Hazard Monitors

Hazard	Monitor	How monitor works	Limitations
Corrosivity	pH paper	• Dip pre-moistened pH paper into the sample. • Acids turn paper red. • Bases turn paper blue.	• Use requires good color perception. • Contamination with oil, mud, or some other opaque material is possible. • pH paper does NOT tell the specific concentration of the material. • Use requires close contact with the material being sampled. • Reading the paper is difficult when sampling highly concentrated acids or bases, unless solutions are diluted.
	pH meter	• Insert the probe into the material. • pH is displayed on the meter's display.	Oils, temperature, or other contaminants may affect readings.
Flammability	%LEL CGI	• Monitor has a catalytic filament sensor. • Meter reading is the difference between the temperatures of the two filaments.	• Readings are read relative to the calibrant gas. • Response curves or conversion factors may be required. • A minimum concentration of oxygen is required. • Monitor may be susceptible to catalyst poisons. • Concentrations exceeding the UEL may create false readings. • Sensors may be affected by chlorinated hydrocarbons. • Sensors may become explosion hazards with oxygen-acetylene mixtures. • Meters made by different manufacturers and of different ages may act differently.
	%GAS CGI	• Monitor has a thermal conductivity (TC) filament sensor. • Meter reading shows how cool the TC filament gets compared to the hot compensating filament.	• Gases which cool the filament BETTER than the calibrant will indicate a higher %gas reading than is actually present. • Gases which cool the filament WORSE than the calibrant will indicate a lower %gas reading than is actually present. • All gases that cool the filament will create a meter response, *even if they are not flammable.*
	ppm-range CGI	Monitor measures gas concentration in parts per million (ppm).	• Sensitivity to detect and reliably measure ppm concentrations depends on the type of sensor employed and the calibrant. • Long warm-up times are required.

Hazard	Monitor	How monitor works	Limitations
Flammability (continued)	All CGIs		• All CGI's depend upon a battery supply. • Corrosive gases can deteriorate filaments. • Hot vapors and gases may condense onto the inner surface of the cooler hose. • Recommended operating temperatures are typically between 32° and 104°F (0° to 40°C). • Magnetic fields, high voltage wires, static electricity, radios, and cellular telephones can interfere with readouts. • Liquids and particulates may disable the sensors.
Oxygen deficiency	Oxygen monitor	• Monitor operates by diffusion. • The air sample is drawn in by either a passive sensor or a battery-operated or bulb-operated pump. • Oxygen reacts with electrolytes on the sensor, which generates a current flow to the meter. This current is amplified and displayed as percent-by-volume oxygen between 0% and 25%.	• There is no indication of what type of gas may be displacing the oxygen. • There is no indication of the toxicity of the gas displacing the oxygen. • High concentrations of acid gases can quickly neutralize the electrolyte, causing rapid sensor failure. • Strong oxidants will indicate a high or normal level of oxygen (false positive). • Sensing units deteriorate over time and must be changed. • Changes in humidity, temperature, and atmospheric pressure affect the monitor. • Extreme cold may result in sluggish, delayed movement of the meter.
Radioactivity	Gas-filled detector	• Contains a gas such as air, nitrogen, helium, or argon. • Radiation interacts with the gas and produces ions. A positively charged electrode or anode collects negatively charged ions, while the negatively charged cathode collects positive ions.	
	Geiger-Mueller counter	Monitor responds to X rays, gamma rays, and beta radiation.	• Monitor requires a recovery time of 10^{-4} or 10^{-3} seconds after each pulse or ionization event. • Over time, the counter may become saturated and no counts will be recorded. The meter will then display a zero-reading no matter what amount of radiation is present. • Monitor is designed for nuclear attack emergencies, which pose radiological hazards much different from those of transportation or fixed site accidents. • Alpha or low-energy beta radiation cannot be detected.

Hazard	Monitor	How monitor works	Limitations
Radioactivity (continued)	Ionization chamber	• Measures the ionization current flow in air between two electrodes. • Monitor responds to beta rays, X rays, and gamma radiation. • Those detectors with a thin covering over the chamber may also detect alpha radiation.	
	Proportional counter	• A gas-filled chamber has a central wire that acts as a high-voltage anode. The inner conducting surface of the chamber acts as the cathode. • The amplitude of the pulse peak equals the amount of energy absorbed by the gas. • Monitor can be used to measure alpha and neutron radiation, as well as to identify specific radionuclides.	Monitor requires that the voltage is carefully maintained.
	Light-emitting detector		
	Scintillation detector	• Detector contains solid, liquid, or gas phosphors such as zinc sulfide, sodium iodide, or cesium iodide crystals. • The light created when radiation strikes the phosphors is proportional to the radiation energy absorbed.	
	Luminescent detector	• Detector uses solids such as metaphosphate glass, calcium fluoride, and lithium fluoride that store radiation energy. • When processed, these solids emit a quantity of light proportional to the original amount of radiation energy.	
	Radiation dosimeter		
	Film badge	• Badge consists of a small piece of photographic film wrapped in a light-tight cover and supported with a metal backing. • Radiation interacts with silver ions on the film. • The more radiation the badge is exposed to, the darker the film becomes.	
	Pocket dosimeter	• Dosimeter measures X rays and gamma radiation. • The unit consists of a quartz fiber, a scale, a lens to observe fiber movement across the scale, and an ionization chamber.	• Frequent charging is required. • Some dosimeters display a reading as soon as the unit is removed from the charger. • The unit leaks small amounts of stored charge, causing the quartz fiber to drift and show a radiation reading.

Hazard	Monitor	How monitor works	Limitations
Radioactivity (continued)	Personal alarm	• The unit has visible and audible alarms and responds to any radiation over a preset level, usually between 1.0 and 2.5 mR/hr. • The unit can respond to alpha, beta, X ray, and gamma radiation.	
Toxic levels	Photoionization detector (PID)	• Instrument is effective for measuring low concentrations of materials.	• Detector's ability to work depends entirely upon the transmission of UV light. • Many factors can alter light and thus affect the PID's ability to do its job: – water vapor (humidity) – non-ionizable gases and vapors – lamp condition – dust and particulates – heated atmospheres – corrosive gases – high concentrations of gases and vapors • A meter reading of 0 ppm does NOT necessarily mean that no contaminant is present—PIDs cannot detect all potential contaminants present. • The meter reading is NOT the actual concentration of contaminants present in ppm. • PIDs do not respond to methane; however, methane will significantly decrease meter response to other ionizable contaminants. • Meter readings may change when gases are mixed.
	Flame ionization detector (FID)	• Monitor uses a hydrogen-fed flame to burn organic materials present in the air. • The flame has enough energy to ionize any organic material with an IP of 15.4 or less. • To be detected, the organic material must have multiple carbon-hydrogen bonds or multiple carbon-carbon bonds. • Some FIDs have an additional mode, called the gas chromatography (GC) mode. In this case: – The sample is drawn into a column containing a carrier gas, usually a high-purity inert gas such as nitrogen or helium. – Within the column, the individual components of the sample are separated. – These separated components are represented as peaks on the recorder.	• Monitor requires oxygen in order to burn. • Some FIDs do not have flame-out alerts to notify the user that the flame has gone out. • Not all FIDs are intrinsically safe. • Non-intrinsically safe FIDs are a source of ignition when flammable gases or vapors are present. • Large concentrations of flammable gases may also: – serve as an additional fuel source for the hydrogen flame, causing an increase in flame size and ion production, followed by an automatic, momentary shutoff of the hydrogen supply; this results in a meter reading of 0 – produce oxygen deficiency • The recommended minimum operating temperatures range from 40° to 50°F (5° to 10°C).

Hazard	Monitor	How monitor works	Limitations
Toxic levels (continued)	Colorimetric indicator tubes, (detector tubes)	• Each tube is a hermetically sealed glass tube containing an inert material, such as silica gel, alumina, resin, pumice, or ground glass. • The inert material is mixed with one or more reagents.	• Reagents are usually specific to a particular type or class of chemical. • Detector tubes, filled with reactive chemicals, are affected by any condition that would affect a chemical reaction, including: – temperature – humidity – atmospheric pressure – light – time – interfering gases or vapors • There is a potential for cross-reactivity and false positives. • Detector tubes have a margin of error of up to 35%. • Response times may vary greatly from chemical to chemical. • Responders with impaired color vision should NOT use detector tubes.
	Electrochemical sensor chemical monitor	Monitor measures a variety of specific toxic gases.	• If a chemical monitor uses a single toxic sensor, it will not indicate oxygen deficiency/enrichment or flammability.
	Test strips and papers	• Test strips are available for specific hazards. • They are usually part of a HazMat identification system.	