Introduction – Air Monitoring

- Air monitoring devices are used for the following types of atmospheres:
  - Flammable/explosive
  - Toxic
  - Oxygen-deficient and oxygen-enriched
  - Radioactive
  - Biological (not covered in this module)

Learning Objectives

- At the end of this module, you will be able to :
  - List the purpose 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.

Air Monitoring Objectives

- 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 controls.

Air Monitoring Field Activities

- Air monitoring may be needed during:
  - Initial site characterization
  - Emergency responses to 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
  - Head sampling of groundwater monitoring wells
  - Drilling activities and trenching excavating operations
  - Underground storage tank removal
  - Industrial plant operation
  - Confined space entry activities.

Test your knowledge

- The four types of hazardous atmospheres for which air monitoring is used are oxygen-deficient, toxic, explosive, and radioactive.

- True

- False

Characteristics of Instrumentation/Meters

- To be effective, air monitoring instruments should be:
  - Portable
  - Easy to operate
  - Intrinsically sage
  - Able to generate reliable and useful results
  - Property used and calibrated.

Characteristics of Direct Reading Instruments (DRIs)

- DRIs have the following characteristics:
- Act as primary tools of initial site characterization including flammable or explosive atmospheres, oxygen deficiency and enrichment, general organic vapors, as well as ionizing radiation
- Provide information at sampling time and allow for rapid decision making
- Locate the source of hazardous agents (leak detection)
- Detect changes in contaminant levels during site operations
- Detect and/or measure only specific classes or chemicals
- Need to be calibrated
- Most do not detect airborne concentrations below 1 ppm
- Able to detect several substances and therefore can give false positives.

Types of Direct Reading Instruments

- Direct reading instruments can be categorized into the following types:
  - Oxygen indicators
  - Combustible gas indicators
  - Toxic atmosphere monitors (general or specific)
  - Ionization detectors.

Oxygen Indicator

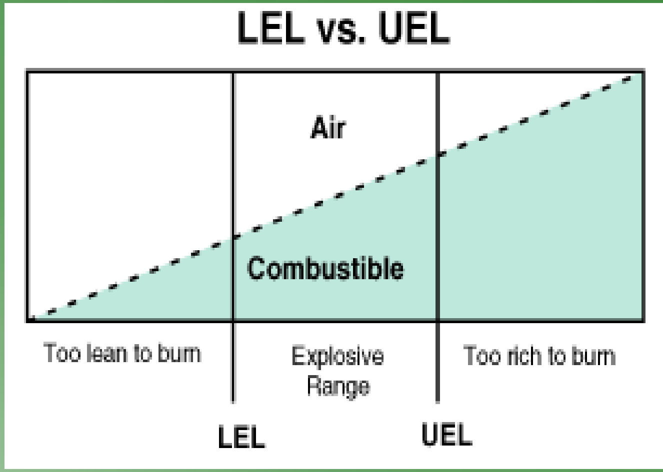
- The most common type of oxygen indicator uses a galvanic sensing cell to determine the oxygen concentration in air. Most oxygen indicators have meters which display the oxygen concentration from 0-25 percent.

- You may choose to use oxygen indicators when there are concerns about:
  - Oxygen Content for Respiratory Purposes
  - Use of Other Instruments
  - Presence of Contaminants
  - Increased Risk of Combustion

Oxygen Indicator

- For field activities, oxygen indicators may be used:
  - During initial site characterization
  - Emergency responses
  - Confined space entry activities
  - Underground storage tank removal
  - Industrial plant operations.

Combustible Gas Indicators



- Combustible gas indictors (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 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.

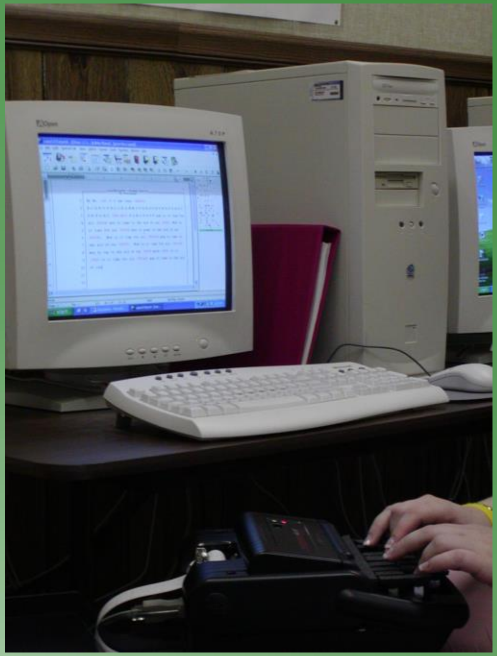
Combustible Gas Indicators

- CGIs have 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 interfering gas/vapor contaminants
  - Excess condensation from vapors cooling in the sampling line causes many meters to provide false readings.

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
  - Determine if engineering controls and work practices are effective
  - Determine medical monitoring needs.

Ionization detectors



- Photoionization detectors and lame ionization detectors 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 ad water samples, underground storage tank removal, and industrial plant operations.

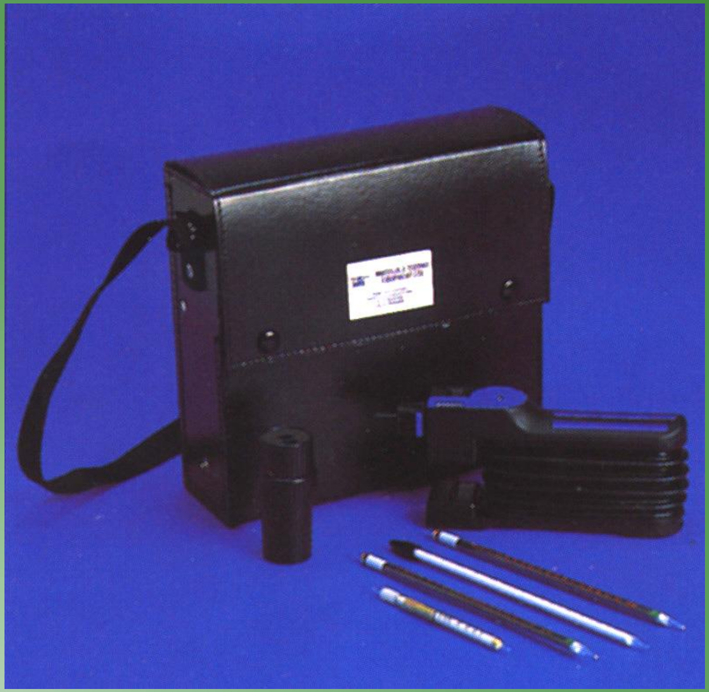
Sampling Pumps Media

- Low/high volume sampling pumps and media are used to complete a thorough assessment of airborne contaminants. After sample collection is conducted using established sampling methods (NIOSH, OSHA, or EPA), laboratory analysis is performed.
- The results provide air quality information such as the presence (qualitative) and concentration (quantitative) of contaminants.
- The general characteristics of air sampling methods are:
  - When sampling air, you must know the identity/class of the contaminant(s) being sampled
  - Laboratory analysis is necessary
  - Air sampling methods are often more accurate than most DRIs
  - Air sampling methods detect low levels of contaminants
  - 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.

Test your knowledge

- Which of the following is a characteristic of sampling pumps and media?
  - Laboratory analysis must be performed on the air sample
  - Air sampling methods are less accurate than most DRIs
  - Air sampling methods are less expensive than DRIs
  - Air sampling methods provide immediate results

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 or onto selected collection media.
- Various sampling collection media are used, depending on the type of contaminant.

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.

Inorganic Acids

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

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 special adsorbent selected for the site.

Test your knowledge

- Aerosols are generally collected in silica tubes.

  - True

  - False

Sample Collection and Analysis

- Samples are analyzed to determine the types and quantities of substances present.

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 0.8-0.5 micrometer pore size is commonly used
  - The sample can be weighed to determine total particulates, then analyzed destructively for metals
  - If a nondestructive analysis is performed or if the filter is sectioned, additional analysis (I.e., inorganics, fiber counting, and optical particle sizing) can be performed.

Sorbent Samples

- 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.

Passive Dosimeters

- 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.

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 (NIOSH/OSHA/EPA) 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.
- 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.

Test your knowledge

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

  - Diffusion samplers and permeation devices

  - Oxygen indicators and Ionization detectors

General Monitoring Practice

- Follow these 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).

Periodic Monitoring

- Periodic monitoring is performed when:
  - Work begins on 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.

NIOSH/OSHA/EPA Methods

- Personal monitoring samples should be collected in the breathing zone and, if workers are wearing respiratory protective equipment, outside the face piece. Sampling should occur frequently enough, with sufficient duration and combination of samples, to characterize the exposures accurately.
- The selective monitoring of workers is required by OSHA (29 CFR 19.10120(h), 29 CFR 19.101000, and other OSHA-specific standards (e.g., benzene, lead). 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 potential for exposure 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.

Meteorological Considerations

- 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
  - Sampling strategy, analysis, and reliability of data.

Long-Term Air Monitoring

- Before implementing any air monitoring program, consider the following:
  - 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)
  - Types of equipment
  - Costs
  - Personnel
  - Accuracy and sensitivity of the sampling method
  - Time to obtain results
  - Availability of analytical laboratories.

Test your knowledge

- Selecting sampling locations, calculating air dispersion, and calibrating instruments are based in part on meteorological information.

- True

- False

Using Vapor/Gas Concentrations to Determine the Levels of Protection

- Protection levels 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 a variety of 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.

Air Monitoring Results

- 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.

Summary

- Steps you can take to ensure efficient air monitoring include:
  - Making sure you understand all aspects of operation for a specific instrument, and it limitations
  - Ensuring that your air monitoring instruments are maintained and functioning properly
  - Calibrating instruments according to the manufacturer's instructions, both before and after sampling
  - Following established methods (OSHA, NIOSH, EPA) or SOPs where possible
  - Being aware of the effects that oxygen content, humidity, wind speed, etc., may have on air monitoring.

- You have completed the module:

- Air Monitoring.