AIR MONITORING

1.0 INTRODUCTION

EPA personnel may potentially be exposed to hazardous contaminants in the air. During the course of many field activities, air monitoring may be necessary to identify these contaminants. Air monitoring devices are used for the following types of atmospheres.

- Flammable/explosive
- Toxic
- Oxygen-deficient and oxygen-enriched
- Radioactive.

Note: This module does not present detailed information on EPA ambient air sampling or stack sampling procedures. Such information can be obtained from "Stack Sampling," or established EPA ambient air sampling methods.

Learning Objectives
At the end of this module, you will be able to:

- List the purposes and uses of air monitoring
- Recognize the characteristics of direct reading instruments and air sampling methods
- Identify common types of sampling equipment and analyses
- Discuss general practices for area, periodic, and personal monitoring
- Interpret air monitoring results.

2.0 OBJECTIVES OF AIR MONITORING

The objectives of air monitoring are to:

- Identify and quantify airborne contaminants
- Ensure proper selection of work practices and engineering controls
- Determine what personal protective equipment is needed
- Ensure compliance with OSHA standards
- Assist in defining work zones
- Locate sources of hazardous airborne contaminants
- Determine further medical monitoring needs
- Evaluate effectiveness of engineering control.

There is a wide variety of field activities for which air monitoring may be needed. Some examples of potential applications are:

- Initial site characterization
- Emergency responses concerning the release of hazardous materials

- Field sampling activities involving the collection and screening of contaminated material, such as headspace sampling of soil and water samples
- Headspace sampling of groundwater monitoring wells (i.e., explosivity, toxic vapors)
- Drilling activities
- Trenching and excavating operations
- Underground storage tank removal
- Industrial plant operations (i.e., leak detection, emission sampling)
- Confined space entry activities.

3.0 CHARACTERISTICS OF INSTRUMENTATION/METERS

To be effective, air monitoring instruments should be:

- Portable
- Easy to operate
- Intrinsically safe
- Able to generate reliable and useful results
- Properly used and calibrated.

All air monitoring equipment requires careful calibration and a knowledgeable operator. Improper calibration or use of such equipment may indicate that an area is safe and free of airborne hazards when, in fact, a hazardous situation exists. The operator should be knowledgeable of the operating procedures for the equipment they are assigned.

3.1 Direct Reading Instruments

Direct reading instruments (DRIs) may be used to quickly detect flammable or explosive atmospheres, oxygen-deficiency and oxygen-enrichment, general organic vapors, specific gases and vapors, and ionizing radiation. DRIs may also be used to identify changing site conditions.

DRIs have the following characteristics:

- Act as primary tools of initial site characterization
- Provide information at the time of sampling (real time) and allow for rapid decisionmaking
- Locate the source of hazardous agents (leak detection)
- Detect changes in contaminant levels during site operations
- Detect and/or measure only specific classes of chemicals
- Need to be calibrated.

Most DRIs are usually not designed to detect airborne concentrations below 1 ppm. Many that are designed to detect one substance also detect other substances, thus giving false positives.

Direct reading instruments can be categorized into the following types:

- Oxygen indicators
- Combustible gas indicators
- Toxic atmosphere monitors (general or specific)
- Ionization detectors.

Appendix 7-A contains a summary of direct reading air monitoring instruments. In addition, the four basic types of DRIs (oxygen indicators, combustible gas indicators, toxic atmosphere meters, and ionization detectors) are discussed in the following sections.

3.1.1 Oxygen Indicators

The oxygen indicator uses an electro-chemical sensor to determine the oxygen concentration in air. Most oxygen indicators have meters which display the oxygen concentration from 0-25 percent. This is generally the most useful range for response since decisions involving air-supplying respirators and the use of combustible gas indicators fall into this range.

Oxygen indicators are used to evaluate an atmosphere for the following reasons:

- **Oxygen content for respiratory purposes:** Normal air is 20.9 percent oxygen. If the oxygen content decreases below 19.5 percent, it is considered oxygen deficient by OSHA and special respiratory protection is needed.

- **Increased risk of combustion:** Concentrations above 23.5 percent are considered oxygen-enriched and increase the risk of combustion.

- **Use of other instruments:** Some instruments require sufficient oxygen for operation. For example, some combustible gas indicators do not give reliable results at oxygen concentrations below 10 percent. Inherent safety approvals for instruments are for normal, not oxygen-enriched, atmospheres.

- **Presence of contaminants:** A decrease in oxygen content may be due to oxygen consumption (e.g., combustion, rusting) or air displacement by a chemical. If the decrease is due to consumption, the lack of oxygen is the primary concern. If the decrease is due to displacement, a flammable or toxic contaminant may be present.

Oxygen indicators may be found in individual meters/ dosimeters and may also be included in "multigas" meters. Oxygen indicators traditionally have low and high concentration alarms (e.g., visible, audible).

For field activities, oxygen indicators may be used during initial site characterization, emergency responses, confined space entry activities, underground storage tank removal, or industrial plant operations.

3.1.2 Combustible Gas Indicators

Combustible gas indicators (CGIs) measure the air concentration of a flammable vapor or gas. The results are measured as a percentage of the lower explosive limit (LEL) of the calibration gas. The LEL of a combustible gas or vapor is the minimum concentration of the substance in the air which will propagate flame on contact with an ignition source. The upper explosive limit (UEL) is the maximum concentration. Above the UEL the mixture is "too rich" to support combustion whereas below the LEL the mixture is "too lean" to support combustion.

Users of CGIs must be aware of the following limitations:

- When the atmosphere has a gas concentration above the UEL, the meter needle (analog) may rise above the 100 percent mark and then return to zero. Do not be fooled into thinking this is a safe atmosphere.

- Meters are designed to operate in normal environments. Readings can be affected by oxygen level, temperature, humidity, and/or contaminants.

- Excess condensation causes many meters to provide false readings.

CGIs may be used during a variety of field activities such as underground storage tank removal, industrial plant operations, ground water monitoring wells operations, initial site characterization, and emergency responses.

3.1.3 Toxic Atmosphere Meters

Toxic atmosphere monitoring is performed to:

- Identify airborne concentrations that could pose a toxic risk to workers and the public
- Evaluate the need for personal protective equipment and the type of equipment required
- Set up work zones or areas where contaminants are, or are not, present.

The following are groups of instruments and meters that can be used to monitor atmosphere toxicity:

- **Colorimetric indicator pumps and tubes:** These consist of glass tubes containing a packing material which is impregnated with indicating chemicals. A bellows- or piston-type pump is used to draw a known volume of contaminated air at a predetermined rate through the tube per the directions on the package. The contaminant reacts with the indicator chemical in the tube which produces a change in color whose length is proportional to the contaminant concentration. One must know the specific vapor gas or class of the airborne contaminant to be monitored.

- **Specific chemical monitors:** These use electrochemical cells or metal oxide semi-conductors to detect specific chemicals. The most common meters are used to detect carbon monoxide and hydrogen sulfide.

- **Combination meters:** Several instruments combine two or more detectors. Normally, each detector operates independently, allowing one to be used even if the other is not needed or is not working properly.

Toxic atmosphere meters are useful for a range of field activities including drilling and trenching operations, headspace sampling, initial site characterization, emergency responses, and industrial plant operations.

3.1.4 Ionization Detectors

Photoionization detectors and flame ionization detectors are commonly used to detect a variety of compounds in air. The two instruments differ in their modes of operation and in the number and types of compounds they detect. Both instruments can be used to:

- Detect leaks of volatile substances from drums and tanks
- Determine the presence of volatile compounds in soil
- Make ambient air surveys
- Collect continuous air monitoring data.

Care must be taken when interpreting the data because the instruments are nonspecific and their response to different compounds is relative to the calibration gas and settings.

The applications for ionization detectors in the field include initial site characterization, emergency responses, the collection of soil and water samples, underground storage tank removal, and industrial plant operations.

3.2 Sampling Pumps and Media

Low/high volume sampling pumps and media are used to complete a thorough assessment of airborne contaminants. After sample collection is conducted using established (NIOSH, OSHA, or EPA) sampling methods, laboratory analysis is performed, which results in air quality information such as the presence (qualitative) and concentration (quantitative) of contaminants.

The following are general characteristics of air sampling methods:

- When sampling air, you must know the identity/class of the contaminant(s) being sampled.
- Laboratory analysis is necessary.
- Air sampling methods are more accurate than most DRIs.
- Air sampling methods detect low levels of contaminants (and are more precise).

- Air sampling methods provide concentrations of contaminants over the lifetime of site operations (i.e., eight-hour day).
- Air sampling methods do not provide immediate results.
- Analysis may be expensive
- Personal and area sampling is possible
- Ambient sampling (high volume) can be performed to determine potential off-site migration.

4.0 SAMPLING EQUIPMENT AND MEDIA

A variety of sampling equipment and media may be used to collect air samples. Sampling systems generally include a calibrated low or high flow air sampling pump, set at a known flow rate, that draws air into/onto selected collection media. Some common types of sampling and collection media are described below. They are listed by type of contaminant. Appendix 7-B, Summary of Common Air Collection/Analytical Methods, summarizes the following information.

4.1 Aerosols (solid or liquid particulates)

Aerosols are generally collected on a particulate filter, such as:

- Glass fiber
- Polyvinyl chloride (PVC)
- Mixed cellulose ester (MCE) fiber membrane.

4.2 Inorganic Gases

Silica gel tubes are generally used as the sampling media for inorganic gases. Impingers filled with selected liquid reagents can also be used.

4.3 Organic Vapors

Sorbent tubes are generally used as the sampling media for organic vapors. The sorbent tubes may contain:

- Activated carbon
- Porous polymer
- Polar sorbent
- Any other specialty adsorbent selected for the site.

5.0 SAMPLE COLLECTION AND ANALYSIS

Samples are analyzed to determine the types and quantities of substances present. This section provides general guidance on sample collection and analysis.

5.1 Aerosols

Samples for aerosols should be taken at a prescribed flow rate using a suitable sampling pump and filter assembly.

- To collect total particulates, a membrane filter having a 0.8 micrometer pore size is commonly used.
- The sample can be weighed to determine total particulates, then analyzed destructively or nondestructively for metals.
- If a nondestructive analysis is performed or if the filter is sectioned, additional analysis (i.e., organics, inorganics, and optical particle sizing) can be performed.

5.2 Sorbent Samples

The sorbent material chosen, the amount used, and sample volume will vary according to the types and concentrations of substances anticipated at a particular site.

- Polar sorbent material such as silica gel will collect polar substances that are not absorbed well onto activated carbon and some of the porous polymers.
- Activated carbon and porous polymers will collect a wide range of compounds. Since exhaustive analysis to identify and quantify all the collected species is prohibitively expensive at any laboratory and technically difficult at a field laboratory, samples should be analyzed for principal hazardous constituents (PHCs).
- The selection of PHCs should be based on the types of materials anticipated at a given site and on information collected during the initial site survey.

5.3 Passive Dosimeters

A less traditional method of sampling is the use of passive dosimeters (gases and vapors only). Although passive dosimeters are used primarily to monitor personal exposure, they also can be used to monitor areas. Some passive dosimeters may be read directly, while others require laboratory analysis similar to that conducted on solid sorbents. Passive dosimeters are divided into two groups:

- Diffusion samplers
- Permeation devices.

5.4 NIOSH/OSHA/EPA Methods

NIOSH and OSHA develop, evaluate, and revise analytical methods for over 200 chemicals. These methods are intended to promote accuracy, sensitivity, and specificity in the analyses while preserving practicality. The methods not only include detailed instructions for performing the analyses, but also information concerning:

- Sampling (i.e., media, flowrate, maximum/minimum volume, field blanks)
- Accuracy
- Interferences
- Chemical formula and molecular weight
- Regulatory limits
- Physical properties of the chemical
- Special precautions.

These methods are universally recognized and commonly used by accredited laboratories and field sampling technicians. EPA has also developed specialized methods for high volume ambient air monitoring and stack sampling.

The EPA is frequently responsible for conducting general exposure monitoring. The sensitivity required of these tests is typically much greater than OSHA compliance air monitoring. This frequently calls for methods and equipment, different from standard OSHA methods, with substantially lower detection levels.

Information regarding NIOSH approved sampling methods can be obtained by contacting NIOSH at (513) 533-8236 or by writing to the National Institute for Occupational Safety and Health (NIOSH) 4676 Columbia Parkway, Cincinnati, Ohio 45226.

6.0 GENERAL MONITORING PRACTICE

Air sampling should be conducted using a variety of media to identify the major classes of airborne contaminants and their concentrations. After visually identifying the sources of possible generation, use the following guidelines when collecting air samples:

- Samples should be collected downwind from the designated source along the axis of the wind direction.
- Air samples should also be collected upwind from the source to ensure that there is no background interference and that the detected substance(s) originated from the identified source.
- The level of protection for subsequent sampling should be based upon the results obtained and the potential for an unexpected release of chemicals.
- After reaching the source or finding the highest concentration, samples should be collected along the cross-axis of the wind direction to determine the degree of dispersion.
- Sampling equipment must be calibrated according to the manufacturer's recommendations both before and after the sampling period.
- Field blanks should be analyzed for each sampling period (i.e., generally 10 percent of samples).

6.1 Periodic Monitoring

Site conditions and atmospheric chemical conditions may change following the initial characterization. Periodic monitoring should be conducted when the possibility of a dangerous condition has developed or when there is reason to believe that exposures may have risen above the permissible exposure limits (PELs) or threshold limit values (TLVs). Periodic monitoring is performed when:

- Work begins on a different portion of the site
- Different contaminants are being handled
- A markedly different type of operation is initiated

- Workers are handling leaking drums or working in areas with liquid contamination
- Employees display or indicate symptoms of exposure.

6.2 Personal Monitoring

The selective monitoring of workers is required by OSHA (29 CFR 1910.120 (h), 29 CFR 1910.1000, and other OSHA-specific standards (e.g., benzene, lead). Personal monitoring samples should be collected in the breathing zone and if workers are wearing respiratory protective equipment outside the facepiece. Sampling should occur frequently enough with sufficient duration and combination of samples to characterize the exposures accurately. If any employee is exposed to concentrations above the PEL, monitoring must continue to ensure the safety of all workers likely to be exposed to concentrations above those limits. If a group of workers have similar exposure potential to hazardous agents (homogeneous exposure groups or HEGs), then members of the HEG could be sampled for different exposure agents using different monitoring devices. For example, if field personnel are making a team entry, it may be appropriate to assign a different type of monitoring instrument to each member of the team.

7.0 METEOROLOGICAL CONSIDERATIONS

Meteorological information is an integral part of any air monitoring program. Data concerning the following areas is necessary:

- Wind speed
- Wind direction
- Temperature
- Barometric pressure
- Altitude
- Humidity.

This information is needed for:

- Selecting air sampling locations
- Calculating air dispersion
- Calibrating instruments
- Determining population at risk of exposure from airborne contaminants.

8.0 LONG-TERM AIR MONITORING

A variety of long-term air monitoring programs can be designed to detect a wide range of airborne compounds. Before implementing any program, the following factors should be considered:

- The objectives of the air monitoring program (e.g., identify/quantify worker exposure, determine compliance, identify sources of exposure)

- Regulatory requirements
- Types of sampling (area/personal)
- Type of equipment
- Costs
- Personnel
- Accuracy of analysis
- Time to obtain results
- Availability of analytical laboratories.

9.0 USING VAPOR/GAS CONCENTRATIONS TO DETERMINE THE LEVELS OF PROTECTION

Total atmospheric vapor/gas concentrations obtained using flame or photoionization detectors can be used as a guide for selecting the level of protection (e.g., Level A, B, C, or D) until more definitive criteria can be determined. However, the protection level should not be based solely on the total vapor/gas criterion for the following reasons:

- An instrument does not respond with the same sensitivity to several vapor/gas contaminants as it does to a single contaminant.
- Total vapor/gas field instruments detect all contaminants in relation to a specific calibration gas, the concentration of unknown gases or vapors may be either overestimated or underestimated.
- Suspected carcinogens, particulates, highly hazardous substances, infectious wastes, or other substances that do not elicit an instrument response may be known or suspected to be present.

10.0 SUMMARY

There are varieties of sampling equipment and methods that can be used for air monitoring. However, the uses, limitations, and operating characteristics of the monitoring instruments must be recognized and understood. Interpretation of air monitoring results requires experience, knowledge, and good judgement to complement the data obtained by the instrument, as well as consideration of any other relevant factors (e.g., meteorological considerations).

Key concepts presented in this module are:

- The types of field activities for which air monitoring may be needed (e.g., drilling, trenching, excavating, sample collection, etc.)
- The operation, maintenance, and limitations of the types of air monitoring instruments you will be using
- Considerations for sample collection and analysis

- Where to obtain information or data relevant to the particular air monitoring method (i.e., OSHA/NIOSH methods, specific EPA documents)
- Effects that weather conditions may have on air monitoring
- Practices and procedures to follow/consider when conducting air monitoring.

Steps you can take to ensure efficient air monitoring include:

- Make sure you understand all aspects of operation for a specific instrument, and its limitations, before bringing it into the field
- Ensure that your air monitoring instruments are maintained and functioning properly before bringing them into the field
- Calibrate instruments according to the manufacturer's instructions, both before and after sampling.
- Follow established methods (OSHA, NIOSH, EPA) or SOPs where possible
- Be aware of the effects that oxygen content, humidity, wind speed, etc., may have on air monitoring.

EXERCISE

Read the questions below and fill in the blank or circle the correct response.

1. The four types of hazardous atmospheres for which air monitoring is used are:
   _________, _________, _________, and _________

2. List four characteristics an effective air monitoring instrument should have:
   ________________________   ________________________
   ________________________   ________________________

3. The following is/are a characteristic (s) of direct-reading instruments (DRIs):

   a. Provide information at the time of sampling
   b. Need to be calibrated
   c. Detect and/or measure only specific classes of chemicals
   d. All of the above

4. The following is/are a characteristics (s) of sampling pumps and media:

   a. Laboratory analysis is necessary
   b. Less expensive than DRIs
   c. Less accurate than DRIs
   d. All of the above

5. Passive dosimeters, which are used primarily to monitor personal exposures, are divided into two groups:

____________________ and ____________________

6. Meteorological information is needed for:

   a. Selecting sampling locations
   b. Calculating air dispersion
   c. Calibrating instruments
   d. All of the above

7. What type of collection media is commonly used for alcohols?

   a. Glass fiber filter
   b. Silica gel
   c. Charcoal

8. List the types of information which should be known before beginning any sampling using pumps and collection media.

   ____
   ____
   ____
   ____

9. Name the four types of DRIs:

   _______________________ _______________________
   _______________________ _______________________

10. If the needle on a CGI rises above 100 percent of the LEL and then returns to zero, this means the atmosphere does not present a combustible hazard.

   a. True b. False

EXERCISE KEY

Read the questions below and fill in the blank or circle the correct response.

1. The four types of hazardous atmospheres for which air monitoring is used are:

   Oxygen-deficient, toxic, explosive, and radioactive

2. List four characteristics an effective air monitoring instrument should have:

   Portable

Easy to operate
Inherently safe
Able to generate reliable and useful results

3. The following is/are a characteristic (s) of direct-reading instruments (DRIs):

   a. Provide information at the time of sampling
   b. Need to be calibrated
   c. Detect and/or measure only specific classes of chemicals
   d. All of the above

4. The following is/are a characteristic (s) of sampling pumps and media:

   a. Laboratory analysis is necessary
   b. Less expensive than DRIs
   c. Less accurate than DRIs
   d. All of the above

5. Passive dosimeters, which are used primarily to monitor personal exposures, are divided into two groups:

   Diffusion samplers and Permeation devices

6. Meteorological information is needed for:

   a. Selecting sampling locations
   b. Calculating air dispersion
   c. Calibrating instruments
   d. All of the above

7. What type of collection media is commonly used for alcohols?

   a. Glass fiber filter
   b. Silica gel
   c. Charcoal

8. List the types of information which should be known before beginning any sampling using pumps and collection media.

   - ***The identity of the contaminant being sampled***
   - ***Collection media to be used and analysis to be performed***
   - ***Duration of the sampling period***
   - ***Flow rate***
   - ***Maximum/minimum volume***
   - ***Any interferences***
   - ***Approximate concentration of contaminant***

- ***Relevant meteorological considerations***

9. Name the four types of DRIs:

Oxygen indicators	***Combustible Gas Indicators***
Toxic atmosphere monitors	***Ionization detectors***

10. If the needle on a CGI rises above 100 percent of the LEL and then returns to zero, this means the atmosphere does not present a combustible hazard.

a. True ***b. False***

APPENDIX A: SUMMARY OF DIRECT READING AIR MONITORING INSTRUMENTS

Principle of Detection and Monitoring Need	Instrument	Features	Limitations
Wheatstone Bridge Filament **Monitoring Need:** Combustible Gas	Combustible Gas Detector	• 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 • Probe provides remote operating life for most models • Eight- to twelve-hour battery operating life for most models • Accuracy varies depending upon the model; accuracies of ±2 to 3% are attainable	• Potential interferences from leaded gasoline and silicates, which are more strongly absorbed 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%)
Chemical Cell **Monitoring Need:** Oxygen Deficiency	Oxygen Meter	• Direct readout in percent oxygen • Visual and audible alarm • Lightweight, portable, and easy to use • Probe provides remote sensing capabilities • Accuracies of ±1% are attainable, but depend on the particular model • Generally eight- to ten-hour battery life	• High humidity may cause interference • Strong oxidants may cause artificially high readout
Chemical Sensor			
Wheatstone Bridge Filament **Monitoring Need:** Combustible Gas/	Combination Oxygen Meter and Combustible Gas Detector	• Calibrated to Pentane and Hexane • Measure percent oxygen and gas concentration	• Same limitation are oxygen meters and combustible gas detectors • In certain units, acid

Oxygen Deficiency		as a percentage of LEL • Both visual and audible alarm • Remote sensing capabilities • Lightweight, portable, and easy to use • Accuracies of +2% are attainable but may be as high as +10%, depending on the models	gases and high CO2 concentrations shorten the life of oxygen sensor/cells • Certain units require conversion factor for true specific compound response readings • In certain units, oxygen calibration is altitude dependent
Optical, Electrical, Piezoelectric **Monitoring Need:** Aerosol/ Particulate	Aerosol/ Particulate Monitor	• Selectable ranges • Particle size differentiation available • Certain units have data logging capabilities	• Factory recalibration required on certain units • Values represent total particulates on certain units • Values represent total particulates: dust, mist, aerosols are all inclusive with no differentiation • Cold weather may have adverse effect on detector
Infrared Radiation **Monitoring Need:** Toxic Gas/Vapors	Infrared Analyzer	• 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 photoionization or the flame ionization detectors	• Not as sensitive as PID or the FID

• 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 not available for all compounds			
Chemical Reaction Producing a Color Change **Monitoring Need:** Toxic Gas/Vapors	Indicator Tubes	• Provides qualitative, semi-quantitative identification of volatile organics and inorganics • Accuracy of only about ±25%	• Low accuracy • Subject to leakage during pumping
Chemical Reaction Producing a Color Change **Monitoring Need:** Toxic Gas/Vapors (Continued)		• Simple to use, and relatively inexpensive • Real-time/semi-real-time results	• 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 **Monitoring Need**: Toxic Gas/Vapors Specific Atmospheres	Toxic Atmosphere Monitor	• Ease of operation • Small, compact, lightweight • Audible alarm upon exceeding present action level or TVL • Certain units have digital readout • Generally compound-specific • Certain units interface with data logger	• Cross sensitivity • Slow response/recovery after exposure to high contamination levels • Limited number of chemicals detected
Metal-Oxide Semiconductor **Monitoring Need:** Toxic Gas/.Vapors	Toxic Atmosphere Monitor	• Ease of operation • Small, compact, lightweight • Audible alarm upon exceeding present action level	• Cross sensitivity • Slow response/recovery after exposure to high contamination levels

		or TLV • Certain units have digital readout • Certain units interface with data logger • Nonspecific gas and vapor detection for some organics and inorganics	
Photoionization Ultraviolet Light **Monitoring Need:** Toxic Gas/Vapors	Photoionization Detector (PID)	• Nonspecific gas and vapor detention 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 compounds • Remote sensing capabilities • Response time of 90 percent in less than three seconds	• Does not monitor for specific gases or vapors • Cannot detect hydrogen cyanide or methane • Cannot detect some chlorinated organics • High humidity and precipitation negativity affect meter response

Photoionization Ultraviolet Light **Monitoring Need:** Toxic Gas/Vapors (Continued)		• More sensitive to aromatics and unsaturated compounds than the flame ionization detector (FID) • Eight-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	
Hydrogen Flame Ionization **Monitoring Need:** Toxic Gas/Vapors	Flame Ionization		
Detector (FID)	• In the survey mode, it functions as a non-specific total hydrocarbon analyzer; in the gas chromatograph mode, it provides tentative qualitative/quantitative identification • Most sensitive to saturated hydrocarbons, alkanes, and unsaturated hydrocarbon alkanes	• 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	
Hydrogen Flame Ionization **Monitoring Need:** Toxic Gas/Vapors (Continued)		• Lightweight (12 lbs) and portable • Remote sensing probe is available • Response time is 90% in two seconds • Eight-hour battery operating life • Sounds audible alarms when predetermined levels are exceeded	• Requires changes of columns and gas supply when operated in the GC mode in certain units • Because specific chemical standards and calibration columns are needed, the operator must have some idea of the identification of the gas/vapor • Substances that contain substituted functional group (e.g., hydroxide (OH-) or (CI-) Chloride groups) reduce the detector's sensitivity
Gold Film Sensor **Monitoring Need**: Mercury Vapor	Mercury Vapor Analyzer	• Compound specific; has survey and sample modes • 0.0001 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	• Requires yearly *factory* recalibration • Short battery life • Requires AC power for Heat Cleaning Cycle

		• Certain units have data logging capabilities • Five-hour battery life	

APPENDIX B: SUMMARY OF COMMON AIR COLLECTION/ ANALYTICAL METHODS

Contaminant	Collection Media	Collection Method*	Analytical Method
Alcohols	Charcoal	NIOSH 1400 NIOSH 1401 NIOSH 1402	GC-FID
Aliphatic Amines	Silica Gel	NIOSH 2010	GC-FID
Aromatic Amines	Silica Gel	NIOSH 2002	GC-FID
Asbestos	25 mm 0.8 m MCEF filter 25 mm 0.45 m MCEF filter	NIOSH 7400 NIOSH 7402	

			PCM TEM
Cyanides	0.8 m MCEF filter and impinger	NIOSH 7904	ISE
Dioxin	3" polyurethane foam plug/filter	EPA TO -9	GC/MS
Hydrocarbons: BP 36-126 °C Aromatic Halogenated	Charcoal	NIOSH 1500 NIOSH 1501 NIOSH 1003	GC-FID EPA Modified GC/MS
Inorganic Acids	Washed Silica Gel	NIOSH 7903	IC
Mercury	Hopcolite/Hydrar	NIOSH 6009	AA

Metals (elements)	37 mm 0.8 M MCEF filter	NIOSH 7300	ICP-AES
PCBs	Florisil® and 13 mm glass fiber filter	Lewis/McCleod Modified NIOSH 5503	GC-ECD
Pesticides/PCBs	3” polyurethane foam plug	EPA TO -4	GC-ECD
Polyaromatic Hydrocarbons (PAH)	Washed XAD-2, 37 mm PTFE filter w/support O-ring 2” x 1” Polyurethane Foam	NIOSH 5515 NIOSH 5506	

Volatile organics	Tenax®/carbonized molecular sieve (CMS)	EPA TO -1 EPA TO -2
Volatile organics	SUMMA® canister, SUMMA® canister w/critical orifice	GC-ECD, NPD or FID GC/MS

LEGEND:

AA: Atomic Absorption
GC-ECD: Gas Chromatography-Electron Capture Detector
GC-FID: Gas Chromatography-Flame Ionization Detector
NPD: Nitrogen-Phosphorus Detector
GC-MS: Gas Chromatography
IC: Ion Chromatography
ICP-AES: Inductively Coupled Argon Plasma, Atomic Emission Spectroscopy
ISE: Ion Specific Electrode
PCM: Phase Contrast Microscopy
TEM: Transmission electron Microscopy
HPLC-UV: High-Pressure Liquid Chromatography with UV Detector

***Note:** The flow rates that appear in the NIOSH methods are often modified for outdoor ambient air sampling.