Course Learning Outcomes for Unit VIII

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

7. Evaluate common industrial hygiene related hazard assessment and control strategies.
   7.1 Identify industrial hygiene related hazards that are present in an automobile parts manufacturing facility.
   7.2 Determine the sampling and analytical method that would best evaluate personal exposure to any chemical hazards found in an automobile parts manufacturing facility.
   7.3 Explain how control methods that would be the most effective for reducing risk could be implemented and evaluated.

Reading Assignment

Chapter 8:
Ventilation, pp. 159–185

Chapter 9:
Respiratory Protection, pp. 191–211

Chapter 13:
Thermal Stressors, pp. 309–316

Chapter 14:
Ergonomics, pp. 337–345

Unit Lesson

One of the most challenging aspects of an industrial hygienist's job is to recommend, implement, and evaluate control methods. Once hazards have been identified and risk assessments have been performed, controls must be implemented to reduce hazards where unacceptable risks are present. It can be attractive to merely recommend the use of personal protective equipment (PPE) and move on to other tasks. The largest problem with this approach is that the hazard is still present, and an acceptable risk will be present if workers do not use the PPE or do not use the PPE properly. Most industrial hygienists can recount several stories where workers used PPE improperly, which resulted in unacceptable exposures.

One such event occurred in a plant in New Mexico where diatomaceous earth was crushed, sized, and bagged for sale as filtration material. Because the diatomaceous earth contained significant levels of crystalline quartz, employees were required to wear half-mask air purifying respirators (APRs) equipped with high-efficiency particulate air (HEPA) filters (now called N100 filters). One employee was observed wearing the respirator with the exhalation valve removed and smoking a cigar through the opening! Of course, this negated the protection factor provided by the respirator. After being informed of the problem, the employee was still smoking the cigar through the respirator, but he had used duct tape to seal the opening around the cigar!
The Occupational Safety and Health Administration (OSHA) implemented a hierarchy of controls in order to guide the industrial hygienist and safety professional in selecting the most effective control methods. Figure 1 summarizes OSHA’s hierarchy of controls. As you can see, the controls at the top of the pyramid are the most effective for reducing risk associated with hazards, and the controls at the bottom of the pyramid are the least effective. Industrial hygienists must be familiar with the concepts in the hierarchy of controls in order to be effective at implementing and evaluating controls.

The most effective control method available is the elimination of the hazard. Obviously, when you can remove a hazard completely from a workplace, you reduce the risk associated with that hazard to acceptable levels. In many instances, a hazard cannot simply be removed from a work site because some type of chemical must be used in the process. An example would be the use of a solvent to remove paint from surfaces. Some companies have used the solvent styrene to strip paint from aircraft in order to repaint the plane. In one location, the use of spray nozzles to apply the styrene resulted in high personal exposures to workers, requiring the use of supplied air respirators (SARs) even when local exhaust ventilation systems were present. An additional hazard occurred when the styrene saturated the air lines leading from the compressors to the workers’ face pieces, resulting in styrene entering the air supply at levels exceeding OSHA’s permissible exposure limit (PEL). Since some type of chemical had to be used to remove the old paint, several other chemicals were tried to determine their effectiveness at removing the paint. This process is called substitution. A consideration that must be made is whether the substitute chemical is less toxic than the original. In the case of the paint removal, the company started using a hydrogen peroxide solution. The paint was removed after a slightly longer application process, but air samples showed that personal exposures were lower than the OSHA PEL for hydrogen peroxide.

In many cases, the production process will not allow for the substitution of an alternate compound. This typically occurs because of customer specifications for the manufactured process. For example, some companies produce gases for use in manufacturing processes. If a semiconductor process requires the use of the gas arsine, the company that produces the arsine gas would not be able to substitute a less toxic compound for the arsine. In this case, the industrial hygienist would need to go to the next level of the hierarchy of controls and consider engineering controls. The most common engineering control that is used in industrial settings is ventilation.

There are two basic types of ventilation systems that are used: dilution ventilation and local exhaust ventilation. Dilution ventilation systems, as the name implies, simply dilute the concentration of the compound in the air by introducing additional air from outside the work area. If you go inside most industrial buildings, you will typically see some type of dilution ventilation system present. Their specific forms may vary, but they will have some type of fan present. Some of the fans penetrate the roof of the building, and others penetrate the side walls of the building at some height above the floor. The fans will either pull air from outside of the building and blow it into the building, or the fans will pull air out of the building and blow it outside of the building. In some cases, the building also has large fans hanging from the ceiling, which simply move air...
around inside of the building. For many exposures, this type of system is adequate to reduce exposures below OELs.

Some compounds are present at such high concentrations or have such a high toxicity that dilution ventilation alone is not adequate to reduce risks to an acceptable level. In those cases, dilution ventilation may be supplemented by using local exhaust ventilation systems (LEVs) for some specific operations. LEVs collect contaminated air close to the source and then move it to a location where it is treated in some way before being released. The distance to the treatment may be very short (e.g., a portable LEV). The use of portable LEVs in welding operations is a good example. Portable LEVs used for welding typically have an extendable arm, sometimes called an elephant trunk. The opening at the end of the arm is placed near the weld operation, and the welding fumes are pulled away from the welder’s breathing zone and carried a short distance to a high-efficiency particulate air (HEPA) filter bank before the air is returned to the work area. These systems are very efficient but require some work on the safety professional’s part. First, many welders do not take the time to position the LEV prior to welding, so compliance is an issue. Periodic training and monitoring is usually required to overcome these issues. Secondly, the filters on the LEVs must be changed periodically. This requires an ongoing maintenance program.

In some cases, especially when highly toxic compounds are present, more elaborate LEVs are required. Fixed in-place LEVs are sometimes paired with isolation systems to provide more efficient removal of contaminated air. One common example of this setup is a laboratory hood, sometimes called a “fume-hood;” however, in laboratories, they are used more for gases and vapors than for fumes. These LEVs allow the worker to perform operations involving more toxic compounds with lower risk of exposure if the hoods are operated properly. There are several issues that can affect the operation of a hood, including the sash height, the number of articles present inside the hood, the cleanliness of any filters that are present in-line with the hood, and the actions of the worker. Laboratory hoods should be checked periodically for performance. Most industrial hygienists working in areas with laboratory hoods will be familiar with procedures to check face velocities associated with the hoods.

After implementing engineering controls, additional risk assessments should be conducted. If the residual risk is evaluated to still be at an unacceptable level, the next level of controls that should be applied are administrative controls. Administrative controls are not typically as concrete as engineering controls. Administrative controls consist of policies and procedures that are designed to reduce risks. Some good examples of administrative controls include a hearing conservation program, health and safety committees, warning signs, and training. Many of these administrative controls are designed to identify potential high risks and to develop written procedures that can then be used to train employees on how to best work to reduce risks. For example, a safety committee member notices that the floor around one machine becomes slick after a few hours of operation due to the settling of metal working fluids. A written procedure is developed that requires the floor to be cleaned using a floor sweeper at specific times each day, and employees working in the area are trained to recognize the hazard and to take steps to avoid a slip and fall.

After elimination/substitution, engineering, and administrative controls have been implemented, if a subsequent risk assessment shows that residual risks are still unacceptable, the last control method that should be implemented is the use of personal protective equipment (PPE). Unfortunately, in many occupational settings, PPE is the first and only line of defense that is used. This typically occurs because employers mistakenly believe that the use of PPE is easier and cheaper than engineering or administrative controls. Many times, industrial hygienists find that one of their most difficult jobs is demonstrating to upper management the cost benefits of implementing engineering and administrative controls versus simply using PPE. Another mistake that is common is the lack of PPE during the interim period while engineering and administrative controls are being implemented. It may take several months to design and install a new ventilation system. If no PPE is used during that time, employees are being exposed to an unacceptable risk.

There are times when PPE is desirable. In many instances, both engineering and administrative controls are not adequate or not feasible to reduce the risk associated with a hazard to an acceptable level. In those instances, PPE can be used to further reduce the residual risk. In some instances, OSHA has decided that the risk associated with a specific chemical or process is high enough that employees should always use PPE. A good example would be the OSHA construction standard for asbestos. There are some tasks where OSHA requires workers to wear respiratory protection regardless of what the air concentrations are.

One common type of PPE is respiratory protection. A concept that may be confusing to many safety and health officers is voluntary use versus required use. Under the respiratory protection regulation, employers
can allow workers to use a respirator even if the use is not required under the regulation. Some confusion exists as to what constitutes voluntary use and what constitutes required use. There are several conditions that require the use of respiratory protection by OSHA; the most common of these occurs when an OSHA PEL has been exceeded. What some employers do not understand is that if they include a requirement for the use of a respirator in a written scope of work, the respirator use falls under the required use even if it is not required by an OSHA regulation. Designation as required versus voluntary use can greatly increase the costs of a PPE program because of the increased requirements associated with required use of respirators versus voluntary use of respirators.

Voluntary use of respirators occurs when neither OSHA regulations nor written procedures of the employer require the use of a respirator. An employee may request to use a respirator for personal reasons (e.g., stating that he or she feels better when wearing a respirator). The employer may allow the employee to wear a respirator and may either provide the respirator or allow the employee to bring his or her own respirator (as long as the worker’s respirator does not cause an unacceptable risk). The requirements for voluntary use are much less than for required use. In fact, if the voluntary use is for a filtering facepiece respirator (which used to be called a dust mask), the employer may simply have the employee read Appendix D. A medical clearance is still required for all tight-fitting respirators, except filtering facepiece respirators—even for voluntary use. However, fit testing is not required for any voluntary use, and employees can have facial hair when using a respirator voluntarily.

The main concern with a PPE program is the selection of the appropriate PPE for each situation. For example, if the wrong chemically resistant glove is provided to an employee, unacceptable dermal exposures may occur shortly after the employee starts a task. As an example, in one facility, employees were using nitrile gloves and 1, 3 butadiene and xylene to clean parts by hand. The manufacturer’s specifications showed that both of those chemicals break through the nitrile glove in less than five minutes. It is important for safety and health professionals to understand how to evaluate the PPE that will be used by workers to ensure it is adequate to protect against the specific hazards that are present in the workplace.

Reference


Suggested Reading

In order to prepare for the assignment in this unit, it is recommended that you review the following textbook material:

**Chapter 1:**
Introduction to Industrial Hygiene, pp. 13–17

**Chapter 10:**
Dermal Hazards, pp. 228–232

**Chapter 11:**
Noise, pp. 251–254

**Chapter 12:**
Radiation, pp. 272–276

The CSU Online Library contains many articles that relate to this unit’s reading assignment. 

*In order to access the resources below, you must first log into the myCSU Student Portal and access the Academic Search Complete database within the CSU Online Library.*
Respiratory protection is commonly used for reducing risk from airborne contaminants in occupational settings. Safety professionals sometimes have a difficult time selecting the proper respirator. The authors discuss some of the basics for choosing the proper respiratory protection in the following article.


Personal protective devices are only effective if they are properly used. The authors of the article below evaluate the effect of comfort on the effectiveness of noise attenuation for ear plugs.


Ventilation systems are the most widely used engineering control for occupational settings. The American National Standards Institute (ANSI) develops national consensus standards for the design of ventilation systems. The author of the article below summarizes 10 basic ANSI standards for ventilation systems.


The National Institute for Occupational Safety and Health (NIOSH) recently placed an emphasis on preventing injuries and illnesses by “designing out” hazards. The practice is called Prevention through Design (PtD). The following article looks at how the PtD concept fits into the Occupational Safety and Health Administration’s (OSHA) hierarchy of controls.


OSHA’s hierarchy of controls is important when designing controls for workplace hazards because it establishes the priorities for using the various controls available to the safety professional. The application of OSHA’s hierarchy of controls is discussed in the article below.


**Learning Activities (Non-Graded)**

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.

The Occupational Safety and Health Administration (OSHA) has published numerous aids, including free videos. Review the list of available videos, and view several to gain additional knowledge about control methods. In particular, there are several good videos on respiratory protection. The videos can be retrieved at the following link: [https://www.osha.gov/video/index.html](https://www.osha.gov/video/index.html)