Proper Use of the HIERARCHY OF CONTROLS

By Gary A. Morris and Ryan Cannady

THE SAFETY MANAGEMENT ROLE has grown exponentially more important in today's workforce. Regardless of the specific professional title this function holds, a safety professional's objectives and reasons for being employed remain the same. An OSH professional's primary goal is to ensure safe working conditions for employees and the workplace. Through establishing policies, plans, procedures and gaining company participation, a safety professional aims to reduce injuries while maintaining productivity.

According to Bureau of Labor Statistics (BLS, 2019a), overall employment of OSH specialists and technicians is projected to grow 8% between 2016 and 2026. Industries that show an increasing number of these jobs include construction, manufacturing, petroleum, management, scientific fields and technical consulting services. With the development of technology, a changing workforce and fast-paced work environments, employers look to OSH professionals to establish safety management systems. Among a safety professional's primary responsibilities is abating hazards by following the hierarchy of controls; however, it seems that some practitioners have turned the hierarchy of controls model on its head.

Occupational injury and illness cost estimates for U.S. civilians in 2007, both fatal and nonfatal, were found to be $6 billion and $186 billion, respectively (Leigh, 2011). Leigh describes this amount as "at least as large as the cost of cancer." Finding comprehensive data analysis when looking at the cost of U.S. occupational injury and illness data is difficult, as information is not gathered as efficiently or as often as other data. While cost estimates for heart disease, cancer or stroke are updated each year, similar estimates for occupational illness and injury occur far less frequently. Before the 2007 report, the last comprehensive estimate had not been studied since 1992 (Leigh, 2011). The 2007 estimated number of nonfatal injuries experienced in a work setting is 8,558,962. This number and the related costs point directly to the need to diligently follow the hierarchy of controls.

KEY TAKEAWAYS

- **It is critical for safety professionals to change the paradigm of looking first to PPE as an easy solution to any workplace hazard.**
- **Safety professionals must start using that which makes the profession marketable and useful by working with production and maintenance to find creative ways of reducing the hazard or eliminating it altogether, instead of only using PPE to work around the hazard, thereby stalling the process at the least effective level of the hierarchy of controls.**

Ingrained in every safety professional must be to approach abating workplace hazards by first removing the hazard rather than being satisfied with employees working around it. In a survey of literature, "40% of papers published in one journal over a 3½-year period addressed monitoring, 24% addressed physical effects and epidemiology, 8% covered personal protection, and less than 8% were devoted to environmental control (Hammond, 1980)" (Burgess, Ellenbecker & Treitman, 2004). These statistics suggest that safety professionals may focus more on the identification and evaluation process rather than on implementing ways to remove the hazard in the preliminary stages.

The Role of the Safety Professional

The foundation of the OSH profession is the science and art of anticipating, recognizing, evaluating and controlling hazards (Puncochar, 2003). Despite attempts to contain workplace injuries, BLS (2017) reported 5,190 fatalities in 2016, which is the highest reported number of fatalities in 6 years. For example, 849 resulted from slips, trips and falls.

As of 2018, 37% of all fatalities in construction are caused by falls (Zellen, Cannon, Hurley, et al., 2018). OSHA's 29 CFR 1926.501 requires appropriate fall protection in residential construction for those who work at or above 6 ft. The fall protection standard requires employers to provide personal fall arrest systems and training to reduce the risk of a fall hazard; however, the standard does not regulate the safety professional's responsibility to remove such hazard. According to Kaskutas, Evanoff and Miller (2013), OSHA's "Fall Protection in Residential Construction" guidance document outlines controls to protect workers from slips, trips and falls. The authors continue, "it is critical to identify and evaluate these technologies and to diffuse these technologies to construction professionals." Commonly reported in OSHA statistics, fall protection in construction was the most cited standard in fiscal year 2017 (OSHA, 2019).

From a safety management perspective, the focus should be first on abating the hazard completely rather than prescribing PPE, which depletes valuable time and resources while doing nothing to abate the hazard. OSHA's respiratory protection standard states it simply, "the primary objective shall be to prevent atmospheric contamination." However, employers often settle for having employees wear respirators instead of remov-

ing the contaminants and exposure at the source. The consequences of settling for this control can be seen in the 28,000 occupational pneumoconiosis deaths in the U.S. between 1995 and 2004 (NIOSH, 2008). If the fundamental goal of a safety professional is to eliminate hazards, not just work around them, then PPE cannot be the first solution.

Hierarchy of Controls

Safety professionals anticipate and identify hazards through qualitative data gathered from experience, quantitative data, BLS data and OSHA 300 logs to begin protecting the workplace. By utilizing this information, practitioners can anticipate when and how occupational hazards might occur (OSHA, 2016a). During the identification process, safety professionals can use available quantitative data. Based on peer-reviewed articles, safety professionals identify hazards from many of the same sources as the anticipation process. After identifying risks from major work processes, the OSH professional will evaluate collected data and pinpoint areas to improve. The OSH professional must begin by evaluating causes and seeking ways to mitigate and remove the hazard that could cause major injuries or fatalities. Following the evaluation process, controls can be implemented to abate workplace hazards and protect the employee. For the safety profession to remain relevant, it is critical to follow the hierarchy of controls model (Figure 1) and eliminate hazards first when possible.

First, Elimination

This article focuses on the importance of following the process of the sequential steps needed to reduce the risk of workplace hazards. To be successful, the first action must be to attempt to eliminate the hazard. Only if elimination is not possible should safety professionals work their way down the hierarchy of controls. Focusing on elimination to remove the hazard completely can prevent major incidents or fatalities from occurring in the workplace. Safety professionals must strive to first eliminate hazards before attempting to reduce the risk of the present hazard; implementing PPE remains at the bottom of the hierarchy as the least effective control for protecting employees.

Following 30 years of risk control study across nearly every industry, Lyon and Hollcroft (2012) conclude that many organizations fail to carry out effective risk assessments. One reason they cite is a failure to "consider the hierarchy of controls and [failure] to prioritize based on risk." They state that "consideration of the hierarchy on initial risk assessment and those performed after controls are implemented . . . serves to assess risk more accurately and helps continuously improve controls" (Lyon & Hollcroft). By applying the hierarchy properly, safety professionals can protect and ensure a safe working environment.

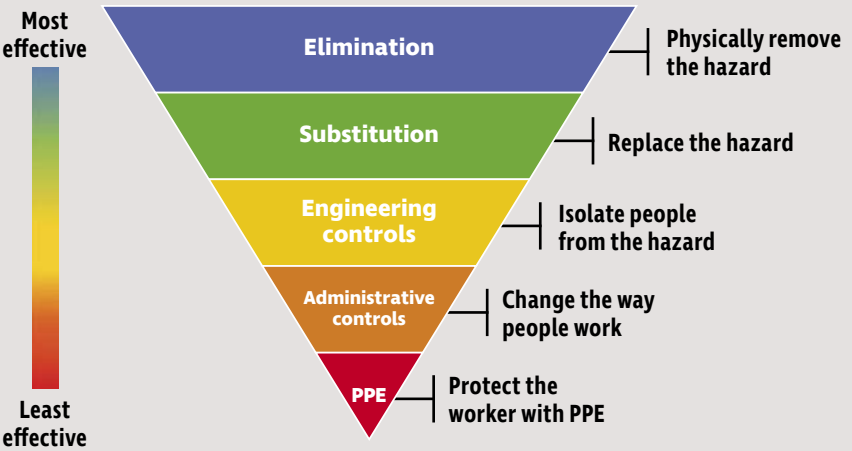
Once the hazard has been both identified and evaluated, the first step should be to either eliminate the risk altogether or to mitigate it to an acceptable risk level. Through the hierarchy of controls (i.e., elimination, substitution, engineering, administrative and PPE), safety professionals sequentially follow the steps necessary to create a safe workplace. Elimination removes the hazard from the workplace. Substitution allows for a less hazardous material or task to be used. Engineering controls are implemented to remove a hazard from its source and protect the worker entirely, which allows for workers to effectively continue their job duties without being exposed to any hazards in the work area. Administrative controls focus primarily on training and job rotation but do not always solve the exposure at hand. This stage of controls is where many practitioners may identify and evaluate a hazard but do not eradicate the overall exposure. The last step is to implement PPE in situations where no thoughtful control has been implemented. PPE helps protect employees, however, the stressor or danger is still present in the work environment.

During the identification and evaluation phases, many companies may look for the cheapest solution to perform and complete the job, and may assume that PPE is the cheapest, easiest method of addressing the hazard. The initial cost of the equipment should not be the only consideration; annual training requirements and PPE maintenance must also be taken into account. Moreover, by settling on this type of thinking, administrative and PPE controls are used without analyzing better ways to protect employees. As a result, statistics show injuries and fatalities continue to occur in the workplace because the hazards are not being resolved at the source.

Further, research shows that while PPE can minimize the risk found in certain work environments, in some cases it can also impact human senses and even decrease performance. According to Caretti, Scott, Johnson, et al. (2001), "respirators can decrease workers' physical, psychomotor and visual acuity, and increase anxiety." The thermal effect on workers increases exposure to heat stress, which also must be accounted for, and shows that PPE cannot be used as a cure-all in worker safety (AlGhamri & Murray, 2013).

Often, companies view engineering controls as a significant investment and may rely on ineffective ways of controling a

FIGURE 1
HIERARCHY OF CONTROLS



Note. Adapted from "Hierarchy of Controls," by NIOSH, 2015, www.cdc.gov/niosh/topics/hierarchy.

By receiving the needed information through drone software, employees can produce a timely and efficient survey compared to the traditional, dangerous inspection process.

hazard. However, investing in engineering controls can save money over time and provide effective methods of keeping employees safe without exposure to the hazard.

Elimination in Action

The danger of working in the construction industry has become increasingly evident in recent years. According to Cekada, Janicak and Ferguson (2009), "the number has steadily increased, with 809 fatalities reported in 2006. Of these 809 fatalities, almost 40% were due to falls from roofs and ladders." For example, typical issues encountered by home inspectors involve the use of ladders, which are essential for the completion of their surveys (BLS, 2019b). Socias, Chaumont Menéndez, Collins, et al. (2014), state, "Falls remain a leading cause of unintentional injury mortality nationwide." According to Lombardi, Smith, Courtney, et al. (2011), ladder falls comprise 16% of all U.S. workplace fall-related fatalities. In addition, falls from ladders account for 20% of all fatal and lost workday injuries in general industry (OSHA, 2016b; Smith, 2014). This hazard to home inspectors can be eliminated by employing a different method, such as the use of drones, to conduct inspections. By receiving the needed information through drone software, inspectors can produce a timely and efficient survey compared to the traditional, dangerous inspection process.

Home inspections are not the only application where a hazard can be eliminated through the use of drones. Falls from varying heights affect employees across many industries, with those in the mining, oil and gas, and wind energy industries also needing to perform tasks at height. Flare stacks at petroleum refineries present not only the danger of a risky climb, but also heat exposure. In the wind energy field, technicians are required to regularly climb towers more than 300-ft tall (Slaven & Dennis, 2012).

The act of inspecting roofs, wind turbines, mines or smoke stacks can be a dangerous, arduous process that may make it difficult to analyze the area and develop accurate measurements. Furthermore, most inspections can be time-consuming for companies to complete. Inspections across many industries can be made safer and potentially more accurate through the use of drones. These devices negate the risk of dangerous climbs taken on by inspectors in the oil and gas industries, or in evaluating the working conditions of mines. Drones can provide a detailed inspection while simultaneously removing the employee from the hazard. Through modern technology, employees in many fields can utilize drones to eliminate these hazards at the source. With the technology now available, drones are easier to fly and have full, high-definition capabilities. Employees are able to inspect the site and accurately record analytical data while remaining in a hazard-free zone. High-resolution, digital feedback of the site allows the employee to analyze and produce reports. The analytical data is often so precise through 3-D imagery that the employee can capture areas of concern without ever having to set foot in a hazardous area.

As technology has developed over the years, drones have become much simpler for consumers to operate (Gilbertson, 2015). The development of waypoint- and point-of-interest-based navigation allow for a drone to establish an automated

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flight path with commercial drones. However, to fly commercially, Federal Aviation Administration (FAA, 2019) finalized a new regulatory framework for small unmanned aerial systems and now requires a remote pilot airman certificate. FAA's (2016) new drone certification process covers a broad spectrum of commercial uses for drones weighing less than 55 lb. This regulation enforces safe working practices to ensure that operators follow procedures to avoid supplementary complications.

Following the hierarchy of controls to first try to eliminate hazards, other innovative technology solutions can be employed to protect employees against workplace hazards. Firefighting is among the most hazardous jobs, and protecting firefighters can be a daunting task for OSH professionals. A 2017 study shows that heart attacks caused by the stress and overexertion is the leading cause of death for firefighters (Hunter, Shah, Langrish, et al., 2017). However, use of gas sensors and cameras with thermal imaging technology can allow responders to conduct search and rescue tasks from a safe location (Sullivan-Nightengale, 2015).

The Future of the OSH Profession

This article evaluates how safety professionals utilize the hierarchy of controls to establish a safety management system, and describes how hazards can be removed in various occupations, for example, through the use of drones and thermal imaging technology. Some may begin to evaluate hazards from the bottom of the hierarchy of controls rather than the top. Those settling for PPE, the least effective control, may be overlooking opportunities to eliminate the hazard.

According to OSHA (2016c), the agency's final rule on Walking-Working Surfaces and Personal Fall Protection Systems "better protects workers in general industries from these hazards by updating and clarifying standards and adding training and inspection requirements." The agency continues, "The rule incorporates advances in technology, industry best practices and national consensus standards to provide effective and cost-efficient worker protection." However, the final rule allows employers to choose different fall arrest systems and training while employees are using ladders. This is an example of how employers may be focusing on administrative controls and PPE rather than on engineering controls and removing a hazard completely. Through the use of drones in the workplace, employees can accomplish the necessary tasks without being introduced to a fall hazard.

The process of seeing hazards and focusing on potential ways to remove the hazard must begin from the top of the hierarchy of controls, not the bottom. It is important to identify ways to improve the workplace by following the hierarchy of controls

in the correct sequence to improve the overall safety of a workplace while sustaining efficient work.

Conclusion

Hazards will remain prevalent in the workplace; approximately 153 million people were employed in 2007, and every position has some level of risk, whether through injury or disease (Leigh, 2011). However, it is the role of the OSH professional to work toward the elimination and control of hazards. According to Krause and Weekley (2005), "the challenge to leadership is to establish an environment and a process whereby hazards are routinely examined to verify that the most effective and practical controls are, in fact, applied." The hierarchy of controls starts at its most effective point, elimination or substitution, and the options become less effective and less desirable (Krause & Weekley, 2005).

It is critical for those in the safety profession to change the paradigm of choosing PPE first as an easy solution to any workplace hazard. Safety professionals must work with production and maintenance to find creative ways of reducing a hazard or eliminating it altogether. This starts with following the model in order, and OSH professionals utilizing their education and training to think through the issue from start to finish. Anyone can respond to a fall hazard by implementing fall protection equipment or training, but it is the unique job of a safety professional to investigate ways of removing the employee from the fall hazard. The overarching purpose of initiatives implemented by OSH professionals must be to "reduce exposure to hazards in the work environment" (Krause & Weekley, 2005). Reducing hazard exposures requires correctly following the hierarchy of controls, by beginning with eliminating or substituting the hazard, and only ending with implementing PPE if no better solution can be found. If safety professionals do not put their training and education to use, then going forward, companies may see no need for hiring them. **PSJ**

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