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# UNITED STATES ARMY ENVIRONMENTAL HYGIENE AGENCY

ABERDEEN PROVING GROUND, MD 21010-5422

## INDUSTRIAL HYGIENE SAMPLING INSTRUCTIONS

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19 ABSTRACT (Continue on reverse if necessary and identify by block number)

This technical guide describes air and bulk industrial hygiene sampling procedures for over 100 potentially hazardous chemical contaminants. The guide contains air volumes, sampling rates and references for IH air sampling. It addresses the types of containers and amount of sample required for bulk samples. Procedures for submitting samples including a listing of Army laboratories that perform industrial hygiene chemistry analysis are provided. The guide lists the expendable monitoring supplies that are compatible with the sampling procedures and includes representative commercial sources.

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U. S. ARMY ENVIRONMENTAL HYGIENE AGENCY
ABERDEEN PROVING GROUND, MARYLAND 21010-5422

REPLY TO ATTENTION OF

HSHB-ML-O

March 1987*

# USAEHA TECHNICAL GUIDE NO. 141

# INDUSTRIAL HYGIENE SAMPLING INSTRUCTIONS

## 1. GENERAL SAMPLING INSTRUCTIONS

a. Industrial hygiene (IH) sampling procedures are summarized in tables A-1, A-2, and A-3.

(1) Table A-1 lists the chemical contaminant, sampling method, recommended sample volume range in liters, and a procedure number corresponding to those procedures performed at the U.S. Army Environmental Hygiene Agency, Aberdeen Proving Ground (USAEHA APG). The procedure numbers are provided as guidance to the industrial hygienists serving USAEHA APG, and do not apply to those methods used by USAEHA field support activities (FSA). Appearing at the end of table A-1 are alternate sampling methods for several chemical parameters. These methods are to be used when submitting samples to the FSA Fitzsimons Army Medical Center (FAMC) laboratory for analysis of these parameters.

(2) The recommended sampling rates and air volumes listed in table A-1 are consistent with documented procedures published by the National Institute for Occupational Safety and Health (NIOSH), American Society for Testing and Materials (ASTM), manufacturers of sampling media, etc. Sampling done based on these recommendations will reasonably ensure that the accuracy and detection limit requirements of the analytical measurement system are met while also minimizing the potential for exceeding kinetic or saturation capacities of the sampling device(s). It is recognized, however, that situations may arise which necessitate deviation from these guidelines.

Use of trademarked names does not imply endorsement by the U.S. Army, but is intended only to assist in identification of a specific product.

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* This technical guide supersedes TG-141, Industrial Hygiene Sampling Instructions, October 1984, and Errata No. 1, 28 June 1985.

For example, a workplace may contain sufficiently high concentrations of a contaminant to require the usage of a "lower-than-recommended" flow rate in order to meet sampling time requirements, or may warrant a lower total sample volume; this is not uncommon with filter sampling in dusty areas. Similarly, pump or time constraints could conceivably lead to the need to sample a "higher-than-recommended" air volume. Since there is a safety factor built into the volume recommendations, there may be no problem with "breakthrough"; but it should be remembered that high humidity or the presence of additional adsorbing compounds could significantly reduce this safety factor. Therefore, while deviations from the recommended volumes may be made, such changes require the exercise of trained judgment and should be made only on an individual case basis.

(3) Table A-2 lists bulk sampling procedures for chemical contaminants. Details are given about container and sample size requirements.

(4) Table A-3 lists the sampling method, analytical method, coefficient of variation (CV), reference, and procedure number for those procedures performed at USAEHA APG. Equivalent documentation for the procedures performed at the FSA should be obtained from their individual laboratories. The CVs included in table A-3 are given for the measurement system which includes the sampling and analytical method. Where sampling errors have not been determined, a 5 percent sampling error has been assumed and included with the analytical measurement error to produce the CV for the procedure. Some procedures listed in table A-3 are not validated (NV). These procedures are assumed to be state-of-the-art and/or the most reliable methods available; however, they have not undergone validation testing such as outlined by NIOSH in the Manual of Analytical Methods, 3rd Edition. The gravimetric procedures employed at USAEHA APG are not considered validated because they deviate significantly from the NIOSH methods. Many chemical substances in the tables have the same USAEHA APG procedure number because they utilize the same analytical procedure for analysis.

(5) Appendix B, section I, tables B-1 through B-4, contain lists of monitoring supplies compatible with the procedures given in the sampling instructions in this guide. The supplies listed in the tables are intended only to assist in identifying a specific product. Other sources may be available for supplying equivalent items. Appendix B, section II, lists

the addresses and telephone numbers of vendors who supply the items listed in tables B-1 through B-4.

b. The supporting laboratory should be contacted prior to sampling for contaminants whenever assistance is needed or for contaminants not listed in table A-1.

(1) Continential United States (CONUS).

(a) USAEHA APG:

For asbestos, quartz, and metals contact the Radiological and Inorganic Chemistry Division (AUTOVON 584-2619)

For organics, solvents, acid mists, and pesticides contact the Organic Environmental Chemistry Division (AUTOVON 584-2208).

(b) Field Support Activities:

For metals, organics, solvents contact either -
FSA Fort McPherson, GA (AUTOVON 572-3234) or
FSA Fitzsimons Army Medical Center, CO (AUTOVON 943-8288)

(2) Outside Continental United Sates (OCONUS). Consult the appropriate supporting laboratory in appendix C.

c. Swipe, wipe, and swab samples should not generally be submitted except by prior approval from the supporting laboratory. The sample collecting material very often presents interferences in analysis. Contact the appropriate laboratory for guidance on collecting swipe, wipe, or swab samples.

2. ASBESTOS SAMPLING

a. Asbestos samples are collected on 25 mm diameter, 0.8 µm pore size, cellulose esters (CE) filters in open face cassettes with 50 mm extension cowls. Sample with the open end of the sampler facing downward. Do not use 37 mm filters because sufficiently low detection limits may not be attained.

b. A sample volume of 360 liters will permit detection of fibers at one-tenth the current permissible exposure limit (i.e., 0.02 fibers per cubic centimeter) using phase contrast microscopical counting techniques. A sample volume of 720 liters is desirable to permit reliable quantitation at this level. Sample at a rate between 0.5 and 2.5 liters per minute.

c. When positive asbestos fiber concentrations can be anticipated (e.g., from prior experience), optimal loading of the sample filters for counting purposes can be achieved.

(1) The range of sample volumes to be collected can be estimated by dividing the anticipated fiber concentration into the constants 40 and 500. For example, if the estimated concentration is 1 fiber per cc, then collect between 40 and 500 liters.

(2) For expected low fiber concentrations (less than 0.1 fiber/cc), excessive volumes are required and optimal loading of the sample filter should not be attempted.

d. For asbestos abatement sampling (after asbestos removal) collect 1300 liters (25 mm filters) or 3000 liters (37 mm filters) as noted in table A-1.

e. All asbestos air samples are analyzed by phase contrast microscopy. USAEHA does not perform electron microscopy analyses such as scanning electron microscopy or transmission electron microscopy.

3. CRYSTALLINE SILICA (QUARTZ) SAMPLING

a. Respirable quartz samples are collected on 37 mm diameter, 5 µm pore size, polyvinyl chloride (PVC) membrane filters for x-ray diffraction analysis for weight of quartz present. Closed-face sample cassettes are mounted in 10 mm nylon cyclones, and a minimum sample volume of 500 liters is collected at a flow rate of 1.7 liters per minute.

b. Crystalline silica samples can be examined qualitatively by x-ray diffraction for the presence of cristobalite and/or tridymite. However, the lack of suitable laboratory standards for these crystalline silica species precludes quantitative analysis.

4. FILTER SAMPLING

a. Types of filters used are:

(1) CE, which is a mixed cellulose ester filter (the same as cellulose nitrate.

(2) Polyvinyl chloride (PVC).

(3) Glass Fiber (GF).

(4) Polymer of tetrafluoroethylene (PTFE).

b. When sampling for metals, dust, and oil mist, use the maximum sampling rate consistent with good pump operation to meet the minimum recommended volume for reliable analysis. However, care should be taken when collecting air samples for metals during sanding and grinding operations to avoid filter over-loading, which may occur due to short-term generation of large volumes of material.

c. At least one field blank filter will be submitted with each set of samples from the same sampling series; if the number of samples in a set exceeds ten, then submit one blank for each ten samples. Asbestos analysis requires a minimum of two blanks, and chromium VI, potassium hydroxide, and sodium hydroxide require at least three blanks. When using preweighed filters, always use corresponding blank filters from the same lot as the samples. The lot can be determined from the code on the top of the USAEHA preweighed filter.

d. After sampling, preweighed filters must be returned to the supporting laboratory that performed the first weighing.

e. Some air contaminants may be collected and analyzed on the same filter. An example is the simultaneous sampling and analysis for lead and total chromium. The following list includes air contaminants which must be collected and analyzed on an individual basis:

(1) antimony

(2) molybdenum

(3) potassium hydroxide

(4) sodium hydroxide

(5) chromic acid mist

(6) chromium VI

f. Some PVC filters, specifically catalog number BSWP from the Millipore Corporation, are not acceptable for sampling chromium VI. This filter has been found to reduce a significant amount of the chromate spike. The NIOSH Sampling Method 7600 suggests use of catalog number FWSB [MSA] or number VM-1 [GELMAN] or equivalent. The storage stability for chromium VI samples has been validated for only a 2-week holding time, therefore, the USAEHA should be notified of analytical requirements prior to the collection of the samples.

5. ADSORPTION TUBE SAMPLING

a. Various types of adsorption tubes are used according to the contaminant being sampled; some of these are charcoal, Tenax®, silica gel, Florisil® and XAD-2®. Table A-1 lists the contaminants and corresponding adsorption tubes. Appendix B lists the sources for consumable supplies (containers, filters, passive monitors, sampler types) detailed in tables A-1 and A-2.

b. Smaller type charcoal tubes (150 mg) may be substituted for the 600 mg tubes listed in table A-1. (Note: The 600 mg tubes are 200/400 mg two section tubes.) However, correspondingly lower air volumes and sampling rates must be used (no more than one-half of the maximum volume and one-half the maximum sampling rate listed in table A-1). This also applies to smaller silica gel tubes for aniline, cresols or methanol sampling. Chromosorb 102 33/66 mg size tube for pesticides may be interchanged with the 50/100 mg size, with no change in the recommended air volume sample being required. Size substitution for other adsorption tubes should generally not be made.

c. Generally, a number of different organic solvents can be analyzed from the same charcoal tube. Organic solvents requiring the same analytical procedure can be sampled and analyzed together. However, the following require a separate charcoal tube for each analysis requested:

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® Florisil is a registered trademark of Floridin Company, ITT System, Pittsburgh, PA.
® XAD-2 is a registered trademark of Rohm and Haas, Philadelphia, PA.

(1) 2-butoxyethanol (Butyl cellosolve®)

(2) t-butyl alcohol

(3) carbon disulfide

(4) 2-ethoxyethanol (ethyl cellosolve)

(5) ethyl alcohol

(6) ethyl ether

(7) isopropanol

(8) isobutyl alcohol

(9) 2-methoxyethanol (methyl cellosolve)

(10) methyl bromide

d. The three stage nitrogen dioxide tubes are used both for nitrogen dioxide and sulfur dioxide sampling. Both parameters can be analyzed from the same tube.

e. The capacity of charcoal tubes and passive monitors may be reduced by either--

(1) High humidity (greater than 50 percent relative humidity) in combination with high ambient temperatures (greater than 85 °F), or

(2) Very high humidity (greater than 80 percent relative humidity) with normal ambient temperatures.

To reduce the probability of breakthrough and sample loss, do not exceed one-half of the recommended maximum sample volume under the above conditions.

® Cellosolve is a registered trademark of Union Carbide Corp, 270 Park Ave, New York, NY.

f. The flow rate through an adsorption tube should be determined for each individual sampling pump before field use. Only one tube need be used since all tubes are packed to provide a uniform pressure drop at the prescribed flow rate. For field sampling, changes in pressure drop and thus flow rate through the adsorption tube are assumed to be negligibly affected by packing and transport.

g. Field blank tubes will be submitted with each set of samples. If the number of samples in a set exceeds 10, then submit at the rate of one blank for each 10 samples, not to exceed 10 blanks per set. The field blank should be opened and capped; no air should be drawn through it.

h. After sampling, snugly replace plastic caps on all adsorption tubes.

6. IMPINGER SAMPLING

a. Impinger sampling, as described in this guide, generally refers to the use of midget impingers fitted with fritted bubbler nozzles. The one exception is ozone, which requires a standard nozzle with a 1 mm inside diameter opening.

b. Samples collected in glass fritted bubblers should be transferred to clean, glass-stoppered bottles with teflon lined caps. Rinse the glass fritted bubblers with a small amount of unused absorbing solution, adding the rinse to the sample. Note: Samples collected for ozone analysis should be transferred to stoppered bottles with teflon septum caps without rinsing.

c. Ground-glass surfaces and fritted bubblers used for sampling with sodium hydroxide absorbent should be thoroughly rinsed or purged with water after sampling. This prevents "freezing" or fusion of the ground-glass surfaces.

d. Reagent grade chemicals and high quality deionized or distilled water must be used in preparation of absorbing solutions.

e. One media blank of unused absorbing solution must be submitted with each set of samples.

7. BULK SAMPLING

a. Bulk sampling procedures for chemical contaminants including container type and amount of sample required are specified in table A-2.

b. When requesting an analysis for organic solvents and metals in the same sample (such as a paint), submit two portions--one for solvents and one for metals.

c. The composition of bulk "unknowns" can often be identified from the information in Material Safety Data Sheets (MSDS). Similar information on product composition may be available through the Department of Defense Hazardous Materials Information System (DOD HMIS) [DOD 6050.5L and Letter Requirement (LR)] if the National Stock Number of the item is known. For those items not in the listing, obtain the MSDS for a product from its manufacturer. If sample analysis is still required, forward the MSDS, sample, and analytical request to the appropriate supporting laboratory (app C).

8. PASSIVE (DIFFUSION TYPE) MONITORS

a. Organic solvent vapors.

(1) Passive monitors for organic solvent vapors contain an adsorbent charcoal element similar to a charcoal tube and are analyzed similarly to a charcoal tube.

(2) The passive monitors should only be used for the contaminants in table A-1 and not for collecting "unknown" organic vapors.

(3) Mixtures of several solvents may be collected only if all the solvents can be analyzed on the monitor and the sampling times are similar.

(4) Manufacturers list many solvents which can be sampled with passive monitors, however, few of these are validated procedures, and consequently are not included in this guide.

(5) A blank monitor (open bag, open monitor, then replace monitor in sample bag) is to be submitted with the field samples. Do not intentionally expose the field blank monitor to the contaminated workplace environment. Passive monitors are not recommended for ceiling or short term exposure sampling.

b. Ethylene oxide (ETO).

(1) Passive monitors for ETO manufactured by 3M® have been validated.

(2) Passive monitors for organic solvent vapors cannot be used for ETO.

9. RADON SAMPLING. For radon sampling procedures, call the USAEHA Health Physics Division, AUTOVON 584-3502.

10. FIELD BLANKS

a. The field blank--

(1) Detects a contaminant in the sorbent.

(2) Detects contamination in shipping and storage.

(3) Aids in determining interferences in the collection media.

(4) Serves as a reference in most spectrophotometric methods.

b. At least one field blank must be submitted with each set of impinger, filter, adsorption tube, or passive monitor samples from the same sampling series. If the number of samples in a set exceeds ten, then submit one blank for each ten samples, or fraction thereof. A set is one or more samples for the same contaminant(s).

c. Blanks should always be from the same lot as the sample tubes filters, or monitors. If two different lot numbers are used in sampling, then two blanks are required, one from each appropriate lot number.

d. All adsorption tubes and passive monitor blanks should be treated like samples except they should be opened and resealed immediately. Do not intentionally contaminate the field blank.

® 3M is a registered trademark of Minnesota Mining and Manufacturing Co., St. Paul, MN.

## 11. PROCEDURES FOR SUBMITTING SAMPLES

a. Air samples.

(1) Complete AEHA Form 9-R (Industrial Hygiene Air Sample Data). Instructions for completing AEHA Form 9-R are in appendix D. AEHA Form 9-R is located at the back of this technical guide. Copies may be locally reproduced on 8 1/2- by 11-inch paper.

(2) The AEHA Form 9-R must accompany all IH samples submitted for air sample analysis.

(3) Field personnel should establish a consecutive numbering system for assigning sample numbers. There should be no duplication of numbers from batch to batch. Number all samples including blanks.

(4) A "blank" must accompany all air samples, be numbered, and the word "BLANK" written on the tube, filter, bottle, passive monitor, or impinger. Indicate on the form the "blank" sample number.

(5) In CONUS, samples may be forwarded directly to either: the Commander, USAEHA, ATTN: HSHB-ML-A, Bldg E2100, APG, MD 21010-5422 or to the appropriate FSA (app C). OCONUS activities can consult their supporting laboratory (app C) for sample analysis.

b. Bulk samples.

(1) Complete AEHA Form 8-R (Bulk Sample Data). Instructions for completing AEHA Form 8-R are in appendix E. AEHA Form 8-R is located at the back of this technical guide. Copies may be locally reproduced on 8 1/2- by 11-inch paper.

(2) The AEHA Form 8-R must accompany all IH samples submitted for bulk analysis.

(3) Include the manufacturer's label information and attach the manufacturer's MSDS when possible.

(4) In CONUS, samples may be forwarded directly to either: the Commander, USAEHA, ATTN: HSHB-ML-A, Bldg E2100, APG, MD 21010-5422 or to the appropriate FSA (app C). OCONUS activities may consult their supporting laboratory (app C) for sample analysis.

# Appendix A

## Tables

Table A-1
Air sampling procedures for chemical contaminants

| Chemical contaminant | Sampling method | Sampling rate or time | Sample volume in liters minimum | Sample volume in liters maximum | USAEHA APG procedure number |
|---|---|---|---|---|---|
| Acetic acid | Chromosorb® P tube for acids (ORBO 70 acid tube) | 100-500 mL/min | 15 | 60 | (1) |
| Acetone | 200/400 mg charcoal tube | 20-100 mL/min | 1 | 6 | (2) |
| Acid mists | See specific acid | | | | |
| Alkali mists (such as NaOH, KOH) | See specific compound | | | | |
| Aluminum | Filter cassette, closed-face (CE 0.8 µm filter) | 1-3 L/min | 100 | 400 | (3) |
| **Ammonia | Ammonia tube (ORBO 77) | 100-500 mL/min | 3 | 24 | (4) |
| Amyl acetate (all isomers) | 200/400 mg charcoal tube | 20-500 mL/min | 5 | 40 | (5) |
| Aniline | 260/520 mg silica gel tube | 200-500 mL/min | 25 | 60 | (6) |
| Antimony compounds | Filter cassette, closed-face (CE 0.8 µm filter) | 1-2 L/min | 100 | 1000 | (7) |
| Arsine | 200/400 mg charcoal tube | 10-20 mL/min | 1 | 10 | (8) |
| Asbestos | 25 mm Filter cassette, open-face shrouded with 50 mm extension cowl (CE 0.8 to 1.2 µm filter) See paragraph 2a | 0.5-2.5 L/min | 360 | 2000 | (9) |
| | NOTE: For monitoring asbestos following abatement actions, sample at 1 to 5 L/min for a sample volume between 1300 and 3000 liters. | | | | |
| Azide | See Hydrazoic acid | | | | |
| Barium compounds | Filter cassette, closed-face (CE 0.8 µm filter) | 1-2 L/min | 300 | 1000 | (10) |
| Benzene | 200/400 mg charcoal tube | 50-500 mL/min | 25 | 40 | (11) |
| Beryllium | Filter cassette, closed-face with spacer (CE 0.8 µm filter) | 1-4 L/min | 250 | 1000 | (12) |

® Chromosorb is a registered trademark of Johns-Manville Products Corp., Denver, CO.

| Chemical contaminant | Sampling method | Sampling rate or time | Sample volume in liters minimum | maximum | USAEHA APG procedure number |
|---|---|---|---|---|---|
| 2-Butoxyethanol (Ethylene glycol monobutyl ether) | 200/400 mg charcoal tube (Refrigerate after sampling) | 50-500 mL/min | 10 | 40 | (13) |
| n-Butyl acetate | 200/400 mg charcoal tube | 50-200 mL/min | 5 | 30 | (5) |
| n-Butyl alcohol | 200/400 mg charcoal tube | 200 mL/min only (ceiling) | 3.0 L only | | (14) |
| tert-Butyl alcohol | 200/400 mg charcoal tube (Refrigerate after sampling) | 50-200 mL/min | 2 | 20 | (15) |
| Cadmium | Filter cassette, closed-face (CE 0.8 µm filter) | 1-3 L/min | 100 | 1500 | (16) |
| Carbon disulfide | 200/400 mg charcoal tube | 50-200 mL/min | 4 | 40 | (17) |
| Carbon tetrachloride | 200/400 mg charcoal tube | 50-500 mL/min | 25 | 40 | (18) |
| Chlordane (chlordane constituents) | 50/100 mg Chromosorb 102 Tube | 1-2 L/min | 300 | 500 | (19) |
| *Chlorpyrifos (Dursban®) | 33/66 mg Chromosorb 102 Tube | 1-2 L/min | 30 | 50 | (20) |
| Chlorobenzene | 200/400 mg charcoal tube | 50-250 mL/min | 10 | 40 | (18) |
| Chloroform | 200/400 mg charcoal tube | 50-500 mL/min | 25 | 40 | (18) |
| Chromic acid mist and Chromium VI | Filter cassette, closed-face (PVC 5.0 µm filter) See paragraph 4f. Submit three blank filters | 1-4 L/min | 100 | 400 | (21) |
| Chromium (as dust or fume) | Filter cassette, closed-face (CE 0.8 µm filter) | 1-3 L/min | 100 | 1000 | (22) |
| Copper | Filter cassette, closed-face (CE 0.8 µm filter) | 1-3 L/min | 60 | 1500 | (23) |
| Cresols | 260/520 mg silica gel tube | 50-500 mL/min | 25 | 40 | (24) |

® Dursban is a registered trademark of Dow Chemical Co., Midland, MI.

| Chemical contaminant | Sampling method | Sampling rate or time | Sample volume in liters minimum | maximum | USAEHA APG procedure number |
|---|---|---|---|---|---|
| **Cyanide | Midget impinger (10 mL of 0.2 N sodium hydroxide) (Transfer to a plastic bottle after collection.) | 1.5 L/min | 20 | 90 | (25) |
| Cyclohexanone | 200/400 mg charcoal tube | 50-500 mL/min | 7.5 | 30 | (2) |
| *Diazinon | 33/66 mg Chromosorb 102 Tube | 1-2 L/min | 30 | 50 | (20) |
| Dichlorobenzene, ortho | 200/400 mg charcoal tube | 500 mL/min only (ceiling) | 7.5 L only | | (18) |
| Dichlorobenzene, para | 200/400 mg charcoal tube | 100-500 mL/min | 7.5 | 40 | (18) |
| Dichlorodifluoromethane (Freon® 12) | 200/400 mg charcoal tube (2 tubes in series) | 50-200 mL/min | 0.5 | 5 | (26) |
| Dieldrin (dust only) | Filter cassette, closed-face (GF 37 mm) | 1.5 L/min | 160 | 200 | (27) |
| *Diesel fuel | (see Fuel oil #2) | | | | |
| 1,1 Dimethylhydrazine | Hydrazine tube [45-60 mesh activated silica gel treated with 20% (by weight) conc $H_2SO_4$] | 200-500 mL/min | 35 | 100 | (28) |
| Dioctylphthalate (DOP, Di-2-ethylhexylphthalate) | Filter cassette, closed-face with spacer (CE 0.8 µm filter) | 1.0 L/min | 30 TWA 15 peak | 120 | (29) |
| Dioxane | 200/400 mg charcoal tube | 50-500 mL/min | 7.5 | 40 | (30) |
| *Dust (total) | Filter cassette, closed-face (PVC 5.0 µm filter preweighed) (Lower volumes may be necessary in very dusty locations where filters may clog.) | 1-2 L/min | 400 | 1000 | (31) |
| *Dust (respirable) | Filter cassette, with cyclone (PVC 5.0 µm filter preweighed) | 1.7 L/min only | 500 | 816 | (31) |
| Endrin | 33/66 mg Chromosorb 102 tube | 1-2 L/min | 30 | 50 | (32) |

● Freon is a registered trademark of E. I. DuPont de Nemours and Co., Wilmington, DE.

| Chemical contaminant | Sampling method | Sampling rate or time | Sample volume in liters minimum | Sample volume in liters maximum | USAEHA APG procedure number |
|---|---|---|---|---|---|
| Enflurane (Ethrane®) | 200/400 charcoal tube or Passive monitor | 25-500 mL/min<br>1.0-8.0 hr | 5<br>- | 20<br>- | (33) |
| Epichlorohydrin | 200/400 mg charcoal tube | 20-200 mL/min | 10 | 40 | (34) |
| 2-Ethoxyethanol (Ethylene glycol monoethyl ether, Cellosolve) | 200/400 mg charcoal tube (Refrigerate after sampling) | 100-500 mL/min | 25 | 40 | (13) |
| 2-Ethoxyethyl acetate (cellosolve acetate) | 200/400 mg charcoal tube | 100-500 mL/min | 25 | 40 | (5) |
| Ethyl acetate | 200/400 mg charcoal tube | 20-500 mL/min | 2 | 20 | (35) |
| Ethyl alcohol | 200/400 mg charcoal tube (Refrigerate after sampling) | 20-50 mL/min | 0.5 | 2 | (15) |
| Ethyl cellosolve | See 2-Ethoxyethanol | | | | |
| Ethylene dichloride (1,2-Dichloroethane) | 200/400 mg charcoal tube | 50-500 mL/min | 7.5 | 20 | (18) |
| Ethylene glycol dinitrate (EGDN) | 50/100 mg Tenax tube | 0.2-1 L/min | 15 | 100 | (36) |
| Ethylene oxide (ETO) | ORBO 78 ETO tube or 3M Passive monitor for ETO | 20-200 mL/min<br>8 hr | 9.6<br>- | 20<br>- | (37)<br>(38) |
| Ethyl ether | 200/400 mg charcoal tube | 50-100 mL/min | 1 | 6 | (39) |

® Ethrane is a registered trademark of Ohio Medical Products, a Division of Airco, Inc., Madison, Wisconsin 53701.

| Chemical contaminant | Sampling method | Sampling rate or time | Sample volume in liters minimum | maximum | USAEHA APG procedure number |
|---|---|---|---|---|---|
| *Fibrous glass dust | Filter cassette, closed-face (PVC 5.0 µm preweighed filter). Quantitative analysis performed gravimetrically; fiber identification can be confirmed qualitatively by microscope upon request. Fibrous glass samples will not be counted microscopically. | 1-2 L/min | 400 | 1000 | (31) |
| *Fluorides (Aerosol and gas) | Filter cassette, closed-face with CE 0.8 µm filter, backed up with filter cassette, closed-face with $Na_2CO_3$-treated cellulose pad. Connect cassette with PVC tubing. | 1-2 L/min | 20 | 800 | (40) |
| *Forane | 200/400 mg charcoal tube | 25-500 mL/min | 5 | 20 | (18) |
| **Formaldehyde | 50/100 mg formaldehyde tube (Refrigerate after sampling) | 20-50 mL/min | 9.6 | 24 | (41) |
| Formic acid | ORBO 70 acid tube | 100-500 mL/min | 15 | 60 | (1) |
| Freon 11 | See Trichlorofluoromethane | | | | |
| Freon 12 | See Dichlorodifluoromethane | | | | |
| Freon 113 | See Trichlorotrifluoroethane | | | | |
| *Fuel oil #2 | 200/400 mg charcoal tube | 50-500 mL/min | 10 | 40 | (201) |
| *Gasoline | 200/400 mg charcoal tube | 50-500 mL/min | 7.5 | 20 | (201) |
| Halothane | 200/400 mg charcoal tube or Passive monitor | 25-500 mL/min 1.0-8.0 hr | 5 - | 20 - | (33) |
| Hexachloroethane | 200/400 mg charcoal tube | 50-200 mL/min | 10 | 40 | (18) |
| Hexane | 200/400 mg charcoal tube | 50-500 mL/min | 6 | 40 | (42) |
| Hexamethylene diisocyanate (HDI) | Midget impinger (10 mL of HCl - acetic absorbent) Absorbent preparation: 3.5 mL concentrated HCl and 2.2 mL acetic acid diluted to 100 mL with distilled or deionized water. | 1-2 L/min | 30 | 60 | (45) |

| Chemical contaminant | Sampling method | Sampling rate or time | Sample volume in liters minimum | maximum | USAEHA APG procedure number |
|---|---|---|---|---|---|
| Hydrazine | Hydrazine tube (45-60 mesh activated silica treated with 20% (by weight) conc $H_2SO_4$) | 200-500 mL/min | 35 | 100 | (28) |
| Hydrazoic acid (Hydrogen azide) | ORBO 70 tube for acids | 2 L/min only (ceiling) | 30 L only | - | (1) |
| Hydrochloric acid | 200/400 high purity silica gel tube (Inorganic acids tube) | 200 mL/min only (ceiling) | 3.0 L only | - | (44) |
| | or | | | | |
| | ORBO 70 tube for acids | 500 mL/min only (ceiling) | 7.5 L only | - | |
| Hydrofluoric acid | See Hydrogen fluoride | | | | |
| **Hydrogen cyanide | Midget impinger (10 mL of 0.2 N sodium hydroxide) (Transfer to a plastic bottle after collection.) | 1.5 L/min only (ceiling) | 22.5 L only | - | (25) |
| Hydrogen fluoride | 200/400 mg high purity silica gel tube (Inorganic acids tube) | 2.5 L/min only (ceiling) | 37.5 L only | - | (44) |
| Hydroquinone | Filter cassette, closed-face (CE 0.8 µm filter). Transfer filter immediately after sampling to glass vial containing 10 mL 1 percent acetic acid. | 1-3 L/min | 30 | 180 | (45) |
| Iron | Filter cassette, closed-face (CE 0.8 µm filter) | 1-2 L/min | 15 | 500 | (10) |
| Isobutyl acetate | 200/400 mg charcoal tube | 50-500 mL/min | 5 | 40 | (5) |
| Isobutyl alcohol | 200/400 mg charcoal tube | 50-500 mL/min | 15 | 40 | (14) |
| Isopropyl alcohol | 200/400 mg charcoal tube (Refrigerate after sampling) | 50-200 mL/min | 2 | 12 | (15) |
| *JP-4 | 200/400 mg charcoal tube | 50-500 mL/min | 7.5 | 20 | (201) |
| *Kerosene | 200/400 mg charcoal tube | 50-500 mL/min | 10 | 40 | (201) |
| Lead, inorganic (fumes and dust) | Filter cassette, closed-face (CE 0.8 µm filter) | 1-4 L/min | 200 | 1200 | (46) |

| Chemical contaminant | Sampling method | Sampling rate or time | Sample volume in liters minimum | maximum | USAEHA APG procedure number |
|---|---|---|---|---|---|
| Lead chromate | See lead, inorganic | | | | |
| Manganese | Filter cassette, closed-face (CE 0.8 μm filter) | 1-2 L/min | 50 | 500 | (10) |
| Mercury vapor | Mercury vapor detector | | | | |
| 2-Methoxyethanol (Methyl Cellosolve, Ethylene glycol monomethyl ether) | 200/400 mg charcoal tube (Refrigerate after sampling) | 100-500 mL/min | 25 | 40 | (13) |
| Methyl alcohol | 260/520 mg silica gel tube | 20-200 mL/min | 1 | 5 | (47) |
| Methyl bromide | 200/400 mg charcoal tube (petroleum base) - two tubes in series | 50-200 mL/min | 9 | 20 | (48) |
| Methyl chloroform (1,1,1-Trichloroethane) | 200/400 mg charcoal tube or | 20-500 mL/min | 1 | 20 | (18) |
| | Passive monitor | 1-4 hr | - | - | (200) |
| Methylenebis(phenyl-isocyanate) (MDI) | Midget impinger (10 mL of HCl - acetic acid absorbent). *See Hexamethylene diisocyanate for absorbent preparation.* | 1-2 L/min only | 30 | 60 | (49) |
| Methylene chloride | 200/400 mg charcoal tube | 20-200 mL/min | 1 | 12 | (50) |
| Methyl ethyl ketone (MEK) | 260/520 silica gel tube | 50-500 mL/min | 5 | 20 | (51) |
| Methyl isobutyl ketone (MIBK) | 200/400 mg charcoal tube | 20-250 mL/min | 1 | 20 | (2) |
| Methyl methacrylate | 200/400 mg XAD-2 tube | 20-100 mL/min | 3 | 6 | (52) |
| Mineral spirits | 200/400 mg charcoal tube | 50-500 mL/min | 5 | 40 | (53) |
| Molybdenum | Filter cassette, closed-face (CE 0.8 μm filter) | 1-4 L/min | 5 | 60 | (54) |
| Naphthalene | 200/400 mg charcoal tube | 200-500 mL/min | 25 | 40 | (11) |

| Chemical contaminant | Sampling method | Sampling rate or time | Sample volume in liters minimum | maximum | USAEHA APG procedure number |
|---|---|---|---|---|---|
| Nickel, soluble compounds | Filter cassette, closed-face (CE 0.8 µm filter) | 1-2 L/min | 100 | 1000 | (10) |
| Nickel, metal | Filter cassette, closed-face (CE 0.8 µm filter) | 1-2 L/min | 100 | 1000 | (10) |
| Nitric acid | 200/400 high purity silica gel tube (Inorganic acid tube) | 200-500 mL/min | 12 | 48 | (44) |
| Nitrogen dioxide | Preferred: Direct reading $NO_2$ meter or 400/600/400 mg nitrogen dioxide tube (ORBO 76) | - 20-50 mL/min | - 2 TWA 0.75 peak | - 4 | (55) |
| Nitroglycerin | 50/100 mg Tenax tube | 0.2-1 L/min | 15 | 100 | (36) |
| N-Nitrosodimethylamine | Thermosorb/N air sampler (Refrigerate after sampling) | 0.2-2 L/min | 75 Liters recommended | | (56) |
| Nitrous oxide | Portable infrared analyzer (e.g. MIRAN®) | | | | (57) |
| *Nuisance particlates | Filter cassette, closed-face (PVC, 5µm filter preweighed) | 1-2 L/min | 400 | 1000 | (31) |
| *Oil mist | Filter cassette, closed-face (preweighed/PVC 5.0 µm filter). Analysis performed gravimetrically. | 1-2 L/min | 400 | 1000 | (31) |
| Ozone | Preferred: Ozone Meter (Direct reading) Alternate: All glass midget impinger (10 mL of alkaline KI). Samples of ozone should be transferred to stoppered bottles with Teflon® lined caps, without rinsing. | 1-2 L/min | 60 | 120 | (58) |
| Pentachlorophenol | Filter cassette, closed-face with spacer (CE 0.8 µm filter) Followed by midget impinger (15 mL of ethylene glycol - Note: Do not use antifreeze in place of ethylene glycol). Ship filter, backing pad, and impinger solution combined in a glass vial with Teflon lined cap. | 1.5 L/min | 90 | 180 | (59) |

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| Chemical contaminant | Sampling method | Sampling rate or time | Sample volume in liters minimum | maximum | USAEHA APG procedure number |
|---|---|---|---|---|---|
| Pentane | 200/400 mg charcoal tube | 10-50 mL/min | 2 | 4 | (42) |
| Perchloroethylene (Tetrachloroethylene) | 200/400 mg charcoal tube | 50-500 mL/min | 5 TWA 2.5 peak | 30 | (60) |
| | or Passive monitor | 1-8 hr | - | - | (200) |
| Petroleum Distillate | 200/400 mg charcoal tube | 50-500 mL/min | 5 | 40 | (53) |
| Phenol | 260/520 silica gel tube | 50 mL/min | 3 | 20 | (61) |
| Phosphoric acid | 200/400 mg high purity silica gel tube (Inorganic acids tube) | 200-500 mL/min | 30 | 120 | (44) |
| *Polychlorinated biphenyls (PCBs) | 50/100 mg Florisil tube preceded by 13 mm glass fiber filter in Swinnex cassette | 50-200 mL/min | 12 | 48 | (62) |
| *Polynuclear Aromatic Hydrocarbons (PAH) | ORBO 43 tube preceded by 37 mm cassette containing PTFE 2 µm filter | 2 L/min | 200 | 1000 | (63) |
| *Potassium hydroxide | Filter cassette, closed-face (CE 0.8 µm filter) Submit three blank filters. | 1-2 L/min | 60 | 480 | (64) |
| n-propyl alcohol | 200/400 mg charcoal tube | 50-200 mL/min | 2 | 20 | (14) |
| Propylene dichloride (1,2 Dichloropropane) | 200/400 mg charcoal tube | 50-500 mL/min | 5 | 30 | (18) |
| Quartz (crystalline silica) | See silica, crystalline (respirable) | | | | |
| Radon | Call USAEHA, Health Physics Division, AUTOVON 584-3502 | | | | |
| RDX (cyclonite) | 50/100 mg Tenax tube | 1 L/min | 15 | 50 | (65) |
| Silica, crystalline (respirable) | Filter cassette, closed-face and 10 mm nylon cyclone (PVC 5 µm filter) See paragraph 3a. | 1.7 L/min only | 500 | 816 | (66) |

| Chemical contaminant | Sampling method | Sampling rate or time | Sample volume in liters minimum | maximum | USAEHA APG procedure number |
|---|---|---|---|---|---|
| Sodium azide | See hydrazoic acid | | | | |
| *Sodium hydroxide | Filter cassette, closed-face (CE 0.8 µm filter) Submit three blank filters. | 1-2 L/min | 60 | 480 | (64) |
| Stoddard solvent | 200/400 mg charcoal tube | 50-500 mL/min | 5 | 40 | (53) |
| Styrene | 200/400 mg charcoal tube | 50-500 mL/min | 5 | 40 | (11) |
| Sulfur dioxide | 400/600/400 mg Nitrogen dioxide tube (ORBO-76) | 20-50 mL/min | 2 | 12 | (55) |
| Sulfuric acid | 200/400 mg high purity silica gel tube (Inorganic acids tube) | 200-500 mL/min | 24 | 48 | (44) |
| Tetrahydrofuran | 200/400 mg charcoal tube | 50-250 mL/min | 5 | 24 | (67) |
| *Titanium Dioxide | Filter cassette, closed-face preweighed (PVC, 5.0 µm filter) | 1-2 L/min | 400 | 1000 | (31) |
| Toluene | 200/400 mg charcoal tube | 50-500 mL/min | 5 | 40 | (11) |
| Toluene diisocyanate (TDI) | Midget impinger (10 mL of HCl - acetic absorbent) See Hexamethylene diisocyanate for absorbent preparation. | 1-2 L/min | 30 | 60 | (49) |
| Trichloroethylene | 200/400 mg charcoal tube or | 50-500 mL/min | 5 | 40 | (68) |
| | Passive monitor | 1-8 hr | | | (200) |
| Trichlorofluoromethane (Freon 11) | 200/400 mg charcoal tube | 50 mL/min only (ceiling) | 0.75 L only | - | (69) |
| Trichlorotrifluoro-ethane (Freon 113) | 200/400 mg charcoal tube | 20-50 mL/min | 0.5 | 5 | (70) |
| Trinitrotoluene (TNT) | 50/100 mg Tenax tube 50/100 mg Tenax with filter (custom ORBO-79) | 1 L/min | 15 | 50 | (65) |
| Welding fumes (total fumes) | Filter, closed-face (PVC 5.0 µm preweighed filter) | 1-2 L/min | 400 | 1000 | (31) |

| Chemical contaminant | Sampling method | Sampling rate or time | Sample volume in liters minimum | maximum | USAEHA APG procedure number |
|---|---|---|---|---|---|
| Welding fumes (metals) | For metal analysis see specific metal. | | | | |
| White phosphorus (yellow phosphorus) | 50/100 mg Tenax tube | 200 mL/min | 12 | 12 | (71) |
| Xylenes | 200/400 mg charcoal tube | 50-500 mL/min | 5 | 40 | (11) |
| Zinc Compounds | Filter cassette, closed-face (CE 0.8 µm filter) Submit three blank filters. | 1-3 L/min | 15 | 400 | (72) |

* Methods included in this Table as "Stopgap Methods" - procedures which are not fully validated.

**Indicates the following alternate procedures are used by FSA-FAMC:

| | | | | | |
|---|---|---|---|---|---|
| Ammonia | 100/200 mg Sulfuric Acid treated silica gel tube | 100-200 mL/min | 15 | 70 | -- |
| Cyanide | Filter cassette (CE 0.8 µm filter) followed by midget impinger with 10 mL of 0.1N KOH solution | 0.5-1.0 L/min | 10 | 180 | -- |
| Formaldehyde | 1650/1650 alumina tube | 200 mL/min | 4 | 10 | -- |
| Hydrogen Cyanide | See cyanide | -- | -- | -- | -- |

Table A-2
Bulk sampling procedures for chemical contaminants

| Chemical contaminant | Container requirements | Sample size |
|---|---|---|
| Asbestos | Screw cap; glass or plastic vial. Plastic bags are not acceptable. | 1/2 inch x 1/2 inch section |
| Corrosive (acidic or basic) | All glass (for acids only) or polyethylene (for acids and bases). | 100 mL (unused material preferred) |
| Lead or chromium in paint | Screw cap; plastic container. | 20-50 mL |
| Lead in paint chips | Screw cap; glass or plastic container, or plastic envelope | 1 gram (A dime weighs about 2 grams.) Do not submit plaster or other backing materials. |
| Organic solvents including paints | All glass container, or glass container with Teflon-lined screw cap, or all metal can. Do not use plastic or paper lined caps. | 100 mL (unused material preferred) |
| Pentachlorophenol in wood | Wrap in aluminum foil. | 2 inch x 2 inch sections. Do not submit sawdust. |
| Polychlorinated biphenyls (PCBs) | Glass container with Teflon-lined screw cap. | 1-2 mL |

Table A 3
Documentation of IH air sampling procedures

| Chemical contaminant | Sampling method | Analytical method | Coefficient of variation | Reference | USAEHA APG procedure number |
|---|---|---|---|---|---|
| Acetic acid | ORBO-70 tube | Ion chromatography | 7.0% | AIHA J. 42(6):476-8 (1981) | (1) |
| Acetone | Charcoal tube | Gas chromatography, FID | 8.2% | NIOSH: 1300 (3rd Ed.) | (2) |
| Aluminum | CE filter | Atomic absorption, flame | 5.8% | NIOSH: 7013 (3rd Ed.) | (3) |
| Ammonia | Ammonia tube (ORBO-77)<br>Sulfuric acid treated silica gel tube | Ion chromatography<br>Ion specific electrode | 8.4%<br>8.0% | AIHA J. 47(2):135-137 (1986)<br>NIOSH: S347 (Vol 5, 2nd Ed.) | (4)<br>-- |
| Amyl acetate | Charcoal tube | Gas chromatography, FID | 5.1% | NIOSH: 1450 (3rd Ed.) | (5) |
| Aniline | Silica gel tube | Gas chromatography, FID | 6.0% | NIOSH: 2002 (3rd Ed.) | (6) |
| Antimony compounds | CE filter | Atomic absorption, flame | 5.9% | NIOSH: S2 (Vol. 2, 2nd Ed.) | (7) |
| Arsine | Charcoal tube | Atomic absorption, graphite furnace | 8.7% | NIOSH: 6001 (3rd Ed.) | (8) |
| Asbestos | CE filter | Microscope, counting | 25% | NIOSH: 7400 (3rd Ed.)<br>Federal Register, Vol. 51, No. 119, EPA 560/5-85-024 | (9) |
| Barium compounds | CE filter | Atomic absorption, flame | 5.8% | NIOSH: 173 (Vol. 5, 2nd Ed.) | (10) |
| Benzene | Charcoal tube | Gas chromatography, FID | 5.9% CT | NIOSH: 1501 (3rd Ed.) | (11) |

| Chemical contaminant | Sampling method | Analytical method | Coefficient of variation | Reference | USAEHA APG procedure number |
|---|---|---|---|---|---|
| Beryllium | CE filter | Atomic absorption, graphite furnace | 6.4% | NIOSH: 7102 (3rd Ed.) | (12) |
| 2 Butoxyethanol | Charcoal tube | Gas chromatography, FID | 6.0% | NIOSH: 1403 (3rd Ed.) | (13) |
| n Butyl acetate | Charcoal tube | Gas chromatography, FID | 6.9% | NIOSH: 1450 (3rd Ed.) | (5) |
| n Butyl alcohol | Charcoal tube | Gas chromatography, FID | 6.5% | NIOSH: 1401 (3rd Ed.) | (14) |
| t Butyl alcohol | Charcoal tube | Gas chromatography, FID | 7.5% | NIOSH: 1400 (3rd Ed.) | (15) |
| Cadmium | CE filter | Atomic absorption, flame | 6.0% | NIOSH: 7048 (3rd Ed.) | (16) |
| Carbon disulfide | Charcoal tube | Gas chromatography, FID | 5.9% | NIOSH: 1600 (3rd Ed.) | (17) |
| Carbon tetrachloride | Charcoal tube | Gas chromatography, FID | 9.2% | NIOSH: 1003 (3rd Ed.) | (18) |
| Chlordane (chlordane constituents) | Chromosorb 102 tube | Gas chromatography, ECD | 7.0% | NIOSH: S278 (Vol. 6, 2nd Ed.) | (19) |
| Chlorpyrifos (Dursban) | Chromosorb 102 tube | Gas chromatography, FPD | NV | Bulletin Environ. Contam. Toxicol (1984) 33:476-483 | (20) |
| Chlorobenzene | Charcoal tube | Gas chromatography, FID | 5.6% | NIOSH: 1003 (3rd Ed.) | (18) |
| Chloroform | Charcoal tube | Gas chromatography, FID | 5.7% | NIOSH: 1003 (3rd Ed.) | (18) |

| Chemical contaminant | Sampling method | Analytical method | Coefficient of variation | Reference | USAEHA APG procedure number |
|---|---|---|---|---|---|
| Chromic acid mist and Chromium VI | PVC filter | Spectrophotometry, visible | 8.4% | NIOSH: 7600 (3rd Ed.) | (21) |
| Chromium (as dust or fume) | CE filter | Atomic absorption, flame | 7.6% (Insol.)<br>8.5% (Sol.) | NIOSH: 7024 (3rd Ed.) | (22) |
| Copper | CE filter | Atomic absorption, flame | 4.4% (Fume)<br>5.1% (Dust) | NIOSH: 7029 (3rd Ed.) | (23) |
| Cresols | Silica gel tube | Gas chromatography, FID | 6.8% | NIOSH: 2001 (3rd Ed.) | (24) |
| Cyanide | Midget impinger with NaOH<br>CE filter plus impinger with KOH | Ion chromatography<br>Ion specific electrode | 4.0%<br>8.1% | ASTM: STP 786 (1982:142-152)<br>NIOSH: 7904 (3rd Ed.) | (25)<br>-- |
| Cyclohexanone | Charcoal tube | Gas chromatography, FID | 6.2% | NIOSH: 1300 (3rd Ed.) | (2) |
| Diazinon | Chromosorb 102 tube | Gas chromatography, FPD | NV | Bulletin Environ. Contam. Toxicol (1984) 33:476-483 | (20) |
| Dichlorobenzene, ortho | Charcoal tube | Gas chromatography, FID | 6.7% | NIOSH: 1003 (3rd Ed.) | (18) |
| Dichlorobenzene, para | Charcoal tube | Gas chromatography, FID | 5.2% | NIOSH: 1003 (3rd Ed.) | (18) |
| Dichlorodifluoromethane (Freon 12) | Charcoal tube | Gas chromatography, FID | 6.4% | NIOSH: S111 (Vol. 2, 2nd Ed.) | (26) |

| Chemical Contaminant | Sampling method | Analytical method | Coefficient of variation | Reference | USAEHA APG procedure number |
|---|---|---|---|---|---|
| Dieldrin (dust) | GF filter | Gas chromatography, ECD | 8.6% | NIOSH: S283 (Vol. 3, 2nd Ed.) | (27) |
| 1 Dimethylhydrazine | Hydrazine tube | Gas chromatography, FID | 4.0% | NIOSH: 248 (Vol. 1, 2nd Ed.) | (28) |
| Dioctylphthalate (DOP, Di 2 ethylhexylphthalate) | CE filter | Gas chromatography, FID | 5.7% | NIOSH: S40 (Vol. 2, 2nd Ed.) | (29) |
| Dioxane | Charcoal tube | Gas chromatography, FID | 5.4% | NIOSH: S360 (Vol. 3, 2nd Ed.) | (30) |
| Dust (total) | Preweighed PVC filter | Gravimetric, Anal. balance | NV | Inhouse procedure based on NIOSH: 0500 (3rd Ed.) | (31) |
| Dust (respirable) | Preweighed PVC filter | Gravimetric, Anal. balance | NV | Inhouse procedure based on NIOSH: 0500 (3rd Ed.) | (31) |
| Endrin | Chromosorb 102 tube | Gas chromatography, ECD | 7.1% | NIOSH: S284 (Vol. 6, 2nd Ed.) | (32) |
| Enflurane (Ethrane) | Charcoal tube or Passive monitor | Gas chromatography, FID | 8.8% (CT)<br>4.9% (PM) | AIHA J. 41(5):317-321 (1980) | (33) |
| Epichlorohydrin | Charcoal tube | Gas chromatography, FID | 5.7% | NIOSH: 1010 (3rd Ed.) | (34) |
| 2 Ethoxyethanol (Ethylene glycol monoethyl ether, Cellosolve | Charcoal tube | Gas chromatography, FID | 5.9% | NIOSH: 1403 (3rd Ed.) | (13) |

| Chemical contaminant | Sampling method | Analytical method | Coefficient of variation | Reference | USAEHA APG procedure number |
|---|---|---|---|---|---|
| 2-Ethoxyethyl acetate (Cellosolve acetate) | Charcoal tube | Gas chromatography, FID | 6.2% | NIOSH: 1450 (3rd Ed.) | (5) |
| Ethyl acetate | Charcoal tube | Gas chromatography, FID | 5.8% | NIOSH: S49 (Vol. 2, 2nd Ed.) | (35) |
| Ethyl alcohol | Charcoal tube | Gas chromatography, FID | 6.5% | NIOSH: 1400 (3rd Ed.) | (18) |
| Ethylene dichloride (1,2 Dichloroethane) | Charcoal tube | Gas chromatography, FID | 7.9% | NIOSH: 1003 (3rd Ed.) | (18) |
| Ethylene glycol dinitrate | Tenax tube | Gas chromatography, ECD | 8.9% | NIOSH: 2507 (3rd Ed.) | (36) |
| Ethylene oxide (ETO) | ORBO 78 or<br>3M Passive monitor for ETO | Gas chromatography, FID | 3.5%<br>4.3% | ANAL. CHEM. 56:1950-3 (1984)<br>AIHA J. 46(10):625-631 (1985) | (37)<br>(38) |
| Ethyl ether | Charcoal tube | Gas chromatography, FID | 5.3% | NIOSH: 1610 (3rd Ed.) | (39) |
| Fibrous glass dust | Preweighed PVC filter | Gravimetric, Anal. balance | NV | Inhouse procedure based on NIOSH: 0500 (3rd Ed.) | (31) |
| Fluorides | CE filter plus $Na_2CO_3$ treated filter | Ion chromatography | NV | NIOSH: 7903/7902 (3rd Ed.) | (40) |
| Forane | Charcoal tube | Gas chromatography, FID | NV | Inhouse procedure based on NIOSH: 1003 (3rd Ed.) | (18) |
| Formaldehyde | Formaldehyde tube<br>Alumina tube | Ion chromatography<br>Spectrophotometry, visible | 9.7%<br>7.8% | NIOSH: 318 (Vol. 6, 2nd Ed.)<br>NIOSH: 235 (Vol. 1, 2nd Ed.) | (41)<br>-- |

| Chemical contaminant | Sampling method | Analytical method | Coefficient of variation | Reference | USAEHA APG procedure number |
|---|---|---|---|---|---|
| Formic acid | ORBO 70 Acid tube | Ion chromatography | NV | AIHA J. 42(6):476-8 (1981) | (1) |
| Fuel oil #2 | Charcoal tube | Gas chromatography, FID | NV | Inhouse procedure based on NIOSH: 1550 (3rd Ed.) | (201) |
| Gasoline | Charcoal tube | Gas chromatography, FID | NV | Inhouse procedure based on NIOSH: 1550 (3rd Ed.) | (201) |
| Halothane | Charcoal tube or Passive monitor | Gas chromatography, FID | 6.4% (CT) 8.4% (PM) | AIHA J. 41(5):317-21 (1980) | (33) |
| Hexachloroethane | Charcoal tube | Gas chromatography, FID | 12.1% | NIOSH: 1003 (3rd Ed.) | (18) |
| Hexane | Charcoal tube | Gas chromatography, FID | 6.2% | NIOSH: 1500 (3rd Ed.) | (42) |
| Hexamethylene diisocyanate (HDI) | Midget impinger (10 mL of HCl - acetic acid absorbent) | Gas chromatography, ECD | 9.1% | ANAL. CHEM. 54:1572-5 (1982) | (43) |
| Hydrazine | Hydrazine tube | Gas chromatography, FID | 4.6% | NIOSH: 248 (Vol. 1, 2nd Ed.) | (28) |
| Hydrazoic acid (Hydrogen azide) | ORBO 70 tube | Ion chromatography | 7.3% | AIHA J. 42(6):476-8 (1981) | (1) |
| Hydrochloric acid | High purity silica gel tube or ORBO 70 tube for acids | Ion chromatography | 5.9% 7.1% | NIOSH: 7903 (3rd Ed.) or AIHA J. 42(6):476-8 (1981) | (44) (1) |

| Chemical contaminant | Sampling method | Analytical method | Coefficient of variation | Reference | USAEHA APG procedure number |
|---|---|---|---|---|---|
| Hydrogen cyanide | Midget impinger with NaOH<br>CE filter plus impinger with KOH | Ion chromatography<br>Ion specific electrode | 4.0%<br>8.1% | ASTM: STP 786 (1982:142-152)<br>NIOSH: 7904 (3rd Ed.) | (25)<br>-- |
| Hydrogen fluoride | High purity silica gel tube | Ion chromatography | 11.6% | NIOSH: 7903 (3rd Ed.) | (44) |
| Hydroquinone | CE filter | Liquid chromatography | 6.1% | NIOSH: 5004 (3rd Ed.) | (45) |
| Iron | CE filter | Atomic absorption, flame | 5.8% | NIOSH: 173 (Vol. 5, 2nd Ed.) | (10) |
| Isobutyl acetate | Charcoal tube | Gas chromatography, FID | 6.5% | NIOSH: 1450 (3rd Ed.) | (5) |
| Isobutyl alcohol | Charcoal tube | Gas chromatography, FID | 7.3% | NIOSH: 1401 (3rd Ed.) | (14) |
| Isopropyl alcohol | Charcoal tube | Gas chromatography, FID | 6.4% | NIOSH: 1400 (3rd Ed.) | (15) |
| JP-4 | Charcoal tube | Gas chromatography, FID | NV | Inhouse procedure based on NIOSH: 1550 (3rd Ed.) | (201) |
| Kerosene | Charcoal tube | Gas chromatography, FID | NV | Inhouse procedure based on NIOSH: 1550 (3rd Ed.) | (201) |
| Lead, inorganic (fumes and dust) | CE filter | Atomic absorption, flame | 7.2% | NIOSH: 7082 (3rd Ed.) | (46) |
| Manganese | CE filter | Atomic absorption, flame | 5.8% | NIOSH: 173 (Vol. 5, 2nd Ed.) | (10) |

| Chemical contaminant | Sampling method | Analytical method | Coefficient of variation | Reference | USAEHA APG procedure number |
|---|---|---|---|---|---|
| Mercury vapor | Mercury vapor detector | See Manufacturer's Literature | | | |
| Methoxyethanol (Methyl Cellosolve, Ethylene glycol monomethyl ether) | Charcoal tube | Gas chromatography, FID | 6.9% | NIOSH: 1403 (3rd Ed.) | (13) |
| Methyl alcohol | Silica gel tube | Gas chromatography, FID | 6.3% | NIOSH: 2000 (3rd Ed.) | (47) |
| Methyl bromide | Charcoal tube (Petroleum base) | Gas chromatography, FID | 10.3% | NIOSH: 2520 (3rd Ed.) | (48) |
| Methyl chloroform (1,1,1-Trichloroethane) | Charcoal tube or Passive monitor | Gas chromatography, FID | 5.4% (CT)<br>4.7% (PM) | NIOSH: 1003 (3rd Ed.) or<br>AIHA J. 42(10):752-6 (1981) | (18)<br>(200) |
| Methylenebis(phenyl-isocyanate) (MDI) | Midget impinger (10 mL of HCl - acetic acid absorbent) | Gas chromatography, ECD | 5.3% | AIHA J. 43(3):151-5 (1983) | (49) |
| Methylene chloride | Charcoal tube | Gas chromatography, FID | 7.3% | NIOSH: 1005 (3rd Ed.) | (50) |
| Methyl ethyl ketone | Silica gel tube | Gas chromatography, FID | 4.0% | AIHA J. 44(3):201-204 (1983) | (51) |
| Methyl isobutyl ketone (MIBK) | Charcoal tube | Gas chromatography, FID | 6.4% | NIOSH: 1300 (3rd Ed.) | (2) |
| Methyl methacrylate | XAD-2 tube | Gas chromatography, FID | 6.3% | NIOSH: S43 (Vol. 6, 2nd Ed.) | (52) |
| Mineral spirits | Charcoal tube | Gas chromatography, FID | 5.0% | NIOSH: 1550 (3rd Ed.) | (53) |

| Chemical contaminant | Sampling method | Analytical method | Coefficient of variation | Reference | USAEHA APG procedure number |
|---|---|---|---|---|---|
| Molybdenum | CE filter | Atomic absorption, flame or ICP | 4.9% | NIOSH: 7300 (3rd Ed.) | (54) |
| Naphthalene | Charcoal tube | Gas chromatography, FID | 5.5% | NIOSH: 1501 (Vol. 3, 2nd Ed.) | (11) |
| Nickel, soluble compounds | CE filter | Atomic absorption, flame | 5.8% | NIOSH: 173 (Vol. 5, 2nd Ed.) | (10) |
| Nickel, metal | CE filter | Atomic absorption, flame | 5.8% | NIOSH: 173 (Vol. 5, 2nd Ed.) | (10) |
| Nitric acid | High purity silica gel tube | Ion chromatography | 8.5% | NIOSH: 7903 (3rd Ed.) | (44) |
| Nitrogen dioxide | Direct reading $NO_2$ meter or nitrogen dioxide tube | Electrochemical sensor | - | Meter: See Manufacturer's Literature | - |
| | | Ion chromatography | 9.2% | ANAL. CHEM. 53:1689-1691 (1981) | (55) |
| Nitroglycerin | Tenax tube | Gas chromatography, ECD | 10.4% | NIOSH: 2507 (3rd Ed.) | (36) |
| N-Nitrosodimethylamine | Thermosorb/N Sampler | Gas chromatography | 3.7% | OSHA: Method No. 27 | (56) |
| Nitrous oxide | Portable infrared analyzer (e.g., MIRAN) | | | NIOSH: 6600 (3rd Ed.) See Manufacturer's Literature | (57) |
| Nuisance particulates | Preweighed PVC filter | Gravimetric, Anal. balance | NV | Inhouse procedure based on NIOSH: 0500 (3rd Ed.) | (31) |
| Oil mist | Preweighed PVC filter | Gravimetric, Anal. balance | NV | Inhouse procedure based on NIOSH: 0500 (3rd Ed.) | (31) |

| Chemical contaminant | Sampling method | Analytical method | Coefficient of variation | Reference | USAEHA APG procedure number |
|---|---|---|---|---|---|
| Ozone | Preferred: Ozone Meter (Direct reading)<br>Alternate: Midget impinger (10 mL of alkaline KI) | Spectrophotometry, visible | 8.0% | See Manufacturer's Literature<br>NIOSH: 154 (Vol. 1, 2nd Ed.) | (58) |
| Pentachlorophenol | CE filter with midget impinger (15 mL of ethylene glycol) | High performance liquid chromatography, UV | 7.2% | NIOSH: S297 (Vol. 4, 2nd Ed.) | (59) |
| Pentane | Charcoal tube | Gas chromatography, FID | 5.5% | NIOSH: 1500 (3rd Ed.) | (42) |
| Perchloroethylene (Tetrachloroethylene) | Charcoal tube or Passive monitor | Gas chromatography, FID | 5.2% (CT)<br>5.6% (PM) | NIOSH: S335 (Vol. 3, 2nd Ed.)<br>or AIHA J. 43(4):227-34 (1982) | (60)<br>(200) |
| Petroleum distillates | Charcoal tube | Gas chromatography, FID | 5.0% | NIOSH: 1550 (3rd Ed.) | (53) |
| Phenol | Silica gel tube | Gas chromatography, FID | 7.7% | Presentation #176, 1984 AIHA conference | (61) |
| Phosphoric acid | High purity silica gel tube | Gas chromatography, FID | 9.6% | NIOSH: 7903 (3rd Ed.) | (44) |
| Polychlorinated biphenyls (PCBs) | Florisil tube plus glass fiber filter | Gas chromatography, ECD | NV | NIOSH: 5503 (3rd Ed.) | (62) |
| Polynuclear Aromatic Hydrocarbons (PAH) | ORBO 43 tube and PTFE filter in series | High performance liquid chromatography, UV and fluorescence or Gas chromatography, FID | NV | NIOSH: 5506 (3rd Ed.) or 5515 (3rd Ed.) | (63) |

| Chemical contaminant | Sampling method | Analytical method | Coefficient of variation | Reference | USAEHA APG procedure number |
|---|---|---|---|---|---|
| Potassium hydroxide | CE filter | Atomic absorption, flame | NV | NIOSH Publication No. 76-105 | (64) |
| Propylene dichloride (1,2 Dichloropropane) | Charcoal tube | Gas chromatography, FID | 5.6% | NIOSH: 1003 (3rd Ed.) | (18) |
| n Propyl alcohol | Charcoal tube | Gas chromatography, FID | 7.5% | NIOSH: 1401 (3rd Ed.) | (14) |
| RDX (cyclonite) | Tenax tube | Gas chromatography, ECD | 6.7% | AIHA J. 42(8):586-9 (1981) | (65) |
| Silica, crystalline (Respirable) | PVC filter | X-ray diffraction | 9.0% | NIOSH: 7500 (3rd Ed.) | (66) |
| Sodium hydroxide | CE filter | Atomic absorption, flame | NV | NIOSH Publication No. 76-105 | (64) |
| Stoddard solvent | Charcoal tube | Gas chromatography, FID | 5.0% | NIOSH: 1550 (3rd Ed.) | (53) |
| Styrene | Charcoal tube | Gas chromatography, FID | 5.8% | NIOSH: 1501 (3rd Ed.) | (11) |
| Sulfur dioxide | Nitrogen dioxide tube | Ion chromatography | 9.4% | ANAL. CHEM. 53:1689-1691 (1981) | (55) |
| Sulfuric acid | High purity silica gel tube | Ion chromatography | 8.7% | NIOSH: 7903 (3rd Ed.) | (44) |
| Tetrahydrofuran | Charcoal tube | Gas chromatography, FID | 5.5% | NIOSH: S78 (Vol. 2, 2nd Ed.) | (67) |
| Titanium dioxide | Preweighed PVC filter | Gravimetric, Anal. balance | NV | Inhouse procedure based on NIOSH: 0500 (3rd Ed.) | (31) |

| Chemical contaminant | Sampling method | Analytical method | Coefficient of variation | Reference | USAEHA APG procedure number |
|---|---|---|---|---|---|
| Toluene | Charcoal tube | Gas chromatography, FID | 5.2% | NIOSH: 1501 (3rd Ed.) | (11) |
| Toluene diisocyanate (TDI) | Midget impinger (10 mL of HCl - acetic acid absorbent) | Gas chromatography, ECD | 5.2% | AIHA J. 44(3):151-5 (1983) | (49) |
| Trichloroethylene | Charcoal tube or Passive monitor | Gas chromatography, FID | 8.2% (CT)<br>7.7% (PM) | NIOSH: S336 (Vol. 3, 2nd Ed.) or AIHA J. 42(10):752-6 (1981) | (68)<br>(200) |
| Trichlorofluoromethane (Freon 11) | Charcoal tube | Gas chromatography, FID | 7.2% | NIOSH: S102 (Vol. 2, 2nd Ed.) | (69) |
| Trichlorotrifluoroethane (Freon 113) | Charcoal tube | Gas chromatography, FID | 7.0% | NIOSH: S129 (Vol. 2, 2nd Ed.) | (70) |
| Trinitrotoluene (TNT) | Tenax tube | Gas chromatography, ECD | 5.3% | AIHA J. 42(8):586-9 (1981) | (65) |
| Welding fumes (total fumes) | Preweighed PVC filter | Gravimetric, Anal. balance | NV | Inhouse procedure based on NIOSH: 0500 (3rd Ed.) | (31) |
| White phosphorus (yellow phosphorus) | Tenax tube | Gas chromatography, NPD | 6.0% | NIOSH: 257 (Vol. 1, 2nd Ed.) | (71) |
| Xylenes | Charcoal tube | Gas chromatography, FID | 6.0% | NIOSH: 1501 (3rd Ed.) | (11) |
| Zinc compounds | CE filter | Atomic absorption, flame | 5.8% | NIOSH: 7030 (3rd Ed.) | (72) |

# Appendix B
# IH Monitoring Supplies and Vendors
## Section I. Tables

Table B-1
Containers

| Sampler Type | Vendor | CAT No. |
|---|---|---|
| Glass container (25 mL), screw cap, Teflon disc | Pierce | 13074 (Vials)<br>12422 (Teflon Disc)<br>13219 (Screw Cap) |
| | Alltech | 9532 (Vials)<br>95322 (Teflon Disc)<br>95321 (Screw Cap) |
| | Supelco | 2-3284 (15 mL)<br>2-3285 (40 mL) |
| Plastic bottle 30 mL (1 oz) | Most scientific supply houses | Nalge 2002 or equal |

Table B-2
Filters

| Sampler Type | Size (mm) | Porosity (microns) | Suggested Vendor | CAT No. |
|---|---|---|---|---|
| Cellulose Ester (CE) | 25 | 0.8 | Gelman | 64677 |
| (For asbestos)* | 25 | 0.8 | Millipore | AWWP-025-0000 |
| | 25 | 0.8 | Nuclepore | 322575 (assembled) |
| Cellulose Ester (CE) | 37 | 0.8 | Gelman | 64678 (GN-4) |
| | 37 | 0.8 | Millipore | AAWP-037-0000 |
| | 37 | 0.8 | Nuclepore | 321541 (2-piece, assembled) |
| Glass Fiber (For PCBs) | 13 | - | SKC | 225-16 |
| | 37 | - | Gelman | Type A/E |
| PTFE (Zefluor) | 37 | 2 | Gelman | P5PJ037 |
| (For PAH) | 37 | 2 | Membrana | - |
| PVC | 37 | 5 | Gelman | 66467 |
| | 37 | 5 | Nuclepore | 361850 Filter only<br>240810 Pad only |
| Swinnex Cassette (For PCBs) | 13 | - | Millipore | SX 00-013-0000 |

* Use 25 mm monitor with 50 mm conductive extention cowl.

Table B-3
Passive Monitors

| Sampler Type | Suggested Vendor | CAT No. |
|---|---|---|
| Ethylene Oxide | 3M | 3551 (Monitor only) |
| Organic Vapor Monitor | 3M | 3500 |
| (For selected solvents) | 3M | 3520 (with backup section) |
| Pro-Tek Air Monitoring Badge | Dupont | Type GAA |
| (For selected solvents) | Dupont | Type GBB (with backup section) |

Table B-4
Tubes

| Sampler Type | Size (mg) | Suggested Vendor | CAT No. |
|---|---|---|---|
| Alumina | 1650/1650 | SKC | ST 226-64 |
| Ammonia | 250/500 | Supelco | ORBO 77 |
| Charcoal | 200/400 | SKC | ST 226-09 |
| (For solvents) | 200/400 | Supelco | 2-0228 |
| | 50/100 | SKC | ST 226-01 |
| | 50/100 | Supelco | 2-0267 |
| | 50/100 | MDA | 808101 |
| Charcoal (For methyl bromide only) | 200/400 | SKC | ST 226-38-02 |
| Chromosorb 102 | 50/100 | SKC | ST 226-49-23-102 |
| (For pesticides) | 50/100 | Supelco | 2-0264 |
| | 33/66 | Supelco | 2-0262 |
| Chromosorb P for Acids (ORBO-70) | 165/335 | Supelco | ORBO-70 |
| Ethylene Oxide | 200/400 | Supelco | ORBO-78 |
| Florisil | 50/100 | SKC | ST 226-39 |
| Formaldehyde | 50/100 | SKC | ST 226-45 |
| Hydrazine | 200/200 | SKC | ST 226-42 |
| Inorganic Acids | 200/400 | Supelco | ORBO-53 |
| (High Purity Silica Gel) | 200/400 | SKC | ST 226-10-03 |
| Nitrogen Dioxide (For $NO_2$, $SO_2$) | 400/600/400 | Supelco | ORBO-76 |
| ORBO-70 | See Chromosorb P for Acids | | |
| PAH (Polyaromatic Hydrocarbons) | 50/100 | Supelco | ORBO-43 |
| Pesticide, OSHA | - | Supelco | Custom ORBO-80 |
| Silica Gel | 260/520 | SKC | ST 226-15 |
| Silica Gel, High Purity | See Inorganic Acids | | |
| Silica Gel, $H_2SO_4$ treated | 100/200 | SKC | ST 226-10-06 |
| Tenax | 50/100 | SKC | ST 226-35-03 |
| Tenax with built in filter | 50/100 | Supelco | Custom ORBO-79 |
| Thermosorb/N Air Sampler | | Thermedics | 6533 |
| XAD-2 | 200/400 | SKC | ST 226 30 06 |

## Section II. Vendors

1. Alltech Associates, Inc.
   Applied Science Labs
   2051 Waukegan Road
   Deerfield, IL 60015
   (312) 948-8600
   (800) 255-8324

2. E.I. Dupont de Nemours & Co., Inc.
   Applied Technology Division
   Wilmington, DE 19898
   (215) 444-4035
   (800) 344-4900

3. Gelman Sciences
   600 South Wagner Road
   Ann Arbor, MI 48106
   (313) 665-0651
   (800) 521-1520

4. Membrana Inc.
   7070 Commerce Circle
   Pleasanton, CA 94566-3294
   (415) 846-8270

5. Millipore Corp.
   Ashby Road
   Bedford, MA 01730
   (617) 275-9200
   (800) 225-1380

6. Minnesota Mining & Mfg. Co.
   Occupational Health & Safety
   Products Division
   3M Center, 220-7W-02
   St. Paul, MN 55144
   (612) 733-8465
   (800) 328-1300

7. Nuclepore Corp.
   7035 Commerce Circle
   Pleasanton, CA 94566-3294
   (415) 463-2530
   (800) 882-7711

8. Pierce Chemical Company
   PO Box 117
   Rockford, IL 61105
   (815) 968-0747
   (800) 874-3723

9. SKC Inc.
   RD 1, 395 Valley View Road
   Eighty Four, PA 15330-9614
   (412) 941-7701
   (800) 752-8472

10. Supelco
    Supelco Park
    Bellefonte, PA 16823-0048
    (800) 247-6628
    (814) 359-3441
    (814) 359-3446

11. Thermedics, Inc
    470 Wildwood St.
    PO Box 2999
    Woburn, MA 01888-1799
    (617) 938-3786

Appendix C
Supporting Laboratories and Areas Served

| Supporting laboratory | Areas served |
|---|---|
| U.S. Army Environmental Hygiene Agency<br>Field Support Activity<br>Fort McPherson, GA 30330-5000<br>AUTOVON 57?-3234 | Alabama, Arkansas, Florida, Georgia, Western Kentucky, Louisiana, Mississippi, Oklahoma, Panama, Puerto Rico, South Carolina, Tennessee, Central & Eastern Texas |
| U.S. Army Environmental Hygiene Agency<br>Field Support Activity<br>Fitzsimons Army Medical Center<br>Aurora, CO 80045-5001<br>AUTOVON 943-8288 | Alaska, Arizona, California, Colorado, Idaho, Illinios, Iowa, Kansas, Michigan, Minnesota, Missouri, Montana, Nebraska, Nevada, New Mexico, North Dakota, Oregon, South Dakota, West Texas, Utah, Washington, Wisconsin, Wyoming |
| Commander<br>U.S. Army Pacific Environmental Health Engineering Agency<br>Sagami<br>APO San Francisco 96343<br>Camp Zama 228-4111 | Hawaii, Japan, Korea. Okinawa, Philippines, Thailand, and all other Far East |
| Commander<br>10th Medical Laboratory<br>ATTN: AEMML-PM-LAB<br>APO New York 09180<br>Landstuhl Military (2223-)7272 | Europe, Africa, Middle East, Western Europe, Turkey, Africa, and Middle East |
| Commander<br>U.S. Army Environmental Hygiene Agency<br>ATTN: HSHB-ML-A<br>Bldg E2100<br>Aberdeen Proving Ground, MD 21010-5422<br>AUTOVON:<br>584-2619 (metals, quartz, asbestos)<br>584-2208 (solvents, organics, acid mists, pesticides) | a. Worldwide support to laboratories listed above<br>b. Connecticut, Delaware, District of Columbia, Eastern Kentucky, Indiana, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, North Carolina, Ohio, Pennsylvania, Rhode Island, Vermont, Virginia, West Virginia |

Appendix D
Instructions for Completing AEHA Form 9-R, Industrial Hygiene Air Sample Data

1. Return address: Self explanatory.

2. Point of contact: Name and AUTOVON number of person in charge of sampling/project.

3. Samples collected by: Self explanatory.

4. Date collected: Self explanatory.

5. Date shipped: Date samples sent for analysis.

6. Associated bulk samples: Indicate whether bulk samples of materials used in the operation are being submitted along with corresponding air samples. If so, list the sample numbers which identify these bulks. Note: Bulk samples must be shipped separately from air samples.

7. Project number: For USAEHA and FSA use only.

8. Sampled installation: Self explanatory.

9. ARLOC: Army Location Code: reference - DA Pam 525-12 (CONUS) and 525-13 (Foreign).

10. Location (bldg/area): Self explanatory.

11. Description of operation: Briefly describe the industrial operation (e.g., degreasing metal parts, spray painting, vehicles, etc.)

12. Persons exposed/hrs per day: Self explanatory.

13. Method of collection: Air sampling medium used to collect samples (e.g., charcoal tube, 0.8 µm CE filter, etc.).

14. Associated complaints: List worker complaints (e.g., dizziness, nausea, skin irritation, etc.) about exposure problems arising from operation.

15. Analysis desired: List specific parameters when they are known or suspected to be present; otherwise, indicate general type of analysis desired (e.g., unknown solvents, etc.).

16. Sampling data.

a. Sample number: Number assigned to the sample by field personnel. Note: Use a consecutive numbering system so there is no duplication of numbers from batch to batch of samples. Number all samples including blanks.

b. Pump number: Identifying number for sampling pump (if used).

(1) Time on: Start time of pump (e.g., 1430).

(2) Time off: Stop time of pump (e.g., 1615).

(3) Total time: Sampling time in minutes (e.g., 105 min).

c. Flow rate: Sampling rate of pump in liters per minute. If the initial and final calibration flow rates are different, a volume calculated using the higher flow rate should be reported to the laboratory. If an overexposure can not be established using the higher flow rate, the industrial hygienist should recalculate the sample concentration using the lower flow rate. If the concentration using the lower flow rate exceeds the exposure limits, resampling should be considered.

d. Volume: Air volume sampled in liters.

e. GA/BZ: Enter GA if a general area sample or BZ if a breathing zone sample.

f. Employee name/ID: Self explanatory.
Note: Name and social security number is considered Privacy Act information and should be protected.

g. Laboratory number: Leave blank.

17. Results: Lab will provide results in the common conversion (such as ppm, $mg/m^3$, f/cc, etc.).

18. Comments to lab: Insert any comments or information necessary on a particular sample.

19. Lab use only: Leave blank.

20. Calibration information: Self explanatory.

21. Operation: Self explanatory.

22. Personal protective equipment: Check box if equipment is worn. Specify type if applicable.

23. Field notes/additional comments: Self explanatory.

Appendix E
Instructions for Completing AEHA Form 8-R, Bulk Sample Data

1. Return address: Self explanatory.

2. Point of contact: Name and AUTOVON number of person in charge of sampling/project.

3. Sampled installation: Self explanatory.

4. Project number: For USAEHA and FSA use only.

5. ARLOC: Army location code - reference DA PAM 525-12 (CONUS) and 525-13 (Foreign).

6. Samples collected by: Self explanatory.

7. Date collected: Self explanatory.

8. Date shipped: Date samples sent for analysis.

9. Description of operation: Brief description of the industrial operation (e.g., degreasing metal parts, spray painting vehicles, etc.).

10. Location (bldg/area): Self explanatory.

11. Associated complaints: Worker complaints about exposure problems arising from operation (e.g., dizziness, nausea, skin irritation, etc.).

12. Associated air samples: If air samples corresponding to these bulks are submitted for analysis, please so indicate and list the sample numbers which identify these air samples. Air samples must be shipped separately from bulk samples.

13. Label information:

a. Trade name: Self explanatory; if unknown, so indicate.

b. NSN: If available, so indicate.

c. Manufacturer: Self explanatory; if unknown, so indicate.

d. Address: Self explanatory; if unknown, so indicate.

e. MSDS: Attach the MSDS whenever possible and so indicate.

14. Analysis desired: List specific parameters when they are known or suspected to be present otherwise, indicate general type of analysis desired (e.g., unknown solvents, etc.).

15. Lab use only: Leave blank.

16. Sample number: Number that field personnel assigns is the sample number. Use a consecutive numbering system so there is no duplication of numbers from batch to batch of samples.

17. Constituents: Leave blank.

18. Results: Leave blank.

19. Remarks: Leave blank.

20. Comments to lab: Use for any general information or remarks you wish to include.

21. Lab use only: Leave blank.

# Appendix F
# References

## Section I.
## Required Publications

| | |
|---|---|
| DOD 6050.5-L | (DOD Hazardous Materials Information System Hazardous Item Listing). Cited in paragraph 7c. (This listing is available from the U.S. Army AG Publication Center, 2800 Eastern Blvd., Baltimore, MD 21220-2896. |
| DOD 6050.5-LR | (DOD Hazardous Materials Information System Hazardous Item Listing). Cited in paragraph 7c. (This listing is for U.S. Government use only limited because it contains proprietary (limited rights) data. Copies are available from the U.S. Army AG Publication Center, 2800 Eastern Blvd., Baltimore, MD 21220-2895.) |
| DA Pamphlet 525-12 | (Army Location Codes - CONUS). Cited in appendixes D and E. |
| DA Pamphlet 525-13 | (Army Location Codes - CONUS). Cited in appendixes D and E. |

## Section II.
## Related Publications*

| | |
|---|---|
| Title 49 CFR Chapter 1, Subchapter C | (Hazardous Materials Regulations) |

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* A related publication is merely a source of additional information. The user does not have to read it to understand this document.

| | |
|---|---|
| DHEW (NIOSH) Publication No. 75-120 | (Criteria for a Recommended Standard: Occupational Exposure for Crystalline Silica) (This publication is available from Publications Dissemination, DTS, NIOSH, 4676 Columbia Parkway, Cincinnati, OH 45226.) |
| DHEW (NIOSH) Publication No. 76-105 | (Criteria for a Recommended Standard: Occupational Exposure to Sodium Hydroxide) (This publication is available from Publications Dissemination, DTS, NIOSH, 4676 Columbia Parkway, Cincinnati, OH 45226.) |
| DHEW (NIOSH) Publication No. 77-140 | (Criteria for a Recommended Standard: Occupational Exposure to Waste Anesthetic Gases and Vapors) (This publication is available from Publications Dissemination, DTS, NIOSH, 4676 Columbia Parkway, Cincinnati, OH 45226.) |
| DHEW (NIOSH) Publication No. 77-147A | (Manual of Analytical Methods. Vol 1) (This publication is available from Publications Dissemination, DTS, NIOSH, 4676 Columbia Parkway, Cincinnati, OH 45226.) |
| DHEW (NIOSH) Publication No. 77-157B | (Manual of Analytical Methods. Vol 2) (This publication is available from Publications Dissemination, DTS, NIOSH, 4676 Columbia Parkway, Cincinnati, OH 45226.) |
| DHEW (NIOSH) Publication No. 77-157C | (Manual of Analytical Methods, Vol 3) (This publication is available from Publications Dissemination, DTS, NIOSH. 4676 Columbia Parkway, Cincinnati, OH 45226.) |

| | |
|---|---|
| DHEW (NIOSH) Publication No. 78-175 | (Manual of Analytical Methods, Vol 4) (This publication is available from Publications Dissemination, DTS, NIOSH) 4676 Columbia Parkway, Cincinnati, OH 45226.) |
| DHEW (NIOSH) Publication No. 79-141 | (Manual of Analytical Methods, Vol 5) (This publication is available from Publications Dissemination, DTS, NIOSH, 4676 Columbia Parkway, Cincinnati, OH 45226.) |
| DHEW (NIOSH) Publication No. 80-125 | (Manual of Analytical Methods, Vol 6) (This publication is available from Publications Dissemination, DTS, NIOSH, 4676 Columbia Parkway, Cincinnati, OH 45226.) |
| DHEW (NIOSH) Publication No. 82-100 | (Manual of Analytical Methods, Vol 7) (This publication is available from Publications Dissemination, DTS, NIOSH, 4676 Columbia Parkway, Cincinnati, OH 45226.) |
| DHHS (NIOSH) Publication No. 84-100 | (NIOSH Manual of Analytical Methods. 3rd Ed., Peter M. Eller, Editor) (This publication is available from Publications Dissemination, DTS, NIOSH, 4676 Columbia Parkway, Cincinnati, OH 45226.) |
| TLVs® Booklet | (TLVs® - Threshold Limit Values and Biological Exposure Indices for the current year.) (This publication is available from ACGIH, 6500 Glenway Ave., Bldg D-5, Cincinnati, OH 45211.) |

APPENDIX G
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## GLOSSARY

APG.....Aberdeen Proving Ground

CE.....cellulose ester

CONUS.....continental United States

Cr.....chromium

CT.....charcoal tube

CV.....coefficient of variation

DOD.....Department of Defense

ECD.....electron capture detector

ETO.....ethylene oxide

FAMC.....Fitzsimons Army Medical Center

FID.....flame ionization detector

FPD.....flame photometric detector

FSA.....field support activity

GF.....glass fiber

HMIS.....hazardous materials information system

ICP.....inductively coupled plazma

ID.....inside diameter

IH.....industrial hygiene

LR.....letter requirement

MSDS.....material safety data sheets

NIOSH.....National Institute for Occupational Safety and Health

NPD.....nitorgen phosphorus detector

NV.....not validated

OCONUS.....outside continental United States

PCB.....polychlorinated biphenyls

PM.....passive monitor

PTFE.....polymer of tetrafluoroethylene

PVC.....polyvinyl chloride

TDI.....toluene diisocyanate

TLV.....threshold limit value

TNT.....trinitrotoluene

TWA.....time weighted average

USAEHA.....US Army Environmental Hygiene Agency

UV.....ultraviolet

## INDUSTRIAL HYGIENE AIR SAMPLE DATA

*For use of this form see USAEHA TG 141; the proponent is HSHB-LO.*

| | | | |
|---|---|---|---|
| **Return Address** *(complete address including Zip Code)* | | | **Point of Contact** *(name/AUTOVON)* |
| **Samples Collected By** | **Date Collected** | **Date Shipped** | **Associated Bulk Samples** ☐ Yes ☐ No Bulk Sample No(s): |
| **Project Number** | **Sampled Installation** | | **ARLOC** ☐☐☐☐☐ |
| **Location** *(BLDG/AREA)* | **Description of Operation** *(details on reverse)* | | |
| ☐ **Persons Exposed** ☐ **Hrs/Day** | **Method of Collection** | | |
| **Associated Complaints** *(be specific) (state NONE if applicable)* | | | |
| **Analysis Desired** | | | |

**Sampling Data**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Sample No. | | | | | | | | |
| Pump No. | | | | | | | | BLANK |
| Time On | | | | | | | | |
| Time Off | | | | | | | | |
| Total Time (min) | | | | | | | | |
| Flow Rate (LPM) | | | | | | | | |
| Volume (Liters) | | | | | | | | |
| GA/BZ | | | | | | | | |
| Employee Name/ID | | | | | | | | |
| Laboratory No. | | | | | | | | |

**Results**

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**Comments to Lab:**

**Lab Use Only**

| Analyst *(initials)* | Reviewed By *(initials)* | Date Received | Date Dispatched |
|---|---|---|---|
| | | | |

AEHA Form 9-R, 1 Oct 84

Replaces AEHA Form 9, 1 Oct 80 which is obsolete.

## Calibration Information

| Pump No. | Calibration (L/min) Pre-Use | Calibration (L/min) Post-Use | Rotometer Setting | Date |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

Name of Calibrator

## Operation

Source of Contaminant:

Operation Employee(s) Perform:

Ventilation: ☐ Local Exhaust ☐ General Area ☐ None

## Personal Protective Equipment *(check if worn)*

☐ Respiratory Protective Equipment Type: _____

☐ Protective Clothing Type: _____

☐ Gloves Type: _____

☐ Goggles/Face Shield

☐ Ear Protection

☐ Other: _____

## Field Notes/Additional Comments

## BULK SAMPLE DATA

*For use of this form see USAEHA TG 141; the proponent is HSHB-LO.*

| **Return Address** *(complete address including Zip Code)* | **Point of Contact** *(name/AUTOVON)* |
|---|---|
| | |

| **Sampled Installation** | **Project Number** | **ARLOC** |
|---|---|---|
| | | ☐☐☐☐☐ |
| **Samples Collected By** | **Date Collected** | **Date Shipped** |
| | | |
| **Description of Operation** | | **Location** *(BLDG/AREA)* |
| | | |

**Associated Complaints** *(be specific)*

**Associated Air Samples** If yes, list sample numbers

☐ Yes ☐ No

**Label Information**

| Trade Name | NSN | Manufacturer |
|---|---|---|
| | | |
| Address | | MSDS Attached ☐ Yes ☐ No |
| | | |

**Analysis Desired**

| Lab Use Only | Sample No. | Constituents | Results | Remarks |
|---|---|---|---|---|
| | | | | |
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| | | | | |

**Comments to Lab:**

**Lab Use Only**

| Analyst *(initials)* | Reviewed By *(initials)* | Date Received | Date Reported |
|---|---|---|---|
| | | | |

| Procedures Performed | Comments: |
|---|---|
| | |

AEHA Form 8-R, 1 Oct 84

Replaces AEHA Form 8, 1 Oct 80 which is obsolete.