

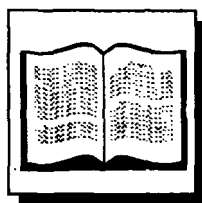


Personal Air Sampling and Air Monitoring Requirements Under 29 CFR 1910.120

Office of Emergency and Remedial Response
Emergency Response Division MS-101

Quick Reference Fact Sheet

Background and Purpose



Under the authority of Section 126 of the Superfund Amendments and Reauthorization Act of 1986 (SARA Title I), the U.S. Environmental Protection Agency (EPA) and the U.S. Occupational Safety and Health Administration (OSHA) issued identical health and safety standards to protect workers engaged in hazardous waste operations and emergency response. The OSHA regulations, codified at 29 CFR 1910.120, became effective on March 6, 1990 (54 FR 9294). On April 13, 1990, corrections to these regulations were published (55 FR 14072) to clarify certain medical surveillance requirements and to identify which employers must comply with 29 CFR 1910.120(p). The EPA regulations, published on June 23, 1989, at 54 FR 26654, incorporate the OSHA standards by reference and are codified at 40 CFR Part 311.

Although the two sets of standards contain identical substantive provisions, the EPA and OSHA standards address different audiences. In states that do not have an OSHA-approved program, federal OSHA standards protect all private and federal employees engaged in hazardous waste operations and emergency response; EPA worker protection standards protect all state and local government employees. In states that do have an OSHA-approved program, the state program covers all private, state, and local government employees; OSHA covers federal employees. The OSWER Fact Sheet, *Hazardous Waste Operations and Emergency Response (HAZWOPER): Uncontrolled Hazardous Waste Sites and RCRA Corrective Action* (OSWER Publication 9285.2-08FS, 1991), provides a general overview of the worker protection standards as they apply to operations conducted at uncontrolled hazardous waste sites.

OSHA requirements for monitoring at uncontrolled hazardous waste sites are codified at 29 CFR 1910.120(h). While the provisions outlined in this

section may be interpreted to include the collection of samples (i.e., surface wipes in the support area on a lead-contaminated site), the purpose of this Fact Sheet is to summarize the HAZWOPER air monitoring and sampling aspects of these requirements. The Fact Sheet is composed of five parts: (1) Introduction to Air Monitoring and Air Sampling; (2) Air Monitoring Requirements Upon Initial Entry; (3) Air Monitoring Requirements After Initial Entry; (4) Conducting Air Monitoring and Sampling; and (5) Information Sources and Contacts.

Introduction to Air Monitoring and Air Sampling



The presence of hazardous materials at a site, as well as actions taken to address these materials, can result in the release of hazardous substances into the air. Chemical fires, transportation accidents, open or leaking containers, wind-blown dust, and site cleanup activities all produce emissions that can rapidly affect the health and safety of response personnel (site workers or emergency response) and the public. Hazardous atmospheres may be:

- Explosive (characterized by the presence of ignitable or explosive vapors, gases, aerosols, and dusts);
- Toxic/hazardous (characterized by the presence of vapors, gases, particulates, and aerosols);
- Oxygen-deficient (characterized by the consumption or displacement of oxygen in ambient air); or
- Radioactive (characterized by the presence of radioactive materials).

The presence of one or more of these hazards is an important factor in determining subsequent actions that should be taken to protect workers, the community, and the environment. Their presence may dictate operations that are necessary to mitigate the likelihood of an incident, and will dictate safety considerations for response personnel.

OSHA requirements for air monitoring are set forth in the HAZWOPER standards at 29 CFR 1910.120(h). Specifically, §1910.120(h)(1)(i) states that monitoring must be performed "where there may be a question of employee exposure to hazardous concentrations of hazardous substances in order to assure proper selection of engineering controls, work practices and personal protective equipment [PPE] so that employees are not exposed to levels which exceed permissible exposure limits [PELs], or other published exposure levels...." The regulations also require air monitoring for use in identifying health hazards in order to determine appropriate level of PPE. Once the appropriate PPE is selected, personal air sampling should be continued in order to ensure that personnel exposures are not exceeding these limitations.

NOTE: OSHA does not define the term "air monitoring." Rather, OSHA uses this term to refer to both monitoring using direct reading instrumentation and to air sampling using personal sampling pumps or other quantitative methods. However, in this Fact Sheet, the term "air monitoring" refers to the use of direct reading instruments producing instantaneous data, while the term "air sampling" refers to the use of a sampling pump and collection media that produce samples that must be sent to a laboratory for analysis. The specific distinctive features of each are:

Air monitoring:

- Provides "real-time" results;
- Provides rapid response;
- Is generally not compound-specific;
- Has limited detection levels; and
- May not detect certain classes of compounds.

Air sampling:

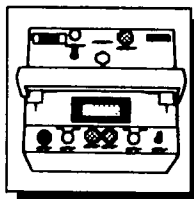
- Can be compound- or class-specific;
- Provides greater accuracy of detection;
- Requires more time for results; and
- Requires additional pumps, media, analytical support.

One example of the difference between air monitoring and air sampling is that air monitoring can be performed to identify the existence of a hazardous atmosphere during initial site entry, while air sampling is performed to identify and quantify an employee's personal exposure to a hazardous chemical or range of hazardous chemicals. Further, air monitoring data are instantaneous and are useful in comparing conservative action guidelines to determine an appropriate level of protection relative to the work activity. Air sampling data are information used to compare an employee's exposure to OSHA 1971 time-weighted average PELs (PEL-TWA), PEL-ceiling (PEL-C), the American Conference of Governmental Industrial Hygienists time-weighted average Threshold Limit Values (TLV-TWA), and associated values (STEL,C).

In addition to the requirements at 29 CFR 1910.120(h), OSHA mandates air sampling for specific chemical contaminants under 29 CFR 1910.1000, which lists approximately 428 substances in Tables Z-1-A, Z-2, and Z-3. OSHA also has comprehensive health standards that have additional PELs and other requirements (see **Highlight 1**). Consult individual standards for specifics.

NOTE: The U.S. Court of Appeals, Eleventh Circuit, issued a decision on July 7, 1992, vacating the "Final Rule" of the Air Contaminants Standard. A decision was made on March 22, 1993, not to appeal to the Supreme Court, and the Eleventh Circuit Court's decision stands. Employers and Employees can find the 1971 permissible exposure limits that are now in effect listed in the Air Contaminants Standard, in the columns headed "Transitional Limits" in Table Z-1-A and in Tables Z-2 and Z-3 in 29 CFR 1910.1000 (1989 or later).

Air Monitoring Requirements Upon Initial Entry



During the initial site entry, information is gathered to evaluate site-specific risks and hazards. This information is used to select and develop site-specific engineering/administrative controls, PPE, medical monitoring, and air sampling requirements. **Highlight 2** identifies some of the contaminant and hazard risks that may be encountered during initial site entry.

Highlight 1
SUBPART Z, TOXIC AND HAZARDOUS
SUBSTANCES

| | |
|------------------|---|
| 29 CFR 1910.1001 | Asbestos, tremolite, anthophyllite, and actinolite |
| 29 CFR 1910.1002 | Coal tar pitch volatiles (interpretation of term) |
| 29 CFR 1910.1003 | 4-Nitrobiphenyl |
| 29 CFR 1910.1004 | alpha-Naphthylamine |
| 29 CFR 1910.1006 | Methyl chloromethyl ether |
| 29 CFR 1910.1007 | 3,3'-Dichlorobenzidine (and its salts) |
| 29 CFR 1910.1008 | bis-Chloromethyl ether |
| 29 CFR 1910.1009 | beta-Naphthylamine |
| 29 CFR 1910.1010 | Benzidine |
| 29 CFR 1910.1011 | 4-Aminodiphenyl |
| 29 CFR 1910.1012 | Ethyleneimine |
| 29 CFR 1910.1013 | beta-Propiolactone |
| 29 CFR 1910.1014 | 2-Acetylaminofluorene |
| 29 CFR 1910.1015 | 4-Dimethylaminoazobenzene |
| 29 CFR 1910.1016 | N-Nitrosodimethylamine |
| 29 CFR 1910.1017 | Vinyl chloride |
| 29 CFR 1910.1018 | Inorganic arsenic |
| 29 CFR 1910.1025 | Lead |
| 29 CFR 1910.1027 | Cadmium |
| 29 CFR 1910.1028 | Benzene |
| 29 CFR 1910.1029 | Coke oven emissions |
| 29 CFR 1910.1043 | Cotton dust |
| 29 CFR 1910.1044 | 1,2-dibromo-3-chloropropane |
| 29 CFR 1910.1045 | Acrylonitrile |
| 29 CFR 1910.1047 | Ethylene oxide |
| 29 CFR 1910.1048 | Formaldehyde |
| 29 CFR 1910.1101 | Asbestos (Applies in lieu of revised standards governing occupational exposure to asbestos, tremolite, anthophyllite, and actinolite) |

Air monitoring techniques are used to assess the risks that may be present during initial site entry. As specified at 29 CFR 1910.120(h)(2), air monitoring must be conducted during the initial site entry to identify:

- IDLH conditions;
- Exposure over permissible exposure limits or published exposure levels;
- Exposure over radioactive materials dose limits; or
- Exposure to other dangerous conditions (e.g. presence of flammable atmospheres or oxygen-deficient environments).

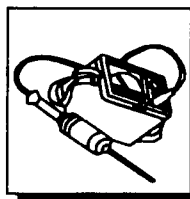
Highlight 2
CONTAMINANT AND HAZARD RISKS DURING
INITIAL SITE ENTRY

- Exposure exceeding the OSHA PELs or other published exposure levels;
 - Exposure to immediately dangerous to life and health (IDLH) concentrations;
 - Exposure through skin absorption and irritation (chemical or biological);
 - Eye irritation;
 - Explosions resulting from shock-sensitive substances and flammable atmospheres;
 - Confined space-entry;
 - Injury from physical hazards; and
-
- Exposure to radioactive (ionizing radiation) materials.

NOTE: While required in 29 CFR 1910.120 (h)(2), monitoring for radioactive materials under initial entry conditions is not an "air" monitoring technique. If the main concern is to identify exposure over radioactive material dose limits, the contaminant of interest is gamma radiation. Gamma radiation is not air-matrix dependent.

Air sampling is not usually performed during the initial entry. Instead, information about the potential chemical hazards is gathered during the initial entry and used to make decisions about air sampling needs. For any contaminants discovered during the initial entry that are regulated by 29 CFR 1910.1000 or Subpart Z (see Highlight 1) or that could be considered hazardous, the air sampling needs must be assessed according to the requirements.

Air Monitoring Requirements After Initial Entry - Periodic Monitoring



Site conditions and atmospheric chemical conditions may change following the initial site characterization. As stated at 29 CFR 1910.120(h)(3), periodic monitoring must be conducted when "the possibility of an IDLH condition or flammable atmosphere has developed or when there is indication that exposures may have risen over permissible exposure limits or published exposure

levels since prior monitoring." **Highlight 3** identifies situations that call for periodic monitoring required at 29 CFR 1910.120(h)(3)(i-iv).

Highlight 3
SITUATIONS THAT REQUIRE
PERIODIC MONITORING

- When work begins on a different portion of the site;
- When contaminants other than those previously identified are being handled;
- When a different type of operation is initiated (e.g., drum opening as opposed to exploratory well drilling); or
- When employees are handling leaking drums or containers, or working in areas with obvious liquid contamination (e.g., a spill or a lagoon).

Once cleanup activities begin on-site, 29 CFR 1910.120(h)(4) requires employers to "monitor those employees likely to have the highest exposures to hazardous substances and health hazards likely to be present above permissible exposure limits or published exposure levels by using personal sampling frequently enough to characterize employee exposures." Air sampling for high-risk employees is performed to identify the "worst-case exposure." If the worst-case exposure is above the PEL, then monitoring should be conducted to identify all employees likely to be above those limits. (Note: It is not required to monitor employees engaged in site characterization operations covered under 29 CFR 1910.120(c). Appropriate PPE based upon the preliminary evaluation is required.)

Post-initial entry situations that require periodic monitoring also should be characterized by air sampling, as appropriate, and should be determined by a competent health and safety professional. Air sampling information can be compared to the air monitoring data for the same period of time to: (1) illustrate trends in the accuracy of the air monitoring data; (2) develop a correlation to the air monitoring readings; and (3) develop better air monitoring action guidelines. Air monitoring data may also be used to determine when further sampling is needed (i.e., if site conditions have changed).

Personal sampling generally is not used to characterize overall site air quality. However, air sampling conducted in areas of high concentration may assist in determining whether personal sampling is necessary. Air sampling may also assist On-Scene Coordinators (OSCs), Remedial Project Managers (RPMs), or other site managers in determining whether chemical contaminants covered under 29 CFR 1910.1000, Subpart Z, need to be monitored.

An air sampling strategy outlined in the site-specific health and safety plan must address frequency and type of air monitoring, personal monitoring, and environmental sampling (29 CFR 1910.120(b)(4)(ii)(E)). **Highlight 4** identifies additional information that should be provided in area and personnel air sampling strategies.

Highlight 4
EXAMPLES OF ELEMENTS TO INCLUDE IN
AN AREA AIR SAMPLING STRATEGY

- The locations where air sampling will be performed;
- The hazardous substances that will be sampled during the task;
- The duration of the sample;
- The equipment that will be used to sample for the different hazardous substances; and
- Collection of meteorological data.

EXAMPLES OF ELEMENTS TO INCLUDE IN
A PERSONNEL AIR SAMPLING STRATEGY

- Employee sampled;
- Tasks performed;
- Duration;
- Hazardous substances; and
- Equipment to be used.

Conducting Air Monitoring



Table 1 at the end of this Fact Sheet, "Summary of Direct-Reading Air Monitoring Instruments," lists the direct-reading instruments (DRIs) used during air monitoring to characterize hazardous atmospheres. DRIs may be used to rapidly detect flammable or explosive atmospheres, oxygen deficiency, certain gases and vapors, and ionizing radiation. DRIs are the primary tools of initial site characterization. The information provided by DRIs can be used to: select appropriate protective measures such as personal protective equipment, evacuation, and other similar measures; determine the most appropriate equipment for further monitoring; and assist in developing optimum sampling and analytical protocols.

DRIs have limitations. For example, the Flame Ionization Detector (FID) and Photoionization Detector (PID) are commonly used at hazardous waste sites to monitor for a broad range of organics and some inorganics. However, they do not detect some particularly toxic agents such as hydrogen cyanide and hydrogen sulfide. Thus, these devices must be supplemented with other methods of detection (e.g., electrochemical sensors or colorimetric indicator tubes). Many DRIs designed to detect one particular substance may also detect other (cross sensitive) substances, thus rendering a "false positive." All DRI information should be interpreted with a certain degree of caution.

To characterize personal exposure, air monitoring should be performed in the breathing zone of the individual. Emission sources may be characterized through head-space monitoring (e.g. drums) or close-range monitoring, if this can be done safely. Emission source measurements are not representative of personal exposure.

Air monitoring instruments should be field-calibrated on a daily basis prior to the initial entry and/or any field activity. Calibration must be performed according to manufacturer's instructions. Field calibration should take place in field atmospheric conditions in a "clean" area, such as the command post. Calibration must be documented, either in a site logbook, or a logbook designated for instrument calibration records as required in the site safety plan (29 CFR 1910.120(b)(4)(ii)(E)).

Air monitoring data should be documented in the individual's field or the site logbook. Observations pertaining to the monitoring data (i.e., weather conditions, drum label information, activity performed

during monitoring, number/names of individuals being monitored, etc.) should be recorded with the monitoring data.

Conducting Air Sampling



Table 2 at the end of this Fact Sheet, "Common Air Sampling Methods and Media Used by the EPA/ERT," summarizes some sampling methods commonly used on hazardous waste sites. Personal air sampling is generally performed using a personal sampling pump capable of both low-flow (20-750 cc/min) and high-flow (1-4 L/min) operation. Low-flow operation with various media-packed tubes is used to sample volatile organic materials and acid gas mists. High-flow operation with various filter media or bubbler/impinger solutions is generally used to sample particles, particulate aerosols, and inorganic gases. Personal air sampling is performed for the duration of the workshift. Employees with the highest exposure potential wear the sampling pumps with the sample media positioned on their shoulders and the inlet of the filter or tube facing down toward the chest. (Applying protective "covers" often eases decontamination of the pumps.) Personal air sampling results are generally compared to the 8-hour PEL-TWA.

Sampling for comparison to the PEL-Short-Term Exposure (PEL-STEL) will require collecting a 15-minute sample at higher flow rates. PEL-STEL and PEL-C sampling may be run throughout the workshift alongside the PEL-TWA sampling. PEL-STEL and PEL-C sampling may be performed once every hour throughout the workshift, at the times of highest potential exposure. Judgment should be used when identifying times of highest potential exposure and performing a PEL-STEL and/or PEL-C sampling event simultaneously during this high-risk exposure period.

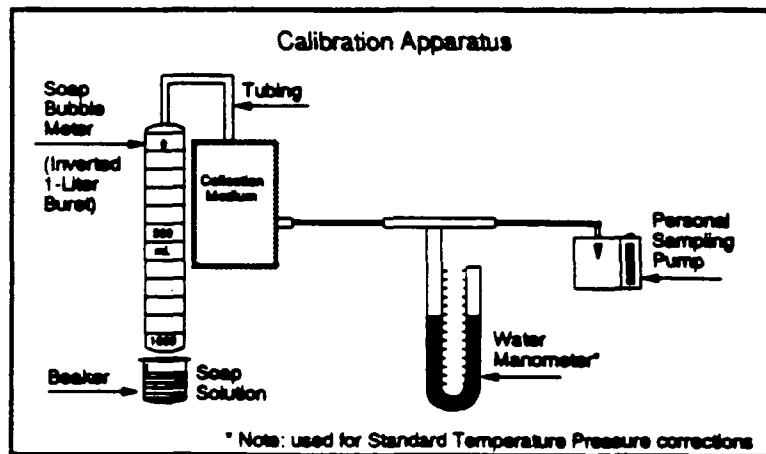
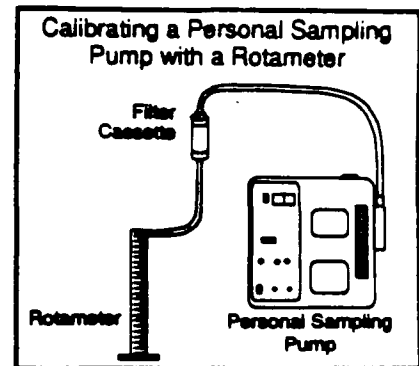
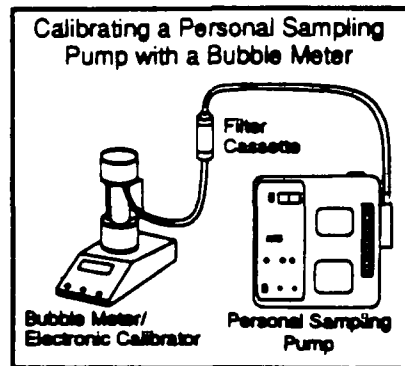
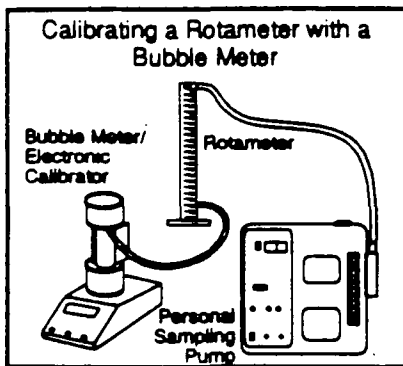
There are a number of references that list standard methods for performing personal air sampling. OSHA and the National Institute for Occupational Safety and Health (NIOSH) publish two sets of the most widely used personal air sampling methods. Both NIOSH and OSHA methods are "recipes" for performing both air sampling and chemical analysis. The methods outline the sampling device, collection media, and flow rate at which to set the sampling device. OSHA and NIOSH usually include in the methods any interferences that may bias the sampling. The EPA/Environmental Response Team (EPA/ERT) has developed standard sampling methods that incorporate existing NIOSH and OSHA methods. The "Information Sources" section of

this Fact Sheet identifies sources to obtain more information on these methods.

Before a sampling method is chosen, the laboratory should be contacted to determine whether it can perform the desired analysis. The EPA/ERT recommends using laboratories accredited by the American Industrial Hygiene Association (AIHA) for performing analysis on personal air samples. A list of AIHA-accredited laboratories may be obtained by contacting the AIHA (see the "Contacts" section of this Fact Sheet for AIHA's address and phone number).

As with DRIs, sampling pumps must be calibrated prior to use. The goal of calibrating the personal sampling pump is to set, and ensure that the pump can maintain, a known flow rate. Calibration requires a pump, a sampling train (including the sample media and all connecting tubing), and a primary standard-flow indicator, such as a bubble meter (Buck calibrator/Gillibrator), or an inverted buret with bubble mixture. A secondary standard flow indicator, such as a rotameter, may be used to calibrate the pump as long as the secondary standard has been previously calibrated to a primary standard. **Highlight 5** illustrates several different methods of calibration.

Highlight 5 EXAMPLES OF CALIBRATION METHODS



Source: Manual of Analytical Methods (Volume 1, 3rd Edition)
(NIOSH, 1984, Pub No. 84-100)

Highlight 6
EXAMPLES OF PERTINENT INFORMATION
FOR AIR SAMPLING DOCUMENTATION

- Name of employee sampled;
- Task performed during sampling period;
- Suspected hazardous substances;
- Level of PPE;
- Type of collection media;
- Flow rate of the calibrated pump (pre- and post-sampling event);
- Duration of the sample;
- Date of sampling event;
- Location of sampling event;
- Environmental conditions during sampling event (e.g., temperature, Rh, wind speed, etc.);
- Unique sample number;
- Volume of air sampled during event;
- Any special handling requirements; and
- Analytical holding times.

Documentation of all aspects of the sampling/monitoring event is critical for both air monitoring and air sampling. Documentation provides information for data interpretation and, in the case of air samples, for tracking the sample from the sample taker to the laboratory. Air sampling documentation is more formalized than documentation for air monitoring. **Highlight 6** identifies pertinent information that must be documented for air sampling.

If sampling media (tubes or filters) are changed throughout the day to prevent overloading, sample duration for that media must be noted. Judgment must be used in deciding how to document such a sampling event. Each tube/filter may be designated a unique number and treated as a single sample, or each tube/filter may be designated the sample number with a different consecutive letter of the alphabet attached. The tubes or filters are unique, but together they represent one complete workshift sample. Setting up and performing personal air sampling generally requires more preparation time than air monitoring; however, in both cases, the correct instrument or sampling train must be chosen, the instrument or sampling train must be calibrated, and the monitoring or sampling event must be observed.

TABLE 1
SUMMARY OF DIRECT-READING AIR MONITORING INSTRUMENTS

| Principle of Detection and Monitoring Need | Instrument | Features | Limitations |
|---|--|--|--|
| Wheatstone Bridge Filament <i>Monitoring Need:</i> Combustible Gas | Combustible Gas Indicator | <ul style="list-style-type: none"> ◆ Calibrated to pentane, hexane, or methane ◆ Nonspecific detector for combustible gases measures gas concentrations as a percentage of lower explosive limit (LEL) ◆ Lightweight, portable, and easy to use ◆ Visual and audible alarms (some models) ◆ Probe provides remote sensing capabilities ◆ 8- to 12-hour battery operating life for most models ◆ Accuracy varies depending upon the model; accuracies of ± 2 to 3 percent are attainable* | <ul style="list-style-type: none"> ◆ Potential interferences or filament damage from leaded gasoline, silicones, and silicates, which are more strongly adsorbed on catalyst than oxygen or gas in question. Membranes are available to minimize these effects. ◆ Most models do not measure specific gases ◆ May not function properly in oxygen-deficient atmospheres (< 10 percent) |
| Chemical Cell <i>Monitoring Need:</i> Oxygen Deficiency | Oxygen Meter | <ul style="list-style-type: none"> ◆ Direct readout in percent oxygen ◆ Visual and audible alarms ◆ Lightweight, portable, and easy to use ◆ Probe provides remote sensing capabilities ◆ Accuracies of ± 1 percent are attainable, but depend on the particular model ◆ Generally 8- to 10-hour battery life | <ul style="list-style-type: none"> ◆ High humidity may cause interference ◆ Strong oxidants may cause artificially high readout ◆ Oxygen calibrations are dependent on altitude and barometric pressure ◆ CO₂ "poisons" detector cell |
| Chemical Sensor Wheatstone Bridge Filament <i>Monitoring Need:</i> Combustible Gas/Oxygen Deficiency | Combination Oxygen Meter and Combustible Gas Indicator | <ul style="list-style-type: none"> ◆ Calibrated to pentane, hexane, or methane ◆ Measure percent oxygen and gas concentration as a percentage of LEL ◆ Both visual and audible alarms (some models) ◆ Remote sensing capabilities ◆ Lightweight, portable, and easy to use ◆ Accuracies of ± 2 percent are attainable* | <ul style="list-style-type: none"> ◆ Same limitation as oxygen meters and combustible gas detectors ◆ In certain units, acid gases and high CO₂ concentrations shorten the life of oxygen sensor/cells ◆ Certain units require a conversion factor for true specific compound response readings ◆ In certain units, oxygen calibration is altitude dependent |
| Optical, Electrical, Piezoelectric <i>Monitoring Need:</i> Aerosol/Particulate | Aerosol/Particulate Monitor | <ul style="list-style-type: none"> ◆ Selectable ranges ◆ Particle size differentiation available ◆ Certain units have data logging capabilities | <ul style="list-style-type: none"> ◆ Factory recalibration required on certain units ◆ Values represent total particulates: dust, mist, aerosols are all inclusive with no differentiation ◆ Cold weather may have adverse effect on detector ◆ High humidity and precipitation negatively affect meter response |

* Manufacturer specifications. Actual field use may yield greater variations.

TABLE 1 (CONT'D)
SUMMARY OF DIRECT-READING AIR MONITORING INSTRUMENTS

| Principle of Detection and Monitoring Need | Instrument | Features | Limitations |
|---|--|--|--|
| <p>Photoionization Ultraviolet Light</p> <p><i>Monitoring Need:</i> Toxic Gas/Vapors</p> | <p>Photo-ionization Detector (PID)**</p> | <ul style="list-style-type: none"> ◆ Nonspecific gas and vapor detection for organics and some inorganics ◆ Not recommended for permanent gases ◆ Lightweight (4 to 9 lbs) and portable ◆ Sensitive to 0.1 ppm benzene. Sensitivity is related to ionization potential of compound ◆ Remote sensing capabilities ◆ Response time of 90 percent in less than 3 seconds ◆ More sensitive to aromatics and unsaturated compounds than the flame ionization detector (FID) ◆ 8-hour battery operating life; certain units with external interchangeable battery packs ◆ Audible alarm is available ◆ Certain units have data logging/computer interface capabilities ◆ Certain units available with calibration libraries ◆ Certain units available with interchangeable lamps | <ul style="list-style-type: none"> ◆ Does not monitor for specific gases or vapors ◆ Cannot detect hydrogen cyanide or methane ◆ Cannot detect some chlorinated organics ◆ High humidity and precipitation negatively affect meter response ◆ Readings relative to calibration standard |
| <p>Hydrogen Flame Ionization</p> <p><i>Monitoring Need:</i> Toxic Gas/Vapors</p> | <p>Flame Ionization Detector (FID)</p> | <ul style="list-style-type: none"> ◆ In the survey mode, it functions as a nonspecific total hydrocarbon analyzer; in the gas chromatograph mode, it provides tentative qualitative/quantitative identification (OVA-specific) ◆ Most sensitive to saturated hydrocarbons, alkanes, and unsaturated hydrocarbon alkanes ◆ Lightweight (12 lbs) and portable ◆ Remote sensing probe is available ◆ Response time is 90 percent in 2 seconds ◆ 8-hour battery operating life ◆ Sounds audible alarm when predetermined levels are exceeded | <ul style="list-style-type: none"> ◆ Not suitable for inorganic gases (e.g., Cl₂, HCN, NH₃) ◆ Less sensitive to aromatics and unsaturated compounds than PID ◆ Requires skilled technicians to operate the equipment in the GC mode and to analyze the results (OVA-specific) ◆ Requires changes of columns and gas supply when operated in the GC (gas chromatography) mode in certain units (OVA-specific) ◆ Because specific chemical standards and calibration columns are needed, the operator must have some idea of the identification of the gas/vapor (OVA-specific) ◆ Substances that contain substituted functional groups (e.g., hydroxide (OH-) or (Cl-) chloride groups) reduce the detector's sensitivity |

UV sources vary in strength among available units (10.2ev, 10.6ev, 11.7ev). Each source has a range of compounds it cannot detect based upon ionization potentials. See manufacturer's literature for specifics.

TABLE 1 (CONT'D)
SUMMARY OF DIRECT-READING AIR MONITORING INSTRUMENTS

| Principle of Detection and Monitoring Need | Instrument | Features | Limitations |
|--|--------------------------|---|---|
| Infrared Radiation <i>Monitoring Need:</i> Toxic Gas/Vapors | Infrared Analyzer | <ul style="list-style-type: none"> ◆ Overcomes the limits of most infrared (IR) analyzers by use of a variable filter; can be used to scan through a portion of the spectrum to measure concentration of several gases or can be set at a particular wavelength to measure a specific gas ◆ Detects both organic and inorganic gases ◆ Portable but not as lightweight (32 lbs.) as the PIDs or FIDs | <ul style="list-style-type: none"> ◆ Less portable than other methods of gas/vapor detection ◆ Requires skilled technicians to operate and analyze results when positive identification is needed ◆ Interference by water vapor and carbon dioxide ◆ Most require AC power source ◆ Positive identification requires comparison of spectrum from strip chart recorder with published adsorption spectrum; infrared spectrum not available for all compounds ◆ Intrinsic safety is unit dependent; see manufacturer's literature |
| Chemical Reaction Producing a Color Change <i>Monitoring Need:</i> Toxic Gas/Vapors | Indicator Tubes | <ul style="list-style-type: none"> ◆ Quantitative accuracies are variable ◆ Simple to use, and relatively inexpensive ◆ Real time/semi-real time results | <ul style="list-style-type: none"> ◆ Low accuracy ◆ Subject to leakage during pumping ◆ Requires previous knowledge of gases/vapors in order to select the appropriate detector tube ◆ Some chemicals interfere with color reaction to read false positive ◆ Temperature and humidity may affect readings |
| Electrochemical Cell <i>Monitoring Need:</i> Toxic Gas/Vapors Specific Atmospheres | Toxic Atmosphere Monitor | <ul style="list-style-type: none"> ◆ Ease of operation ◆ Small, compact, lightweight ◆ Audible alarm upon exceeding pre-set action level or Threshold Limit Value (TLV) ◆ Certain units have digital readout ◆ Generally compound-specific ◆ Certain units interface with data logger | <ul style="list-style-type: none"> ◆ Cross sensitivity ◆ Slow response/recovery after exposure to high contamination levels ◆ Limited number of chemicals detected |
| Metal-Oxide Semiconductor <i>Monitoring Need:</i> Toxic Gas/Vapors | Toxic Atmosphere Monitor | <ul style="list-style-type: none"> ◆ Ease of operation ◆ Small, compact, lightweight ◆ Audible alarm upon exceeding present action level or TLV ◆ Certain units have digital readout ◆ Certain units interface with data logger ◆ Nonspecific gas and vapor detection for some organics and inorganics | <ul style="list-style-type: none"> ◆ Cross sensitivity ◆ Slow response/recovery after exposure to high contamination levels |

TABLE 1 (CONT'D)
SUMMARY OF DIRECT-READING AIR MONITORING INSTRUMENTS

| Principle of Detection and Monitoring Need | Instrument | Features | Limitations |
|---|------------------------|---|--|
| Scintillation Detector <i>Monitoring Need:</i> Radiation | Radiation Meters | <ul style="list-style-type: none"> ◆ Measures radiation in R/hr or fractions thereof (gamma) (battery operated) ◆ Probe provides remote sensing capabilities ◆ Accuracy and sensitivity varies considerably with manufacturer and type of meter ◆ A variety of meters are available. Some measure total ionizing radiation; others are specific for gamma, alpha, or a combination of two or more types | <ul style="list-style-type: none"> ◆ Some meters do not determine type of radiation <p><u>NOTE:</u> Initial entry surveys should focus on the presence of gamma radiation. If alpha or beta are suspected, consult your health physicist.</p> |
| Gold Film Sensor <i>Monitoring Need:</i> Mercury Vapor | Mercury Vapor Analyzer | <ul style="list-style-type: none"> ◆ Compound specific; has survey and sample modes ◆ 0.001 mg/m³ detection limit ◆ Provides sensor saturation readout; saturated sensor cleaning capabilities ◆ Can be used with dosimeters for on-site dosimetry ◆ Microprocessor serves reading; automatically re-zeros ◆ Certain units have data logging capabilities ◆ 5-hour battery life | <ul style="list-style-type: none"> ◆ Requires yearly <u>factory</u> recalibration ◆ Short battery life ◆ Requires AC power for Heat Cleaning Cycle |

Sources: Mathamel, 1981; Spittler, 1980; McEnery, 1982; National Mine Service Company, 1980; Gas-Tech, 1980; Enmet Corporation, 1979; Foxboro Analytical, 1982; HNU Systems, 1982, 1991; Photovac International, Inc., 1989; Jerome, 1990; MIE, 1990.

**TABLE 2
COMMON AIR SAMPLING METHODS AND MEDIA USED BY EPA/ERT¹**

| CONTAMINANT | AIR SAMPLING METHODS | FLOW RATE | COLLECTION MEDIA | SAMPLE DURATION (HOURS) |
|--|---|-------------------------|--|-------------------------|
| Hydrocarbons: BP 36-126 Deg. C Aromatic Halogenated | NIOSH 1500 NIOSH 1501 NIOSH 1003 | 1 L/m 1 L/m 1 L/m | Charcoal | 2-8 |
| Inorganic Acids | NIOSH 7903 | 1 L/m | Silica Gel | 2-8 |
| Alcohols | NIOSH 1402 | 0.5 L/m | Charcoal | 2-8 |
| Acetic Acid | NIOSH 1603 | 1 L/m | Charcoal | 2-8 |
| Acetaldehyde | NIOSH 2538 | 1 L/m | 2-Hydroxymethyl (2-HMP) Piperidine on XAD-2 Resin | 2-8 |
| Aliphatic Amines | NIOSH 2010 | 1 L/m | Silica Gel | 8 |
| Aromatic Amines | NIOSH 2002 | 1 L/m | Silica Gel | 8 |
| Volatile Organic Compounds | EPA TO1 and TO2 | 20 cc/m | Tenax/Carbon Molecular Sieve (CMS) | 1-2 |
| Volatile Organic Compounds | EPA TO14 | Grab 10-50 cc/m | Summa Canister Summa Canister with Critical Orifice | Grab, 4-12 |
| Polynuclear Aromatic Hydrocarbons (PAH) | NIOSH 5515 | 2.5 L/m or 5 L/m | XAD-2 Resin Tube with 37 mm 2 um Teflon ^R Filter with Polytetrafluoroethylene (PTFE) O- Ring Support | 2-8 |
| PAH | NIOSH 5506 | 260 L/m | 2" x 1" Polyurethane Foam (PUF) with 50 grams XAD Resin | 8-12 |
| Pesticide/PCBs | Lewis and McCleod, Modified EPA TO4 | 3.5 L/m | 2" x 3" PUF with Glass Fiber Filter | 2-8 |
| Dioxin ² | EPA TO9 | 260 L/m | 2" x 3" PUF and Glass Fiber Filter | 72 |
| Metals | NIOSH 7300 | 3 L/m | 0.8 um Mixed Cellulose Ester Filter (MCEF) | 2-8 |
| Formaldehyde | NIOSH 3500 | 1 L/m | 1 um PTFE Filter and 2 Impingers, Each with 20 ml of 1 percent Sodium Bisulfite Solution | 2-8 |
| Formaldehyde | NIOSH 2541 | 0.1 L/m | 10 percent 2-HMP on XAD-2 Resin | 4-8 |

¹ This table is to be considered a guideline only. NIOSH methods were developed for indoor industrial use. Most NIOSH methods cited here have modified flow rates for use in outdoor ambient conditions. Sample duration should reflect extent of work shift when used in personal monitoring. If area sampling is being conducted for site characterization, sample durations may need to be modified to achieve desired detection limits.

² For dioxin, method is for area sampling only.

Note: OSHA analytical methods should also be evaluated for appropriate, applicable use. Most are available on OSHA's Computerized Information System (OCIS)

Information Sources

Federal Regulations

The OSHA HAZWOPER regulations are codified at 29 CFR 1910.120 (54 FR 9294 and 55 FR 14072). Subpart Z, Toxic and Hazardous Substances, can be found at 29 CFR 1910.1000.

The EPA HAZWOPER regulations are codified at 40 CFR 311 (54 FR 26654).

Computer Software

Air Methods Database (EPA/Environmental Response Team, Edison, NJ).

Available on the Cleanup Information electronic bulletin board (CLU-IN), formerly OSWER BBS. For further information, call (301) 589-8366. Communications: No Parity, 8 Databits, 1 Stopbit, F Duplex.

EPA Health and Safety Planner: Software and User's Guide (EPA, OSWER Publication 9285.8-01, 1990).

Fact Sheets

Hazardous Waste Operations and Emergency Response: General Information and Comparison (EPA, OSWER Publication 9285.2-09FS, 1991).

Explains the scope and purpose of the HAZWOPER standards, and distinguishes the SARA Title I standards from regulations and consensus standards covering the same or similar subject matter.

Hazardous Waste Operations and Emergency Response: Uncontrolled Hazardous Waste Sites and RCRA Corrective Action (EPA, OSWER Publication 9285.2-08FS, 1991).

Explains the principle HAZWOPER requirements as they apply to employees engaged in hazardous waste operations and emergency response at uncontrolled hazardous waste sites, including employees who perform corrective actions at RCRA TSD facilities.

Hazardous Waste Operations and Emergency Response: RCRA TSD and Emergency Response Without Regard to Location (EPA, OSWER Publication 9285.2-07FS, 1991).

Describes the HAZWOPER planning, training, and medical surveillance requirements as they apply to emergency responders regardless of location, and employees who perform routine hazardous waste operations at RCRA TSD facilities.

Establishing Work Zones at Uncontrolled Hazardous Waste Sites (EPA, OSWER Publication 9285.2-06FS, 1991).

Defines the different work zones usually found at a hazardous waste site (i.e., Exclusion, Contamination Reduction, and Support) and provides information on selecting and maintaining work zones.

Hazardous Waste Operations and Emergency Response: Available Guidance (EPA, OSWER Publication 9285.2-10FS, 1993).

Provides a list and description of computer software, fact sheets, guidance documents, and ERT training programs that pertain to the worker protection standards.

General Health and Safety Guidance Documents

Standard Operating Safety Guides (EPA, OSWER Publication 9285.1-03, 1992).

Provide guidelines for use by any organization in developing specific operation safety procedures. These Guides should be adapted to address the safety criteria required for protection of response personnel from the hazards created by a specific operation or incident.

Standard Operating Procedures for Air Sampling and Monitoring at Emergency Responses (EPA, OSWER Publication 9285.2-03A, draft).

Describes the types and methods of air surveillance, procedures and equipment for air monitoring, and a method for analyzing organic solvents by gas chromatography.

Standard Operating Procedures for Site Safety Planning (EPA, OSWER Publication 9285.2-05, being updated).

Describes the general requirements for a site safety plan, discusses development and implementation of a site safety plan, and provides sample plans and a checklist.

Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities (NIOSH/OSHA/USCG/EPA, NIOSH Publication 85-115, GPO No. 017-033-00419-6, 1985).

Draft International Document on Guide to Portable Instruments for Assessing Airborne Pollutants Arising from Hazardous Wastes (U.S. National Working Group (NWG-4 OIML) Pilot Secretariat PS-17: "Measurement of Pollution." Reporting Secretariat RS-5: "Measurement of Hazardous Waste Pollution." ISBN: 0-936712-75-9).

Provides guidance for using portable instruments to assess airborne pollutants arising from hazardous waste.

Procedures for Conducting Air Pathway Analyses for Superfund Applications addresses a variety of issues relevant to the air impacts at Superfund sites in four volumes entitled:

Volume I: Application of Air Pathway Analyses for Superfund Applications (EPA, EPA-450/1-89-001, NTIS PB90 113374/AS, 1989).

Volume II: Estimation of Baseline Air Emissions at Superfund Sites (EPA, EPA-450/1-89-002, NTIS PB89 18053/AS, 1989).

Volume III: Estimation of Air Emissions from Clean-up Activities at Superfund Sites (EPA, EPA-450/1-89-003, NTIS PB89 180061/AS, 1989).

Volume IV: Procedures for Dispersion Modeling and Air Monitoring for Superfund Air Pathway Analysis (EPA, EPA-450/1-89-004, NTIS PB90 113382/AS, 1989).

Standard Air Sampling Method Documentation

OSHA Analytical Methods. The OSHA Technical Center maintains an updated data base of analytical testing methods. Printouts of analytical methods for individual chemicals are available by request. For more information about the data base, contact:

OSHA Technical Center
1781 South 300 West
Salt Lake City, UT 84115
(801) 487-0521

Occupational Exposure Sampling Strategy Manual (Leidel, N.A., K.A. Busch, and J.R. Lynch. U.S. Department of Health, Education, and Welfare, Publ.(NIOSH) pp. 77-173, 1979).

Manual of Analytical Methods (Volumes 1-3, 3rd Ed., with supplements) (NIOSH Publication 89-127, 1989).

Recommended Exposure Limit Documentation

1991-1992 Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices (American Conference of Governmental Industrial Hygienists, 1991).

Guide to Occupational Exposure Values-1992 (American Conference of Governmental Industrial Hygienists, 1991).

NIOSH Pocket Guide to Chemical Hazards (NIOSH Publication 90-117, updated annually).

Contacts

The following contacts can provide additional information on air monitoring and air sampling at uncontrolled hazardous waste sites:

American Industrial Hygiene Association (AIHA)
Washington, D.C.
2700 Prosperity Avenue
Suite 250
Fairfax, Virginia 22031
(703) 849-8888

U.S. EPA
Environmental Response Team
2890 Woodbridge Avenue,
Building 18 (MS-101)
Edison, NJ 08837-3679
(908) 321-6740
24-Hour Hotline: (908) 321-6660

OSHA
U.S. Department of Labor
200 Constitution Avenue, NW
Room N-3647
Washington DC 20210
(202) 219-8036

OSHA Notification Service
(Complaint Hotline) for Emergency Situations: 1-800-321-6742

EPA REGIONAL OFFICES

EPA Region 1
Emergency Planning and Response Branch
60 Westview Street
Lexington, MA 02173
(617) 860-4367

EPA Region 2
Response and Prevention Branch
2890 Woodbridge Avenue, Raritan Depot
Building 209
Edison, NJ 08837
(908) 321-6656

EPA Region 3
Superfund Removal Branch
841 Chestnut Street, 9th Floor
Philadelphia, PA 19107
(215) 597-0992

EPA Region 4
Emergency Response and Removal Branch
345 Courtland Street, NE
1st Floor
Atlanta, GA 30365
(404) 347-3931

EPA Region 5
Emergency and Enforcement Response Branch
77 West Jackson Boulevard
Chicago, IL 60604
(312) 353-9295

EPA Region 6
Emergency Response Branch
1145 Ross Avenue, 9th Floor
Dallas, TX 75202-2733
(214) 655-2270

EPA Region 7
Emergency Planning and Response Branch
25 Funston Road, 2nd Floor
Kansas City, KS 66115
(913) 551-5037

EPA Region 8
Emergency Response Branch
999 18th Street, Suite 500
Denver, CO 80202-2405
(303) 924-7129

EPA Region 9
Field Operations Branch
75 Hawthorne Street
San Francisco, CA 94105
(415) 744-2353

EPA Region 10
Superfund Branch
1200 6th Avenue, 11th Floor
Seattle, WA 98101
(206) 553-1677