3M

Technical Data Bulletin

OH&ESD

Organic Vapor Monitor Sampling and Analysis Guide

3M™ Organic Vapor Monitors 3500/3510 and 3M™ Organic Vapor Monitors 3520/3530

3M manufactures a variety of organic vapor monitors. The 3M Organic Vapor Monitors 3500 and 3510 are identical in that they contain a single charcoal adsorbent pad. The 3500 monitor is designed to be analyzed by the user or by an independent laboratory. The 3510 includes a prepaid analysis from 3M for up to three compounds per monitor. The 3M Organic Vapor Monitors 3520 and 3530 are also identical in that they both contain two adsorbent pads. The 3520 monitor is designed to be analyzed by the user or by an independent laboratory. The 3530 includes a prepaid analysis from 3M for up to three compounds per monitor.

This Guide summarizes information on sampling and analysis of the 3M organic vapor monitors. The Guide is divided into 4 sections, see below:

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For more Information

Technical Assistance:
1-800-243-4630
Sales Assistance: 1-800-896-4223
Fax-on-Demand: 1-800-646-1655
Internet: www.3M.com/occsafety
Material Safety Data Sheets (MSDS): 1-651-737-7222

Section 1.0: Sampling Information

1.1 Standards

Most countries have occupational exposure limits (OEL) for chemical substances in the workplace. In the United States the ACGIH Threshold Limit Values (TLV) and the OSHA Permissible Exposure Limit (PEL) standards are the most cited contaminant airborne standards. TLVs are guidelines and are not legal standards in the U.S. but are legally enforceable in some countries. They are reviewed on a periodic basis and changed or reviewed if sufficient data warrants.

There are three categories for TLVs. First, "Threshold Limit Value-Time Weighted Average (TLV-TWA)—the time weighted average concentration for a normal 8-hour workday and a 40 hour workweek, to which nearly all workers may be repeatedly exposed, day after day, without adverse effects." Second, Threshold Limit Value-Short Term Exposure Limit (TLV-STEL)—the concentration to which workers can be exposed continuously for a short period of time without suffering 1) irritation, 2) chronic or irreversible tissue damage, or 3) narcosis of sufficient degree to increase the likelihood of accidental injury." The STEL is defined as a 15 minute TWA exposure which should not be exceeded at any time during a workday even if the 8 hour TWA is within the TLV-TWA. Third, Threshold Limit Value-Ceiling (TLV-C) — the concentration that should not be exceeded during any part of the working exposure."

The OSHA standards (PELs) can be found in Federal Register 29 CFR 1910 and are legally enforceable standards in the U.S. OSHA PELs have the same three categories as TLVS.

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The 3M organic vapor monitors can be used to sample 8 hour TLV-TWAs and PELs. The organic vapor monitors can also be used to sample TLV-STELs and PEL-STELs if during the 15 minute sampling period, the monitor collects a sufficient quantity of contaminant for analysis. The organic vapor monitor is generally not recommended for sampling periods less than 15 minutes.

1.2 Sampling Time
Sampling a full workshift is recommended in order to determine the workers' daily exposure level to organic contaminants. When monitoring some organic contaminants, sampling shorter than a full shift may be required in order to be within the recommended capacity of the organic vapor monitor. Under these circumstances, sequential sampling with several monitors can be performed to assess the 8 hour exposure. For information on recommended sampling time and capacity see section 4.

To quantitatively confirm the presence and concentration of a contaminant in the atmosphere, most analysts require a minimum of 10 micrograms for G.C. analysis. A sampling period of at least 15 minutes is recommended even when 10 micrograms of the contaminant could be collected in a shorter period.

1.3 Accuracy
3M™ Organic Vapor Monitors are simple to use, but they do have limitations just like all types of sampling devices. Therefore, prior to using the monitor, the user must understand the limitations of this sampling device. Accurate results can be obtained if they are used within their performance limitations and if the analytical laboratory conducting the analysis can accurately provide correct information. Some of the more common sampling errors are overloading the sorbent pad, sampling for contaminants that cannot be captured and retained by carbon, and the laboratory using incorrect recovery coefficients. It is vital that the organic vapor monitor be used within its performance limits and the analytical laboratory has experience in analyzing organic vapor industrial hygiene samples.

For further assistance and information on accuracy and validation you may contact OH&ESD Technical Service in the U.S. at 1-800-243-4630. In other countries, contact the local 3M subsidiary.

1.4 Sampling Strategy
The first step in developing a sampling strategy is to establish the purpose and objective. Some examples of typical objectives are: evaluating worker exposure levels, evaluating high exposure periods during the workday, evaluating control measures such as ventilation, screening work groups to identify high risk groups, measuring worst case exposures, regulatory monitoring to ensure that all workers' exposure levels are below OSHA PELs, and long term environmental monitoring. After the purpose and objectives have been outlined the study can be designed. The American Industrial Hygiene Association (AIHA) manual[1] on exposure assessment discusses the concept of homogeneous exposure group (HEG) and outlines methods for defining HEGs. The manual reviews the following approaches: task based approach, job-description based approach, and chemical based approach. Each separate and unique HEG should be evaluated. After the study has been designed, samples then can be taken. Patty's Industrial Hygiene and Toxicology[2] also contains information regarding sampling strategy and exposure assessments.

1. *Hawkens, N.C., Norwood, S.K., Rock, J.C. (1991): "A Strategy for Occupational Exposure Assessment," American Industrial Hygiene Association, Fairfax, VA.*

2. *Harris, R.L., Cralley, L.J. Cralley, L.V.: Patty's Industrial Hygiene and Toxicology, Vol. III, Par A, Wiley-Interscience Publication, 1994.*

1.5 Unsuitable Compounds
The organic vapor monitor is not recommended for the following compounds because of adverse or inadequate interactions with the sorbent material.

Ammonia
Carbon Monoxide
Ethylene Oxide (3)
Formaldehyde (4)
Hydrogen Sulfide
Isocyanates
Methane, Ethane, Propane
Methyl Alcohol (Methanol)
Methyl Chloride
Methyl, Dimethyl, Trimethyl Amines
Organic Solids
Sulfur Dioxide

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Compounds not on this list or in Section 4 should be handled by consultation with 3M OH&ESD Technical Service at 1-800-243-4630 or contact your local 3M subsidiary.

3. Ethylene Oxide can be monitored using 3M™ Ethylene Oxide Monitor 3550/3551.

4. Formaldehyde can be monitored using 3M™ Formaldehyde Monitor 3720/3721.

1.6 Analytical Laboratory

The following compounds can be analyzed using the 3510 or 3530 monitor sold with a prepaid analysis. A more extensive list of compounds which may be sampled using the 3M™ Organic Vapor Monitors 3500 or 3520 is contained in Section 4.

Section 2.0: Analysis Procedure

2.1 Procedure to Calculate Contaminant Concentrations

The time weighted average concentration of the environment sampled can be calculated by knowing the length of the sampling period, the contaminant weight determined by gas chromatography, the recovery coefficient, and the calculation constant, either A or B. The calculation constant "A" is used to calculate the concentration when expressed in units of milligrams per cubic meter (mg/m^3) and constant "B" when expressed in units of parts per million (ppm). The calculation constants A and B have been determined for every contaminant found in Section 4.

3510/3530 Compound List

†Acetone (2) (c)
Acetonitrile (2) (c)
Acrylonitrile (8)
Allyl Alcohol (8)
Amyl Acetate (8)
n-Amyl Alcohol
s-Amyl Alcohol
Benzene (8)
Benzyl Chloride (8)
Bromoform (8)
1-Bromopropane (m)
n-Butyl Acetate (8)
s-Butyl Acetate (8)
t-Butyl Acetate (8)
Butyl Acrylate (8)
n-Butyl Alcohol (8)
s-Butyl Alcohol (8)
t-Butyl Alcohol (8)
Butyl Cellosolve Acetate
Butyl Cellosolve (8)
Butyl Glycidyl Ether (8)
p-tert Butyl Toluene (8)
Camphor (8)
Carbon Tetrachloride (8)
Cellosolve (8)
Cellosolve Acetate (8)
Chlorobenzene (8)
Chloroform (8)
o-Chlorostyrene (8)
o-Chlorotoluene (8)
Cumene (8)
Cyclohexane (6)
Cyclohexanol (8)
Cyclohexanone (8)
Cyclohexene (8)
n-Decane
Diacetone Alcohol (8)
o-Dichlorobenzene (8)
p-Dichlorobenzene (8)
trans-1,2-Dichloroethylene (6)
Diisobutyl Ketone (DIBK) (8)
p-Dioxane (8)
Dipropylene Glycol Methyl Ether Acetate
Enflurane (8)
Epichlorohydrin (8)
Ethoxy Perfluorobutane (HFE-7200)
Ethyl Acetate (6)
Ethyl Acrylate (8)
Ethyl Benzene (8)
Ethylene Chlorohydrin (8)
Ethylene Dichloride (EDC) (8)
Ethyl Ether (4) (c)
Furfural (8)
Halothane (8)
n-Heptane (8)
n-Hexane (8)
iso-Amyl Acetate (8)
iso-Butyl Alcohol (8)
Isoflurane (Forane)
Isopar G
Isophorone (8)
Isopropyl Acetate (7)
Isopropyl Alcohol (m) (c)
Mesitylene (8)
Mesityl Oxide (8)
Methoxy Perfluorobutane (HFE-7100)
Methyl Acrylate (8)
Methyl t-Butyl Ether (MTBE) (8)
Methyl Butyl Ketone (MBK) (8)
Methyl Cellosolve (8)
Methyl Cellosolve Acetate (8)
Methylene Chloride (m) (3530 only)
†Methyl Ethyl Ketone (MEK) (8)
Methyl Isobutyl Ketone (MIBK) (8)
Methyl Methacrylate (8)
Methyl Propyl Ketone (8)
Naptha (VM&P) (8)
n-Octane (8)
Perchloroethylene (8)
Phenyl Ether (8)
n-Propyl Acetate (8)
n-Propyl Alcohol (6)
Propylene Dichloride (8)
Propylene Glycol Mono Methyl Ether (8)
Propylene Glycol Mono Methyl Ether Acetate
Stoddard Solvent (8)
Styrene (8)
1,1,2,2-Tetrachloroethane (8)
Tetrahydrofuran (8)
Toluene (8)
1,1,1-Trichloroethane (Methyl Chloroform) (m)
Trichloroethylene (8)
1,1,2-Trichloro-1,2,2-trifluoroethane (1) (c)
†Vinyl Acetate (8)
Vinyl Toluene (8)
Xylene (8)
Total Hydrocarbons as n-Hexane

The number in parenthesis is the recommended sampling period in hours. This time has been estimated using the capacity of the 3510 organic vapor monitor, a relative humidity of <50% and the 1998 ACGIH TLVs. Use of the 3530 allows the sampling time to increase.

(c) Because of their high vapor pressures (low boiling points), the (c) compounds are best sampled initially with the 3520 or 3530 monitor (with back-up section). Subsequent sampling may be done with the 3500/3510 monitor if determined, by 3520 results, that contaminant concentrations are within the 3500/3510 capacity limits.

†NOTE: certain compounds (e.g. acetone, methyl ethyl ketone, vinyl acetate, etc.) may show a decreased recovery when sampled in high relative humidity. Refrigerate and/or expedite for analysis to help ensure accurate results.

(m) See technical bulletin.

$A = \frac{1000}{\text{sampling rate}}$

$B = \frac{1000 \times 24.45}{\text{sampling rate} \times \text{molecular weight}}$

The following information is needed in order to calculate the contaminant concentration:

- Contaminant identity
- Sampling time in minutes **(t)**
- Calculation Constant A or B from Section 4
- Contaminant weight in micrograms **(W),** corrected for blank
- Recovery coefficient **(r)**
- Temperature effects

Air temperature will slightly influence the sampling rate of the diffusion monitor. All formulas calculate the time weighted average concentrations at a sampling temperature of 25°C (77°F) and pressure of 760 mm. The expressions can be multiplied by the following temperature correction factors (CF_T) for samples collected at temperatures other than 25°C (77°F). No correction is needed for differences in pressure.

Sampling Temperature - Temperature Correction Factor

(C)	(F)	(CF_T)
44	111	0.97
37	99	0.98
31	88	0.99
25	77	1.00
19	66	1.01
13	55	1.02
7	45	1.03
2	36	1.04
-3	27	1.05
-8	18	1.06

From the above table, every 10–11°F above or below 77°F requires one percent correction at the calculated time-weighted average concentration.

2.2 Procedure for the 3M™ Organic Vapor Monitor 3500

The time-weighted average concentration of contaminant in milligrams per cubic meter can be calculated from the following expression:

$C(mg/m^3) = \frac{W \text{ (micrograms)} \times A}{r \times t \text{ (minutes)}}$

The time-weighted average concentration of contaminant in parts per million (ppm) can be calculated from the following expression:

$C(ppm) = \frac{W \text{ (micrograms)} \times B}{r \times t \text{ (minutes)}}$

If the temperature correction is desired, the time-weighted average concentration can be calculated by multiplying by CF_T.

Example Calculation
Contaminant: Benzene
Length of Sampling Time **(t):** 420 minutes
Temperature **(T):** 75F
Calculation Constant **A:** 28.2
B: 8.82
Contaminant Weight **(W):** 27.2 micrograms
Recovery Coefficient **(r):** 0.97

Using Calculation Constant A (mg/m^3)

$C(mg/m^3) = \frac{27.2 \text{ micrograms} \times 28.2}{0.97 \times 420 \text{ minutes}}$

$C = 1.88 \text{ mg/m}^3$

Using Calculation Constant B (ppm)

$C(ppm) = \frac{27.2 \text{ micrograms} \times 8.82}{0.97 \times 420 \text{ minutes}}$

$C = 0.59 \text{ ppm}$

2.3 Procedure for 3M™ Organic Vapor Monitor 3520

After analysis of the primary and secondary sorbent pads the validity of the sample can be determined. Validity of the sample can be determined by evaluating the ratio of the contaminant weight (W_S) on the secondary sorbent pad to the contaminant weight (W_P) on the primary sorbent pad. The sample is valid if the following criteria is met:

$\frac{W_S}{W_P} \leq 0.50$

W_P: weight collected on the primary pad corrected for blank (micrograms)

W_S: weight collected on the secondary pad corrected for blank (micrograms)

If the sample is valid then the total concentration of the sample can be determined with the following equations:

$C(mg/m^3) = \frac{(W_P + 2.2 \times W_S) \times A}{r \times t \text{ (minutes)}}$

$C(ppm) = \frac{(W_P + 2.2 \times W_S) \times B}{r \times t \text{ (minutes)}}$

Section 3.0: Recovery Coefficient

3.1 Recommended Procedure to Determine Recovery Coefficients

We encourage the user to verify the recovery coefficients, since laboratory and analysis techniques can affect recovery coefficients. The recovery coefficient is determined by vapor-state spiking of monitors. The following procedures are recommended for spiking 3M organic vapor monitors:

1. Remove plastic ring and white film from a monitor.

2. Place a 2.5 cm diameter filter paper on spacer plate.
3. Apply the elution cap. Snap onto the monitor to assure tight seal.
4. Calculate the amount of material to be spiked. The following formula will calculate the spiked amount, in milligrams, that corresponds to the amount that would be collected by an organic vapor monitor at sampling conditions chosen. By varying the chosen concentration levels and exposure times, a recovery coefficient curve can be generated.
   $W = (K_O) \times (C) \times (t) \times (10^{-6}\ m^3/cm^3)$

Where:

W = Amount of liquid injection in milligrams

K_O = Sampling rate of monitor cm^3/min.

C = Average concentration in mg/m^3

t = Sampling time in minutes

For compounds that are solid at room temperature, prepare a solution in Carbon Disulfide such that no more than a 5 microliter injection is needed to spike the required number of milligrams of compound. A suggested starting point would be to assume an average concentration equal to the PEL (Permissible Exposure Limit) or OEL (Occupational Exposure Limit) and an 8 hour exposure period, as long as the amount in milligrams does not exceed the recommended capacity of the monitor.

5. Spike the known quantity of the organic material with a microliter syringe through the center port onto the filter paper. Close the ports.
6. Allow the monitor to sit 16-24 hours to allow total vapor phase transfer of the organic material from the filter paper to the sorbent before elution.
7. Remove filter paper from monitor.
8. Proceed with elution and determination of amount recovered by G.C. analysis.

Section 4.0: Sampling and Analysis Tables

3M™ Organic Vapor Monitor Sampling and Analytical information is contained in the following table. The table outlines sampling rates, recommended sampling periods for a variety of organic compounds, capacity information, recovery information and calculation constants.

4.1 Sampling Rates

The sampling rates are tabulated as cubic centimeters/minute. The sampling rates for (*) compounds have been verified experimentally in the laboratory. The sampling rates given for the remaining compounds in this table were determined from empirical relationships outlined in a publication on "Sampling Rate Validation" available from 3M on request. Sampling rates for compounds not found in the Guide are available upon request. The top section of the 3520 organic vapor monitor has the same dimensions as the 3500 organic vapor monitor; therefore, the sampling rate is the same.

4.2 Length of Sampling Period

The recommended maximum sampling period has been estimated using the capacity of the 3500/3510 organic vapor monitor, at a relative humidity of <50% and the 1998 American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values. Full work shift sampling periods are recommended as the most comprehensive measures of worker exposure. When sampling some organic contaminants, sampling periods shorter than a full workshift are required in order not to exceed the recommended capacity of the monitor. Under these circumstances, sequential sampling with several monitors can be performed to determine the full shift exposure. In order to determine the time weighted average (TWA) concentration over a work shift with sequential sampling the following calculation can be used:

$$ppm = \frac{C_1 \times T_1 + C_2 \times T_2 + \ldots C_n \times T_n}{T_1 + T_2 + \ldots T_n}$$

For those compounds where the recommended length of the sampling period for the 3M™ Organic Vapor Monitor 3500/3510 is less than a full workshift, the length of the sampling period can be increased by using the 3M™ Organic Vapor Monitor 3520/3530.

4.3 Capacity

The capacity of the monitor for each individual compound is a function of molecular structure, vapor pressure, environmental conditions, etc. The capacity values listed in the Guide were determined for the 3500 under dry conditions (<50%RH), and were then used to estimate the length of a recommended sampling period for concentrations equal to the 1998 TLVs. The capacity and sampling time under high relative humidity may be reduced significantly.

Because of the back up section, the effective capacity of the 3M™ Organic Vapor Monitor 3520/3530 is greater than the values listed for the 3500/3510. When sampling environments containing high concentrations, mixtures, high relative humidity, and/or compounds listed with a (c) in the table, we recommend using the 3520/3530.

When sampling contaminants listed in the table with the 3500/3510, the combined weights of the contaminants collected should not exceed the listed value for the single contaminant with lowest capacity. For the 3520/3530, the weight (W_S) collected by the secondary adsorbent on the back-up section can be compared with the weight (W_P) collected by the primary adsorbent to determine sample validity. The ratio W_S/W_P must be equal to or less than 0.50 for a valid sample.

4.4 Recovery Coefficients (Desorption Efficiency)
The collected sample is removed from the activated carbon wafer for analysis by desorption with Carbon Disulfide (CS_2) or other suitable solvents as noted. In order for the laboratory to accurately determine the amount of contaminant collected by the adsorbent, it is necessary to know the efficiency of the desorption process.

Recovery coefficient or desorption efficiency is determined by adding a known weight of contaminant onto the adsorbent and measuring the weight of contaminant recovered by the desorbing solvent. The recovery coefficient is calculated by dividing the recovered weight of contaminant by the known amount. Refer to Section 3 for details on determining recovery coefficients.

We recommend that recoveries listed in this table be used only as a guideline, and that laboratories perform their own recovery studies. Industrial hygiene literature/methods should be consulted for elution solvents which exhibit improved recovery when CS_2 is not adequate.

NOTE: Certain compounds (e.g. acetone, methyl ethyl ketone, vinyl acetate, etc.) may show a decreased recovery when sampled in high relative humidity. Refrigerate and/or expedite for analysis to help ensure accurate results.

Please see Technical Data Bulletin #125 “Storage and Recovery” for more information.

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	Sampling Rate (cc/min)	Recommended Sampling Time (Hrs.)	Capacity (mg)	Recovery Coefficient	Calculation Constant A (mg/m^3)	Calculation Constant B (ppm)
* Acetone (c)	40.1	2	7	0.91 (i)	24.9	10.50
Acetonitrile (c)	48.2	2	0.5	1.02 (e)	20.7	12.36
* Acrylonitrile (m)	43.8	8	1.4	0.99 (d)	22.8	10.52
Allyl Alcohol	40.4	8	5	0.74 (d)	24.8	10.42
Allyl Chloride	35.1	8	3	0.86	28.5	9.10
* n-Amyl Acetate	26.0	8	>25	0.98	38.5	7.22
* n-Amyl Alcohol (1-Pentanol)	31.2		24	0.96 (d)	32.1	8.89
s-Amyl Alcohol	31.2		>25	0.98 (d)	32.1	8.89
* Benzene	35.5	8	22	0.97	28.2	8.82
Benzyl Chloride	27.2	8	>25	0.89	36.8	7.10
Bromoform	29.3	8	>25	1.02	34.1	3.30
* 1-Bromopropane	31.7	(m)	(m)	1.02	31.5	6.27
* 1,3-Butadiene (c)	42.8	(m)	(m)	0.75 (d)	23.4	10.56
n-Butyl Acetate	31.6	8	>25	1.07	31.6	6.66
* s-Butyl Acetate	28.6	8	>25	0.98	35.0	7.36
t-Butyl Acetate	29.4	8	23	0.98	34.0	7.16
Butyl Acrylate	27.3	8	>25	1.06	36.6	6.99
* n-Butyl Alcohol	34.3	8	21	0.95 (d)	29.2	9.62
s-Butyl Alcohol	34.8	8	19	0.89 (d)	28.7	9.48
t-Butyl Alcohol	35.2	8	15	0.74	28.4	9.37
* Butyl Cellosolve	28.2	8	>25	0.91 (d)	35.5	7.34
* Butyl Cellosolve Acetate	24.3		>25	0.90	41.2	6.28
Butyl Glycidyl Ether	27.0	8	25	0.93	37.0	6.96
* p-tert-Butyltoluene	20.7	8	25	1.07	48.3	7.97
Camphor	21.4	8	>25	0.92	46.7	7.50
Carbon Disulfide (c)	42.8	8	2.7	0.76 (h)	23.4	7.50
Carbon Tetrabromide	26.6	8	>5	0.99 (h)	37.6	2.77
* Carbon Tetrachloride	30.2	8	>25	0.95	33.1	5.26
* Cellosolve	32.4	8	>25	0.84 (d)	30.9	8.37
* Cellosolve Acetate	26.6	8	>25	0.73	37.6	6.96
* Chlorobenzene	29.3	8	>25	0.96	34.1	7.41
* Chlorobromomethane	34.4	8	18	0.90	29.1	5.49
Chloroform	33.5	8	21	0.95	29.9	6.11
Chloroprene	32.2				31.1	8.58
o-Chlorostyrene	26.0	8	>25	0.78	38.5	6.78
* 2-Chloro-1,1,1,2-tetrafluoroethane (HCFC 124)	35.8		5	0.87 (f)	27.9	5.00
o-Chlorotoluene	27.3	8	>25	0.92	36.6	7.07
* Cumene	24.5	8	>25	1.01	40.8	8.30
* Cyclohexane	32.4	6	13	1.02	30.9	8.97
* Cyclohexanol	29.5	8	22	1.02 (d)	33.9	8.27
* Cyclohexanone	28.9	8	22	0.85	34.6	8.62
* Cyclohexene	32.3	8	21	0.99	31.0	9.21
Cyclopentadiene	39.5				25.3	9.36
Cyclopentane (c)	36.2	1	5	1.02	27.6	9.63

(c) 3M 3520 Organic Vapor Monitor Recommended
(d) Methylene Chloride
(e) 50% Dimethylformamide in carbon disulfide
(f) Isopropanol
(g) Acetonitrile
(h) Toluene
(i) Refrigerate and/or expedite for analysis to help ensure accurate results.
(k) Trichloroethylene
(m) See technical bulletin
* Laboratory verified sampling rate

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continued	Sampling Rate (cc/min)	Recommended Sampling Time (Hrs.)	Capacity (mg)	Recovery Coefficient	Calculation Constant A (mg/m^3)	Calculation Constant B (ppm)
* n-Decane	23.1		>25	1.05	43.3	7.44
* Diacetone Alcohol	28.2	8	>25	0.94 (d)	35.5	7.46
* o-Dichlorobenzene	27.8	8	>25	0.87	36.0	5.98
* p-Dichlorobenzene	27.8	8	>25	0.74	36.0	5.98
1,1-Dichloroethane	33.2	8	13	0.92	30.1	7.44
* 1,2-Dichloroethylene	35.2	6	10	0.96	28.4	7.17
Dichloroethyl Ether	26.1	8	>25	0.95	38.3	6.55
1,1-Dichloro-1-nitroethane	28.5				35.1	5.96
* 1,1-Dichloro-2,2,2-trifluoroethane (HCFC-123)	30.9				32.4	5.17
Dicyclopentadiene	23.6	8	>25	0.96	42.4	7.84
Diethyl Ketone	32.7	8	24	0.98	30.6	8.68
* Diisobutyl Ketone	24.6	8	>25	1.03	40.7	6.99
Dimethylacetamide	32.0	8	>25	0.84 (d)	31.3	8.77
Dimethyl Formamide	35.5	8	>25	0.65 (d)	28.2	9.42
p-Dioxane	34.5	8	21	0.91	29.0	8.04
Dipropylene Glycol Methyl Ether	25.3	8	23	0.82	39.5	6.52
Dipropylene Glycol Methyl Ether Acetate	22.8			0.93	43.9	5.64
Dipropyl Ketone (4-Heptanone)	27.8	8	25	0.66	36.0	7.70
Divinyl Benzene	23.3	8	20	0.47	42.9	8.06
* n-Dodecane	21.5		>25	1.09	46.5	6.68
Enflurane	28.3	8	8	0.88	35.3	4.68
Epichlorohydrin	29.6	8	20	0.85	33.8	8.93
* 1-Ethoxynonafluorobutane (HFE-7200)	24.1		>25	0.82 (k)	41.5	3.84
* Ethyl Acetate	34.5	6	20	0.99	29.0	8.04
Ethyl Acrylate	32.2	8	>25	0.93	31.1	7.58
* Ethyl Alcohol (c)	43.7	1	3.5	0.98 (g)	22.9	12.14
Ethyl Benzene	27.3	8	24	0.96	36.6	8.44
* Ethyl Bromide	36.4	8	6	0.94	27.5	6.18
Ethyl Butyl Ketone	28.0	8	>25	0.68	35.7	7.65
Ethylene Chlorohydrin	33.9	8	11	0.82 (d)	29.5	8.96
* Ethylene Dibromide	29.6		21	0.93	33.8	4.40
* Ethylene Dichloride	33.2	8	16	0.98	30.1	7.44
Ethyl Ether (c)	36.8	4	12	0.96	27.2	8.96
Ethyl Formate	38.8	8	8	0.65	25.8	8.51
Furfural	34.3	8	>25	0.62 (d)	29.2	7.42
Furfuryl Alcohol	30.6	8	>25	0.71 (d)	32.7	8.14
* Gasoline	30.5	8	>25	0.94	32.8	7.49
Glycidol	37.1				27.0	8.90
Halothane	30.2	8	10	1.07	33.1	4.10
* n-Heptane	28.9	8	>25	1.04	34.6	8.44
Hexachlorobutadiene	22.9				43.7	4.09
Hexachlorocyclopentadiene	22.1				45.2	4.06

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(k) Trichloroethylene
(m) See technical bulletin
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continued	Sampling Rate (cc/min)	Recommended Sampling Time (Hrs.)	Capacity (mg)	Recovery Coefficient	Calculation Constant A (mg/m^3)	Calculation Constant B (ppm)
Hexachloroethane	26.7	8	25	0.95	37.5	3.87
* n-Hexane	32.0	8	24	1.07	31.3	8.87
* Hexane Isomers	32.0	7	24	1.03	31.3	8.87
Isoamyl Acetate	27.2	8	>25	0.97	36.8	6.90
* Isoamyl Alcohol	32.3	8	22	0.95 (d)	31.0	8.59
* Isobutyl Acetate	31.0	8	25	1.02	32.3	6.79
* Isobutyl Alcohol	35.9	8	19	0.93 (d)	27.9	9.19
Isoflurane (Forane)	28.3		7	0.88	35.3	4.68
Isooctyl Alcohol	25.1	8	23	0.80	39.8	7.48
Isopar G	24.4		>25	0.98	41.0	7.42
* Isophorone	21.7	8	>25	0.75	46.1	8.15
Isopropoxyethanol	29.5	8	23	0.92	33.9	7.96
Isopropyl Acetate	31.7	7	15	0.96	31.5	7.55
* Isopropyl Alcohol (c)	39.4	(m)	(m)	0.96 (g)	25.4	10.33
Isopropyl Ether (c)	31.2	8	21	1.03	32.1	7.67
Isopropyl Glycidyl Ether	29.1	8	23	0.97	34.4	7.23
* Mesitylene	26.3	8	>25	1.05	38.0	7.73
* Mesityl Oxide	31.2	8	>25	0.89	32.1	7.98
1-Methoxynonafluorobutane (HFE-7100)	25.3		18	0.85 (k)	39.5	3.87
* Methyl Acetate (c)	37.0	2	3	0.92	27.0	8.92
Methyl Acrylate	35.8	8	11	0.87	27.9	7.93
Methylal (c)	37.9	1	10	0.97	26.4	8.48
Methyl Amyl Ketone	27.9	8	24	0.98	35.8	7.67
Methyl Bromide (c)	40.9				24.4	6.30
* Methyl t-Butyl Ether (MTBE)	30.8	8	17	0.98	32.5	9.01
* Methyl Butyl Ketone	29.7	8	24	1.00	33.7	8.22
* Methyl Cellosolve	36.3	8	>25	0.78 (d)	27.5	8.85
* Methyl Cellosolve Acetate	29.0	8	>25	0.65	34.5	7.14
* Methyl Cyclohexane	28.9	7	20	1.03	34.6	8.62
Methyl Cyclohexanol	25.3	8	>25	0.83	39.5	8.46
* Methylene Chloride (c)	37.9	(m)	(m)	0.87	26.4	7.60
* Methyl Ethyl Ketone	36.3	8	18	0.91 (i)	27.5	9.34
Methyl Formate (c)	45.0	1	0.5	0.76 (d)	22.2	9.05
5-Methyl-3-heptanone	26.4	8	24	0.83	37.9	7.22
Methyl Iodide	36.7				27.2	4.69
Methyl Isoamyl Ketone	28.0	8	>25	1.01	35.7	7.65
Methyl Isobutyl Carbinol	29.2	8	21	0.81	34.2	8.19
* Methyl Isobutyl Ketone	30.0	8	>25	0.99	33.3	8.14
Methyl Isopropyl Ketone	32.8	8	24	0.91	30.5	8.65
Methyl Methacrylate	31.8	8	>25	0.98	31.4	7.68
* Methyl Propyl Ketone	33.0	8	24	0.93	30.3	8.60
1-Methyl-2-pyrrolidinone	28.8			0.81 (d)	34.7	8.56
* alpha-Methyl Styrene	25.0	8	25	1.02	40.0	8.28

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continued	Sampling Rate (cc/min)	Recommended Sampling Time (Hrs.)	Capacity (mg)	Recovery Coefficient	Calculation Constant A (mg/m^3)	Calculation Constant B (ppm)
* Naphtha(VM&P)	33.2	8	24	0.92	30.1	7.36
Naphthalene	24.6	8	>25	0.42	40.7	7.75
* n-Nonane	24.6	8	>25	1.09	40.7	7.75
* n-Octane	26.6	8	25	1.05	37.6	8.05
* n-Pentane (c)	35.3	3	12	0.98	28.3	9.60
2,4-Pentanedione	31.7		>25	0.81	31.5	7.70
* Perchloroethylene	28.3	8	>25	1.03	35.3	5.21
Phenyl Ether	20.3	8	>25	0.90	49.3	7.08
Phenyl Glycidyl Ether	22.2	8	19	0.73	45.0	7.33
* n-Propyl Acetate	30.1	8	25	1.00	33.2	7.95
* n-Propyl Alcohol	39.7	6	8	0.85 (d)	25.2	10.25
* Propylene Dichloride	30.6	8	20	1.02	32.7	7.07
* Propylene Glycol Monomethyl Ether (PGME)	32.4	8	>25	0.86 (d)	30.9	8.37
* Propylene Glycol Monomethyl Ether Acetate (PGMEA)	25.2		>25	1.01	39.7	7.34
* Propylene Oxide (c)	37.7	8	2	0.97	26.5	11.17
n-Propyl Nitrate	33.3	8	25	1.02	30.0	6.99
Resorcinol	25.8				38.8	8.61
Stoddard Solvent	24.3	8	21	0.98	41.2	6.99
* Styrene	28.9	8	>25	0.88	34.6	8.12
1,1,1,2-Tetrachloro-2, 2-difluoroethane (c)	27.5				36.4	4.36
1,1,2,2-Tetrachloro-1, 2-difluoroethane (c)	28.2				35.5	4.25
1,1,2,2-Tetrachloroethane	28.4	8	>25	0.92	35.2	5.13
* 1,1,1,2-Tetrafluoroethane (HFC 134a)	37.1		2	0.61 (f)	27.0	6.46
Tetrahydrofuran	37.2	8	15	1.01	26.9	9.11
* Toluene	31.4	8	>25	1.00	31.8	8.45
* 1,1,1-Trichloroethane (Methyl Chloroform)	30.9	(m)	>25	1.00	32.4	5.93
* 1,1,2-Trichloroethane	29.7	8	>25	0.95	33.7	6.17
* Trichloroethylene	31.1	8	>25	1.01	32.2	5.98
1,2,3-Trichloropropane	27.4	8	>25	0.99	36.5	6.05
1,1,2-Trichloro-1,2, 2-trifluoroethane (c)	29.1	1	11	0.92	34.4	4.48
Vinyl Acetate	35.8	8	9	0.98 (i)	27.9	7.93
Vinyl Bromide	37.0				27.0	6.18
* Vinyl Chloride (c)	40.8				24.5	9.59
* 4-Vinyl-1-cyclohexene	27.9	8	>25	1.01	35.8	8.10
Vinylidene Chloride	35.1	8	4	1.00	28.5	7.19
Vinyl Toluene	25.1	8	>25	0.86	39.8	8.24
* Xylene	27.3	8	>25	0.97	36.6	8.44

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