Unit 7: Detection and Monitoring

Using technology to determine the presence and the concentration of hazardous materials in an incident area.

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Unit 7 Objectives

- The student shall identify the basic procedure for using detection and monitoring equipment for the establishment of hazard control zones.
- The student shall identify the purpose, operational usage, and limitations of the following types of detection and monitoring equipment:
  - Combustible gas indicator
  - Electrochemical cells for detecting oxygen or toxic vapors
  - Ionizing radiation detection equipment
- The student shall interpret basic instrument data and select appropriate actions to take.

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Terminology

- **Detection** is the process by which an emergency responder discovers the presence of a contaminant in an area.
- **Monitoring** is the process by which emergency responders measure the amount of material present in an area at a certain time. This allows the emergency responder to see if the problem is getting better or worse.
- **Concentration** is the amount of material in a given volume.
- **Action levels** are reference points. When an action level is reached, a specific action should be considered to prevent further exposure or harm.

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Use the data to determine:

- Presence and amount of flammable or toxic vapors
- Identify control zones
- Determine public protection actions
- Develop response tactics
- Identify the proper level and type of personal protective equipment
- Evaluate response techniques
- Determine what type of decontamination.

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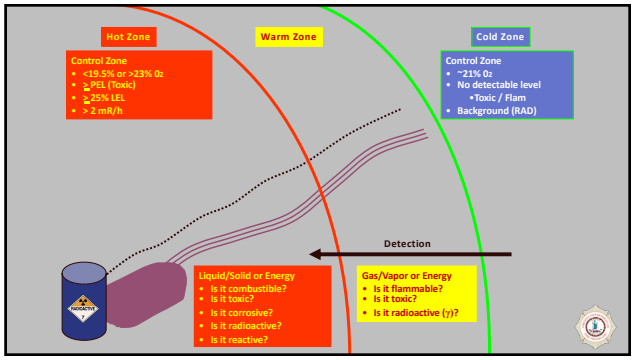

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Combustible Gas Indicators (CGI)

Detect and monitor concentrations of flammable gases or vapors in an environment.

The most common meters report as a percent of the LEL.

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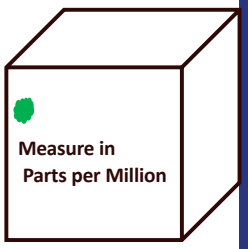
Electrochemical cells

- Sensors used to detect specific gases or families of gases.
- Made up of an electrical circuit and an electrolytic solution
- The current produced by the cell is proportional to the amount of material in the air sample from the environment.
- This change in current is reported onto a digital meter face.



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Special considerations when using electrochemical cells

- Temperature extremes can damage electrochemical cells and make them slow to respond.
- Continued exposure to the material or exposure to high concentrations can shorten the life of the sensor.
- Chemicals in the same chemical family as the sensor may give a reading that may be misinterpreted by the user.

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Oxygen-sensing electrochemical cells

Indicates % (per cent) of Oxygen in atmosphere.

Less than 19.5% O_2 Deficient	19.5 - 23.5% Normal Range	More than 23.5% O_2 Enriched

A 0.1% change on an oxygen-sensing electrochemical cell means that there is 5,000 PPM of "something else" present in the atmosphere.

- Presence of halogen (fluorine and chlorine) will cause false high O2 readings.
- Carbon monoxide may "poison" the oxygen sensor and limit its life.
- May be affected by altitude changes, humidity, and temperature.

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Combination (multigas) meters

- Manufacturers place different sensors inside one instrument package.
- Multiple sensors to look for environments that are:
  - Flammable
  - Toxic
  - Oxygen-enriched or deficient

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The most common multigas meters include:

- A CGI sensor to detect flammable atmospheres
- An oxygen sensor to detect oxygen-deficient or enriched atmospheres
- One or more electrochemical cells for detecting toxic gases. The most commonly seen cells are for detecting hydrogen sulfide and carbon monoxide, but others can be present.

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Action Levels

Hazard	Action Level	Action
Flammability	≥ 25% LEL	EXPLOSION/FIRE HAZARD! Leave area and ventilate.
Oxygen enriched	≥ 23.5% (v/v) (Virginia specific)	INCREASED FIRE HAZARD! Secure oxidizer source and ventilate.
Oxygen deficient	≤ 19.5% (v/v)	SCBA USE REQUIRED!
Ionizing radiation	≥ 2mR/hr above background	CONSULT RADIATION SPECIALIST!

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Toxic Gas Action Levels

PEL – establish control zones
IDLH – mandatory use of SCBA

Chemical	Formula	OSHA PEL(ppm)	IDLH (ppm)
Ammonia	NH_3	50 (TWA)	300
Benzene	C_6H_6	1 (TWA)	500 Ca
Carbon monoxide	CO	50 (TWA)	1200
Chlorine	Cl_2	1 (Ceiling)	10
Hydrogen sulfide	H_2S	20 (Ceiling)	100
Sulfur dioxide	SO_2	5 (TWA)	100

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Radiation Detection

- **Ionizing radiation detection equipment** can be broken into two broad categories of equipment based on use:
- **Survey monitors** – Survey monitors are designed to monitor the field of radiation being emitted from radioactive materials at a given point in time.
- **Dosimeters** – Dosimeters are instruments used to monitor total accumulated radiation exposure. Dosimeters are issued to individuals to wear so that an individual's exposure can be calculated and monitored.

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Radiation-detection equipment is usually chosen based on:

- The type of radiation to be detected
- The capability to have a high enough range span to measure the intensity of the suspected material

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Detection and Monitoring Data Interpretation

Flammable Atmospheres – Using a combustible gas indicator or a multi-gas meter where flammability is reported as %LEL…

- At 10% LEL – Proceed
- Between 10% LEL and 25% LEL – Proceed with continuous monitoring
- At or above 25% LEL – Flammability Hazard – Withdraw from area

Oxygen-containing Atmospheres – Using an electrochemical cell designed to detect oxygen…

- At 19.5% or less – Oxygen Deficient Atmosphere – SCBA or SAR use required by OSHA
- Above 19.5% but less than 23.5% - Continue monitoring
- At or above 23.5% - Oxygen Enriched Atmosphere – Protective equipment required (VA-specific level)

Carbon Monoxide-containing Atmospheres – Using an electrochemical cell designed to detect carbon monoxide…

- Below 35 PPM – Respiratory protection may be required – Consult specialist
- At or above 35 PPM – Respiratory protection required
- At or above 92 PPM – IDLH exclusion zone

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Detection and Monitoring Data Interpretation

Hydrogen Sulfide-containing Atmospheres – Using an electrochemical cell designed to detect hydrogen sulfide…

- At or above 10 PPM – Respiratory protection required
- At or above 332 PPM – IDLH exclusion zone

Radiation Detection

- If the unit alarms or records radiation 5 times background or more, the emergency responder should contact the Virginia Emergency Operations Center (800-468-8892) and ask to speak with a state Hazardous Materials Officer, who can assist the responder with the incident.

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Operating Principles

Each manufacturer has its own instructions for use, there are some general principles that can be applied to all combination meters.

- The instrument is turned on and allowed to warm up.
- The instrument should be exposed to clean air and prepared (calibrated) based on the manufacturer-specific instructions.
- The instrument can be carried into the environment suspected of containing contaminants by a responder wearing appropriate protective equipment.
- The operator of the instrument should walk slowly into the atmosphere and measure the atmosphere at different heights, not just waist-level.
- Remember, there are several gases lighter than air.
  - Carbon monoxide, has a vapor density of 0.9.
  - Propane has a vapor density of about 1.5.
  - Instrument has a response time.
- The instrument readings should be compared to the emergency responder action levels to see if an action applies.

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Thank You!
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