Course Learning Outcomes for Unit VI

Upon completion of this unit, students should be able to:

4. Illustrate how the concepts of exposure assessment, the hierarchy of controls, workplace monitoring, and medical surveillance are used to prevent occupational injuries and illnesses.

5. Recommend action strategies to correct common workplace hazards.

6. Apply the principles of risk assessment and hazard analyses as they relate to industrial hazards.

7. Apply appropriate management tools necessary for the successful development, implementation, and support of decision making for OSH-related endeavors.

Reading Assignment

Chapter 16: Industrial Hygiene and Confined Spaces

Chapter 18: Noise and Vibration Hazards

Unit Lesson

The assigned readings for Unit VI (Chapters 16 and 18) cover industrial hygiene and confined spaces and noise/vibration hazards, respectively.

Since many companies are small or mid-size and may not have a team of safety professionals, on any given day a safety manager might be required to play the role of industrial hygienist and anticipate, recognize, evaluate, and control situations in the work environment pertaining to physical, chemical, biological, and/or ergonomic hazards.

One of the most important skills in the realm of an industrial hygienist (and, by default the “solo” safety manager) is the ability to accurately identify potential exposure situations (chemicals, noise, temperature, radiation, etc.) and to select the right methods to monitor and/or accurately measure exposure levels in order to select the correct mitigation techniques and to protect workers from harm. Some of the most common monitoring and measurement tools are summarized below.

**Colorimetric detector tubes:** Colorimetric detector tubes are graduated glass tubes that are filled with material (specific chemical reagent) that will change color when it comes into contact with a particular toxic contaminant of concern. The detector tubes are sealed at the ends until ready to use, at which time the tips are broken off and air from the area in question is drawn through the chemical reagent in the tube using a manual pump. As the air sample is drawn into the tube, the reagent changes color as it reacts with the contaminant. The length of the color change that occurs is proportional to the concentration and is read off the graduate markings on the glass tube (Interscan, 2014). Colorimetric detector tubes are best used for quick, cursory evaluation of potential spills or leaks when more sensitive instrumentation is not readily available. Detector tubes are not helpful beyond a snapshot in time evaluation since once a contaminant is identified, it must be continuously monitored using a direct reading instrument or eliminated. Detector tubes do not provide quality, accurate analysis void of interferences from other chemicals, and cannot be used for continuous monitoring.
**Photoionization detector:** A photoionization detector (PID) is a meter that is used to detect volatile organic compounds (VOCs) which include solvents, fuels, and many other toxic substances that are comprised of organic molecules. A PID is a broad range detector that measures the aggregate reading of the total VOCs in a given air sample. A PID does not indicate whether there is a particular contaminant in the air sample or the relative concentrations of specific VOCs, but it will allow one to accurately judge the total VOC concentration. The PID uses high energy ultraviolet light from a lamp contained in the detector to knock electrons from the VOC molecules as they pass by in the sample air stream. The fragments (ions) are collected on electrically charged plates which produces a flow of electrical current in proportion to the concentration of the VOCs in the sample. The amount of energy needed to remove and electron from the VOC molecule is called the ionization potential or IP which is measure in electron volts (eV). As long as the lamp energy is greater than the ionization potential, the molecule can be detected by the PID. Ionization potentials, where available, can be found in the NIOSH Pocket Guide to Chemical Hazards published by the U.S. Government through the Centers for Disease Control and Prevention (CDC, 2010), and through PID manufacturers as part of their technical support documents and manuals.

**Flame ionization detector:** A flame ionization detector (FID) detects VOCs by igniting the chemicals contained within an air sample as it passes over a hydrogen flame. In contrast to the PID, the FID uses the hydrogen flame (as opposed to an ultraviolet light source) to break electrons off of organic molecules. Similar to the PID, the FID collects the free electrons on electrically charged plates which produces a flow of electrical current in proportion to the concentration of the VOCs in the sample. FIDs have a wider range of VOCs that they can detect and are not as susceptible to humidity interference as PIDs. Because of the higher overall cost to operate and maintain FIDs as compared to PIDs, they are not used as frequently as PIDs as a field VOC detection instrument.

**Multi-gas meter:** A multi-gas meter is often used when entering spaces that could contain hazardous atmospheres, such as confined spaces. Since the main hazards of confined spaces include asphyxiation and fire/explosion, at a minimum, a multi-gas meter is commonly used to detect the following four parameters before and during confined space entry procedures: lower explosive limit (LEL), oxygen (O₂), hydrogen sulfide (H₂S), and carbon monoxide (CO). The multi-gas meter, as set up for a basic confined space situation (LEL, O₂, H₂S and CO), should appropriately be set to alarm for the following parameters:

- lower explosive limit (LEL) – less than 10%
- Oxygen (O₂) – 19.5% to 23.5%
- Hydrogen Sulfide (H₂S) – less than 10 parts per million (ppm)
- Carbon Monoxide (CO) – less than 35 ppm

In addition to these baseline parameters, a multi-gas meter should have the capability to measure specific concentrations of other toxic gases or vapors that may be present. Other standalone instruments (PID or FID) should be used in coordination with this meter to ensure that all potential exposures are evaluated (Rae Systems, 2014).

**Passive badges:** Passive badges are a discrete, unobtrusive, and cost effective method for conducting personnel monitoring for occupational exposure. Most passive badge collection devices are diffusion devices (McDermott, 2004). These sampling devices consist of a badge-like housing that clips to a shirt collar filled with a charcoal collection pad. Chemical molecules diffuse from the air in the breathing zone into the sampling device (badge) at a fixed rate. After the sampling period is completed, the badge is capped and sent to an analytical laboratory for desorption of contaminant molecules from the collection pad using a solvent and then analyzed by gas chromatography. Using the elapsed time (start and end times) during the sampling period and the contaminant volume detected from the laboratory analysis, a time-weight average exposure can be calculated. Passive badges samplers are available for many different chemicals.

**Active sorbent tube and particulate samplers:** Sorbent tube and particulate sampling requires the use of a pump to draw air through a collection device. In the case of sorbent tubes, gas- or vapor-phase contaminant molecules in the ambient area are pulled through a glass tube filled with filter media (e.g., charcoal, silica gel, tenax) at a constant flow rate using a low or medium flow sampling pump over a specific period of time (Casella, n.d.). The contaminant molecules adsorb to the filter media in the glass tube during the sampling period. At the end of the sampling event, the ends of the tubes are capped and the tubes are submitted to an analytical laboratory for analyses that are specific to the contaminants of concern.
Active particulate sampling also requires the use of the pump calibrated at a constant flow rate over a specific time period. However, particulate sampling media is a cassette outfitted with a filter media that is designed to trap specific size particles on the surface, while allowing smaller particles to pass to the other side (Casella, n.d.). Common filter materials used for particulate sampling include: mixed cellulose esther or MCE (metals, welding fumes, asbestos, and other fibers); polyvinyl chloride or PVC (silica, respirable/total dust and chromates); and, polytetrafluoroethylene or PTFE (PM10, pesticides, acid aerosols, and solvents). At the end of the sampling event, the cassette is sent to an analytical laboratory for gravimetric (pre- and post-weight comparison) and/or specific contaminant volume analysis.

**Noise dosimeter:** A noise dosimeter is similar to a sound level meter in that it can be used to measure sound/noise levels. However, a dosimeter is actually a sampling meter that is most often used to measure an employee’s exposure (dose) to noise during a specific sampling period or work shift. A noise dosimeter is placed on a worker with a microphone clipped in his/her hearing zone (a two-foot sphere around the head). The dosimeter can calculate the employee’s noise exposure in real-time through using standard noise calculations. Noise dosimeters give measurements in average decibels (dB) over a specific period of time.

**Sound level meter:** A sound level meter (SLM) is one of the methods used to measure noise. SLMs can be used to check the accuracy of dosimeter readings, assess a worker’s noise dose in some circumstances (e.g., when a noise dosimeter is not available), identify noise sources that may require abatement measures, assess the efficacy of noise abatement engineering controls, and evaluate the helpfulness of hearing protective devices (HPDs). Some SLMs may have measurement modes that allow for measurement of transient (peak or impulse) sounds. SLMs read in decibels (dB) at a specific moment in time.

**Heat stress/heat index monitor:** Heat stress is a common hazard—especially in workplaces located in hotter climates or with a significant portion of strenuous work performed outdoors during the summer months. A heat stress monitor measures different types of temperatures (dry-bulb, natural wet-bulb, and radiant heat), air movement, humidity, and performs a conversion to what is commonly called wet bulb globe temperature (WBGT). WBGT is a measurement of heat stress in the direct sun (NOAA, 2014) Some heat stress monitors can also calculate heat index (HI), which only takes into account temperature and humidity and is applicable to shaded areas. To obtain accurate measurements, heat stress monitors should be located at the employee’s chest height and be given enough time to allow all of the readings to stabilize. Time-weighted average (TWA) WBGT calculations are useful in helping to assess potential employee over-exposure and to help formulate work-rest regimens.

References


**Suggested Reading**

Read the resources linked below for more information on subjects discussed in this unit.


**Learning Activities (Non-Graded)**

View the video, and reflect on the importance of following safety procedures.


Non-graded Learning Activities are provided to aid students in their course of study. You do not have to submit them. If you have questions, contact your instructor for further guidance and information.