)	Target	Test	Test	Sampler		Amount	Found	Comparison
Tested	Concn	Temp	Humidity	Tested	Qty	Ave	(<u>+</u>)	to Tube
	(ppm)	(°C)	(%RH)			(ppm)	(%)	(%)
	400	10		C Tube	4	101	3%	100%
1,1-dichioro-2,2,2-trifiuoroethane	100	10	14	Monitor	6	113	6%	112%
1.1. diablana 0.0.0 trifluana ath an a	100	40	45	C Tube	4	106.0	5%	100%
1,1-dichioro-2,2,2-trifiuoroethane	100	40	15	Monitor	6	111.5	3%	105%
4.4 diablana 0.0.0 triffuana ath an a	400	40	74	C Tube	4	98.1	3%	100%
1,1-dichioro-2,2,2-trifiuoroethane	100	10 /4		Monitor	6	105.1	3%	107%
	100	40	70	C Tube	3	96.6	3%	100%
1,1-dichloro-2,2,2-trifiuoroethane 100		40	12	Monitor	6	97.7	4%	101%

Personal Safety Division

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