CHAPTER 2.1

Health and Safety

Stacy Kramer and Ed McGowan

THE PROTECTION ENVELOPE

Everyone in the mining and mineral processing business is lured to the same means of making ends meet, with the expectation that they will do so without harm. Consequently, to meet this goal, a substantial commitment and continuous improvement will always be expected. These are fundamental requirements of a *mature safety culture.* All levels of management need to be participate, and employee empowerment is critical to ensure success. Writings in this handbook or in company policy manuals are just that, words to provoke a better way. Regulations are provided for everyone's benefit as well, with each standard providing a specific level of protection. Yet everything businesses commit to is contingent on people of authority implementing best practices and ensuring that those practices prevail. Competence is essential regarding accident prevention, and implementation of a successful safety and health program is not likely without it. People in authority are the first tier of protection. It may sound like a coach cheering on his or her team, but it holds true nonetheless: "If not us, then who? If not now, then when?"

What gives at-risk workers the greatest advantage? Knowledge does. Savvy workers are far less likely to be injured or suffer ill consequences from potential exposures. The premise is simple, yet in practice it requires a robust effort by many to ensure worker safety and positive outcomes every day. In the world of mining and mineral processing, the risks are real and ever present. History has proven that. Without empowerment of every employee, the outcome of dangerous work is left to chance. Statistically, if those in authority allow it, something bad will happen. However, it is not about statistics; it is about people. People can control the outcome of each aspect of their work by applying knowledge, effort, and engineering principles that have proven records of success. There is a safe way to do every job; all accidents can be prevented. The process of accident prevention involves workers, under the assumption they are knowledgeable and completely enabled to make the right choices. A tier of empowered, savvy workers is fundamental to the development of the safety envelope. On this same note, not all workers are cut out for this.

From concept to reality, a safety and health program requires a lot of hard work. Nothing good comes easy. The "protection envelope" involves numerous layers of involvement. At-risk workers are best protected when the work culture recognizes hazards and implements appropriate controls. Communicating the sequence of work and maintaining consistent checks from start to finish is as essential as employee competency. Safety processes should keep workers out of harm's way even when something goes wrong. There is no spin on words here; the protection of workers is a conscious thought. Competent people know what it takes to not only do things right, but to do the right things. Ethos is core to people in the first place. When it comes to employee safety and health, everyone faces this challenge together. This chapter discusses elements that are essential for a successful health and safety program as the Society for Mining, Metallurgy & Exploration (SME) strives to communicate and expand the protection envelope.

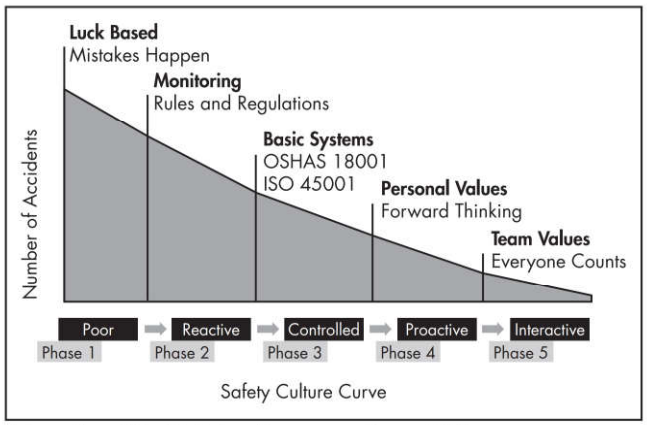
HEALTH AND SAFETY CULTURE

Modern health and safety management systems establish building blocks for a variety of operation types. In all cases there is a leadership expectation. Without top-level involvement, the success of the program will be limited. Likewise, there must be an evaluation process, an audit, which ensures that each aspect of the system is functioning as planned. One could argue that the audit is most essential because the scorecard that leaders are challenged to fulfill would also be the upper limit of their overall success. Therefore, knowing the safety culture becomes an integral part of the overall health and safety audit. What are the expectations, who is responsible for what, and what processes are in place to provoke the desired outcomes? A business can deliver a healthy environment and accident-free workplace every day when its commitment, resources, and finances are in alignment. The culture model helps organizations answer these questions and prioritize their tasks.

Most people in the industry have seen graphics that chart safety programs as either successful or pathetic. Such models

Stacy Kramer, Vice President Global H&S, Freeport-McMoRan Inc., Phoenix, Arizona, USA
Ed McGowan, Safety Manager, Kinross Gold Mining (Bald Mountain) Inc., Elko, Nevada, USA

represent a snapshot in time, but in reality, the system represents only the current team and their commitment to health and safety. An organization may own the strategy, but it is people who make up the results. It would be unwise not to recognize that the culture is subject to frequent change for this reason. People always have something tugging on them. Anything that influences their behavior will impact their decision making. Consequently, a work culture that places people first provides the best health and safety environment. When employee protection is incorporated throughout the system audit, the higher levels of achievement will always be targeted. Members are asked to make a specific note that certified safety and health programs are in the center of the cultural curve. Mature safety cultures recognize that a certified system is a key building block, but not the ultimate goal, for achieving safety and health success. Members of SME and company officials can score themselves using the same criteria. There will not be a test, nor will they have to complete assignments, but they should strive to stay to the right of the curve shown in Figure 1. This figure typifies a conventional health and safety approach for defining culture.



Adapted from FLSmidth Safety Management System 2016

Figure 1 Health and safety culture curve

LEADERSHIP EXPECTATIONS AND THE EMPLOYEE ENGAGEMENT PROCESSES

The first question in the system audit might be: Are all levels of management engaged in safety and health processes? And the second question might be: Are leadership requirements measured in "activities, outcomes, or both"? The questions assume that lack of leadership will be negative and active engagement is necessary for success. Active involvement might include a safety component in every staff meeting, specialized training for key individuals, participation in safety committee functions, or routine participation in plant safety meetings or inspections. Ultimately, at-risk workers need to see support, not just hear of it. When worker confidence in management is high, the motivation of the entire team is elevated. Work is therapeutic when pride is the driving force. Motivation is spurred by recognition of achievement and the opportunity to do interesting work. Recognizing this and being highly visible as a leader is of extreme value. For these reasons, the engagement process should include both individual and team opportunities. Both lagging and leading indicators, including the use of near-miss reporting, can and should be used to determine leadership activities that focus on the prevention of injuries. The audit structure should tally activities that are in alignment with this.

A leader also needs to be cognizant of hazards and critical risks. Some cultures have defined serious risk as a new paradigm where not all safety rules have the same weight. The theory suggests that mobile equipment, working at heights, confined space entry, electrical hazards, certain chemical exposures, lockout/tagout, and rigging/material handling type injuries are less forgiving. Fatal events are more likely to occur in these areas. In turn, critical safe work procedures, the enforcement thereof, and training (including practice) must be used accordingly. The leader must be keenly aware of this because, in the desire to be highly visible, one could unknowingly endorse poor practices within the paradigm. Sam Walton of Walmart got it right in his strategy of management by walking around. He simply shopped at his own stores to determine how things were. The strategy of safety by walking around is of equal value. Are leaders practicing what they say they are? Leadership safety walks, for the purpose of employee engagement, are one of the best tools for ensuring positive outcomes. Leaders should make sure they are well versed on critical safe-work procedures before walking around. They must be respectful of the culture.

In the spirit of taking advantage of every detail, leaders should make it clear they are in the field. They should be in uniform. How leaders dress not only is expected to comply with personal protective equipment (PPE) requirements but also adds to the element of respect. Worker apparel should be distinct, making it clear at a glance who makes up the team. The same is expected of a visitor or vendor; workers should have no doubt who is approaching. Those who are new to a job require a safety briefing. This places the burden on each newcomer to ensure that they check in with the person in charge before they proceed. Doing so is respectful and wise; not doing so is a mistake.

MEASURING PERFORMANCE

Most major mining companies recognize safety performance not only as essential but also as a key performance indicator (KPI). It would be unreasonable to expect a top-notch organization to have poor safety performance. Likewise, it would be unreasonable to expect top-notch safety performance when other KPIs are lagging. Sound safety results and overall efficiencies are one in the same. All safety results are driven by people; thus, accurately measuring performance is essential. An organization's performance indicators ensure the correct focus for financial components, training initiatives, and resources. Watching the trends is important, yet the lessons learned from any event are equally important. Conducting a root-cause analysis digs deeper into the cause of any event. The standard tools to measure safety performance are provided within this chapter to include insurance rating in the form of workers' compensation experience modification factors.

Naturally, incident rates tell us one story. A "zero injury" rate is something all organizations desire. How they have done in the past helps them predict the future. The Occupational Safety and Health Administration (OSHA) and Mine Safety and Health Administration (MSHA) provide ample information regarding reporting criteria and safety performance (OSHA 2001; MSHA 1986). Incident rates can be used for general purposes and are commonly used as a starting point to measure performance. The reporting criteria is the same for all operations in the United States since such reporting is

regulatory driven and typically overseen by a safety professional. A recordable event is the same for all. Major mining companies typically use total rates on a worldwide scale (all-incident rate) since this provides a more accurate measurement of overall performance. Total injury frequency rates use a broader numerator than lost-time incident frequency rates (LTIFRs) and assume any incident has the same potential of loss and is therefore more telling of the success or failure of the accident prevention program. There can also be discrepancies with lost-time events based on an operation's overall capabilities to provide alternate work options for injured workers. Internationally, LTIFRs are still used because a lost-time event is typically defined the same way in any country. Nonetheless, showing incident rates over time (usually annually) is more telling of performance trends. A trend that consistently shows a "zero point something" incident rate is an indicator that the operation is a top-notch performer.

Conventional incident rates are based on 200,000 equivalent hours worked. This is derived from exposure of 100 workers who worked 40 hours per week, 50 weeks per year. It compares the safety performance of 100 workers per year rather than a percent of injury. The formula used by both OSHA and MSHA is as follows:

$$\text{incident rate} = \text{number of injuries} \times 200{,}000/\text{hour worked}$$

This rate is a good barometer to use if an operation has 100 workers or more. If an operation recorded three events in a year and employed 100 workers, the incidence rate would be 3.0, meaning roughly 3% of the workforce had a recordable event that year (even though one person could have been injured more than once). Had this team worked more than 200,000 hours in the year, the incident rate would be slightly less, even though 3% of the workforce had been injured. If this same performance prevailed for a worker's entire career, one could extract from the same numbers that it would be likely for that worker and all others to be injured within a 35-year time frame (with the odds being worse for those performing the riskiest of tasks). For this reason, it is extremely important to sustain at or near-zero incident rates year after year after year.

Performance can be measured using injuries per hours worked, with no association with the 100-worker equivalent, but this is less common. Also, some international operations use 1 million hours rather than the 100-person equivalent-hours work formula. The trend line would mimic that of conventional rates, but the rate would calculate to be five times higher. Both methods mean the same when used as trend indicators and for overall goal-setting. Having an all-incident rate goal of less than 1.0 conventional would be the same as having a goal of less than 5.0 per million hours worked. The latter would scare most major mining companies if they were unaware of the alternate calculation that is sometimes used globally.

Although not applicable to all countries, a common tool to evaluate performance in the United States is the workers' compensation experience modification rating (EMR). It is the insurance rating assigned to an operation or company based on claim costs, frequency of injury, and historical performance as it relates to that company's industry type. A rating of 1.0 is average, below 1.0 is favorable, and above 1.0 is undesirable. In general, the rating is based on a company's performance over the past three years exclusive of current claims that have yet come to maturity. In short, it reveals what it would cost to insure the operation based on criteria used by mandatory no-fault insurance programs. Insurers must know the comparative risk to insure the operation. A low rating indicates that costs to insure are lower, medical costs are lower, and, most important, fewer injuries are occurring in this group. Although saving money is not often cited as the motivation behind accident prevention, as a KPI, less money spent on claims means lower incident and severity rates and lower insurance premiums. The reverse is true of high EMRs: the cost to do business is more, more injuries are occurring, and the operation is viewed as one with higher-than-normal risk.

Figure 2 depicts safety performance using EMRs. Each bar measures three years of performance; therefore, the chart is accurate. As noted previously, 1.0 represents the norm for the related industry. A lower limit of the rating system is identified in the chart as well. This varies by state but is typically set at 0.57 (lower limit = 57% of premium).

By using safety as a KPI, one can quickly assess a company's overall efficiency. The operation depicted in Figure 2 is very efficient and continuously improving, although not incident free. Having an injury-free workplace is both personally and financially wise. For these reasons, an operation's EMR is commonly the first issue addressed on a prequalification questionnaire. Bidding processes commonly use EMR performance comparisons. Mine operators want to know an operation's safety KPI in advance of any alliance or work.

An organization's leaders expect to have safety and health targets associated with both performance and activities. Watching trends is important, yet one must know the limitations of incident rates. Regarding safety and health, the

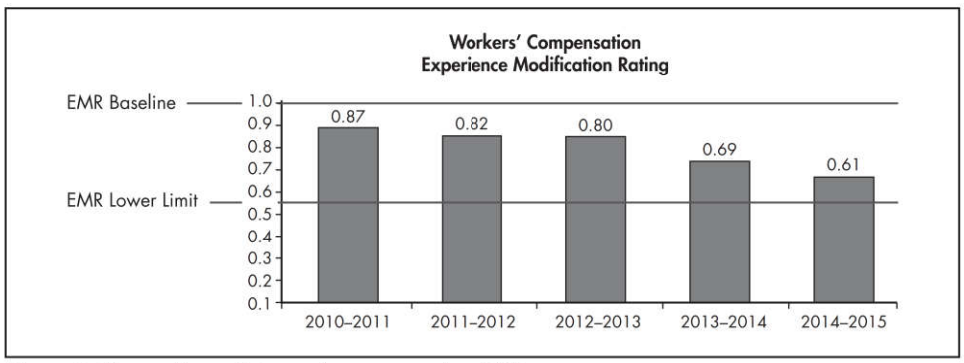


Figure 2 Measuring safety performance using EMR

system simply wants actions that enhance the culture of "zero injuries." The open-door policy, as commonly expressed in business, is part of this as well, as it is likely in use by the organization. It not only gives everyone access to leadership, it also suggests the leader should get out of the office and into the operation. And as the leader does so, he or she should do so with caution, be well read, know the risks, and seek out the persons in charge. The power of perception reminds us that *how* one proceeds is as important as proceeding.

SYSTEMS TO GUIDE HEALTH AND SAFETY MANAGEMENT SYSTEMS

A health and safety management system (HSMS) is a process an employer puts into place to minimize workers' risk of injury and illness. Developing the system is accomplished by identifying, assessing, and controlling risks to workers in all workplace operations (Figure 3). The scope and complexity of an HSMS will vary according to the type of workplace and the nature of its operations. To be effective, the following components should be in place:

- **Health and safety policy.** Develop a statement of the organization's commitment to health and safety. Use this policy as a framework for planning and action.
- **Health and safety hazards and risks.** Identify health and safety hazards, assessment of risks, and the implementation of necessary control measures.
- **Legal and other requirements.** Identify and ensure access to relevant laws and regulations (and other requirements to which the organization adheres).
- **Objectives and targets.** Establish goals for the organization, in line with its policy, health and safety hazards and risks, legal mandates of the organization, and the view of interested parties.
- **Health and safety programs.** Plan actions to achieve objectives and targets.
- **Structure and responsibility.** Establish roles and responsibilities and provide necessary resources.
- **Training awareness and competence.** Ensure that employees are trained and capable of carrying out their health and safety responsibilities.
- **Consultation and communication.** Establish processes for internal and external communications on health and safety management issues.
- **Health and safety documentation.** Maintain information on the HSMS and related documents.
- **Document control.** Ensure effective management of procedures and other system documents.
- **Operational control.** Identify, plan, and manage the operation and activities in line with the policy, objectives, and targets.
- **Emergency preparedness and response.** Identify potential emergencies and develop procedures for preventing and responding to them.
- **Monitoring and measurement.** Monitor key activities and track performance.
- **Accidents, incidents, nonconformance, and corrective and preventive action.** Identify and correct problems and prevent recurrences.
- **Records and record management.** Keep adequate records of health and safety performance.
- **Audit.** Periodically verify that the HSMS is operating as intended.
- **Management review.** Periodically review the HSMS with an eye to continual improvement.

CONTRACTOR REQUIREMENTS AND PREREQUISITES

Contractors are a significant aspect of doing business in the mining industry. Whether the contractors are working side by side with employees in the operation, as part of small projects to improve a site, or as part of a major green- or brownfield construction project, a company has an obligation to ensure that the contract companies and their employees are working within its safety and health programs. Companies that have the best safety performance treat the contractors as they do their own employees by setting clear expectations and then following through to ensure these expectations are met. Contractors are typically responsible for establishing, implementing, and maintaining their safety programs to meet the goals and objectives as stated by the hiring company. This responsibility also applies to subcontracted work that the general contractor may require. In general, most companies have an established process for bidding work and choosing contractors. The following section provides recommended processes for lining up contractors, commencing with the initial bid.

Safety in the Bidding Process

Often, a company addresses safety after the contractor is already on-site. However, it is much more effective to involve contractors as early as possible in the bidding and selection process. Ensuring that the contract company has information on what is required prior to starting will ensure that it has trained employees and the proper equipment when the bid is awarded. Doing so makes the overall project more productive and saves time on making adjustments later. The expected commitment to safety should be clear from the start. Most projects perform some sort of bid walk to review the project scope of work. This typically involves the area where work will be performed, and the site health and safety management group should be involved. This is the time to set expectations and review specific safety processes required. There should be no surprises. After a bid is received, a contractor must make a series of verifications. Some of the prequalifications are regulatory driven, and others are legally driven. Most mining companies have their own customized safety prequalification package, but others use subscription safety verification programs such as BROWZ, ISNetworld, and ComplyWorks, to name a few.

Safety Plan

Prior to beginning work at the site, the contractor should be required to prepare and submit for review a site/task/project-specific safety plan that reflects the contractor's intentions for full and complete compliance for the scope of contracted work. This plan should be reviewed by the project manager and health and safety manager or designated staff to ensure that it meets the minimum standard set by the company. To coincide with this, a project safety meeting should be used to engage all parties. This process will confirm that expectations are clear and health and safety requirements will be met by the contractor's plan. Any site-specific details not addressed

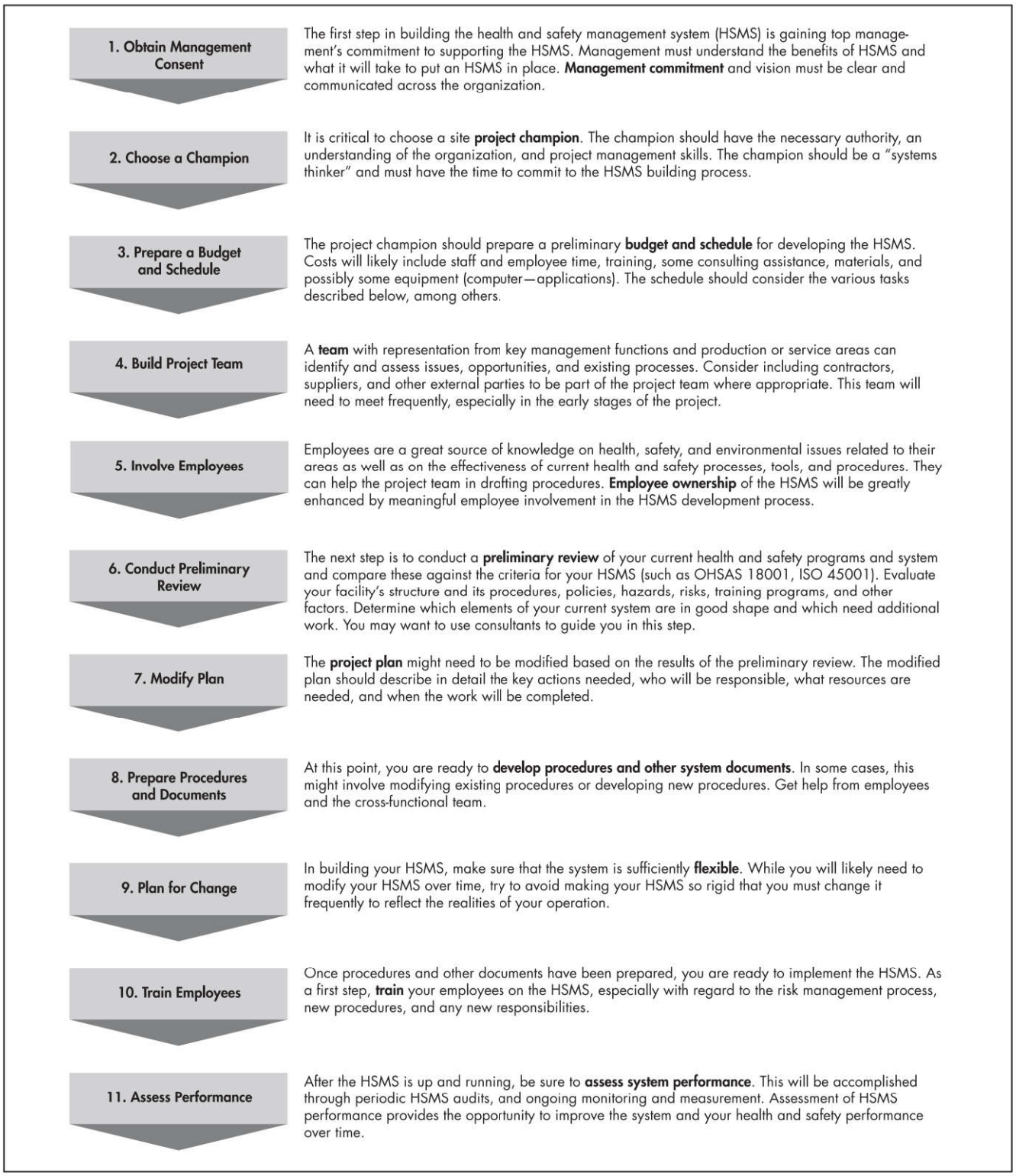


Figure 3 Step-by-step process for building a health and safety management system

by the plan can be implemented or modified at this time. Amendments or changes to the plan should be reviewed and approved by the company before being implemented. Ongoing meetings of a similar nature will be required of the project as the work progresses.

Health and Safety Professional Requirements

To ensure proper health, safety, and environment (HSE) oversight, setting a minimum requirement for a dedicated on-site safety professional is a necessary component of the plan. This professional is in addition to the competency expected of the person in charge of the work. Most companies require a minimum of one full-time, qualified safety professional whenever the contractor's workforce meets or exceeds 50 employees. Additional full-time, competent safety professionals are recommended for each additional 250 employees. As a guide, all contractor health and safety professionals, through education, training, and experience, should be capable of the following:

- Identifying existing or potential risks, including unsafe acts and behaviors
- Identifying and implementing controls to mitigate the risks of tasks
- Identifying working conditions that are unsafe, hazardous, or dangerous to the safety and health of employees and the environment
- Identifying nonconformance with health and safety requirements, including at-risk behavior
- Authorizing prompt action to maintain a healthy and safe work environment

Some companies might require the site safety professional to be degreed or certified in the field of HSE, but in all cases this individual is to be a person of authority. The scope of work will determine the level of expertise and number of professionals needed. When developing the contracts and setting expectations for safe work, a company typically requires that the contract company commits to additional formal processes as follows:

- Complying with national, regional, and local health and safety laws and regulations, the company contractor safety guidelines, and any requirement imposed by the local site where the work will be conducted.
- Providing all contract personnel with PPE for the work for which they are responsible, including safety glasses, hard hats, protective footwear, fall protection, hearing protection, respiratory protection, high-visibility apparel, and/or other safety equipment as may be required.
- Maintaining the highest standards of housekeeping. Workplaces must be kept organized with all debris, waste materials, and so on, cleared as work progresses. All wastes shall be properly disposed of according to the site-specific policies.
- Participating fully in the management of risk by implementing controls in the workplace. Defining and controlling risk is a key element of an HSMS.
- Verifying that all contract employees have received project safety orientation as well as other training that is required specific to the job function being performed (i.e., lockout/tagout/tryout, confined space entry, working at heights, excavation, chemical handling and use, etc.). The contractor must determine that workers understand and are knowledgeable.
- Providing a disciplinary action policy, including exclusion from the site if necessary, for individuals who violate health and safety procedures or drug and alcohol policies, or otherwise work in a careless or unsafe manner.
- Providing the first response for emergencies (first aid, emergency, fire, etc.) while activating site response for supplementary action, treatment, and support.
- Keeping all registers, records, and reports up to date and properly completed, stored in a safe place on-site, and maintained for review by legal or regulatory agencies.
- Immediately removing from the project site any contractor's manager, supervisor, owner, or other person in charge that requires, condones, asks, or allows employees to work in or around unsafe acts or conditions.
- Attending regular site safety meetings as set by the company.

Employee Training

Each contractor is required to provide regular and continuing health and safety training for all employees and to monitor subcontractor training programs. Training should include a site safety orientation as well as task-specific training as required by regulatory agencies or identified by the hiring company. All training should be documented and a process implemented allowing a quick verification of training received by any individual. Maintaining verification of training will ensure regulatory compliance as well.

Auditing Field Performance

It has been stated that what gets measured gets done. After expectations are set, one must verify that those expectations are being met. An audit schedule for the project should be established as part of the scope of a work and safety plan. Scheduling should be jointly organized by the project manager and contractor site manager and performed on a monthly or quarterly basis depending on the project. Area supervisors and safety professionals (contractor and company) should accompany the project and site managers in their respective areas. Audit results should be documented, and corrective actions identified and tracked to completion.

Equipment Inspection and Operation

Any equipment brought to the site that requires inspections (daily, monthly, annually, etc.) should be accompanied by that documentation and made available for review upon request. Equipment added or changed after the project has commenced should be identified by the contractor and be subject to the same requirements. Requirements for pre-shift inspection and safe operation should be made known to the contractor as part of the bidding process so that equipment can be made available that meets company requirements.

Safety Meetings with Contractors

Communication is a key element of success in any safety plan. Having multiple contractors on-site can make it difficult to communicate effectively. Holding a monthly meeting, at a minimum, with all contractors on-site is a good way to keep those communication lines open. Pertinent health and safety issues should be discussed frequently. Reviewing new procedures or policies, talking about any concerns or incidents that

have occurred, and reviewing existing procedures are several suggested agenda items for this meeting. As the sequence of work changes, workers need to be kept up to date. In so doing, appropriate safeguards can match the nature of the work.

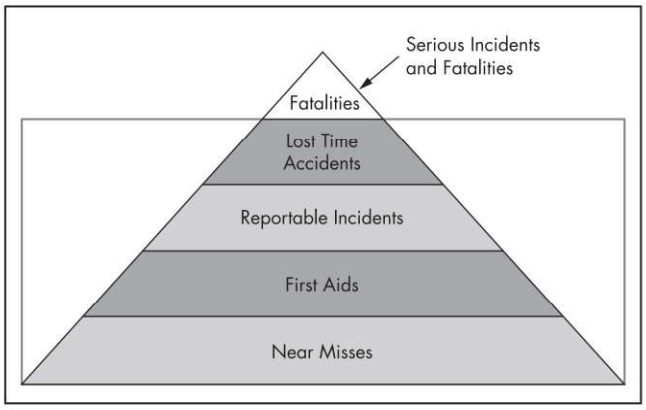
CONTINUOUS RISK ASSESSMENT AND FIELD-LEVEL EVALUATIONS

Many struggle with the concept of zero injuries being achievable. Are all injuries really preventable? Is it possible to eliminate minor incidents like cuts and bruises? Whether one agrees that zero is attainable, everyone can agree that serious injuries and fatalities can be prevented and should rise to the top when a company is prioritizing its efforts. It is hard to focus on everything and do it well. This is why many companies are shifting to a focus on prevention of serious injuries and fatalities. This does not mean other incidents are acceptable or ignored. It means that time and resources are going to be spent on the high-risk tasks that have the potential to permanently affect employees' lives and the lives of their family members.

Figure 4 is a version of the Heinrich pyramid. It depicts the theory presented by H.W. Heinrich in the 1930s that is still used today. According to the theory, for every serious incident there are many less serious incidents that present the opportunity to address issues and prevent a fatality or other life-altering event.

In looking at incident trends, the Heinrich theory applies only to the area outlined in the box. By focusing on near misses and their causes, one can track the less serious incidents and make changes to help reduce the severity rate as well as the number of total reportable incidents. Lessons learned from minor and near-miss events are invaluable; companies do not need to wait for something bad to happen to realize that improvements are necessary.

The narrow triangle in the center of the Heinrich pyramid accurately represents serious injuries and fatalities. The theory suggests that the higher potential of severity events usually results in severe consequences. There may not have been an opportunity for a fatality to be a near miss first; thus, in most cases, companies lack the ability to prevent the situation. For example, if a haul truck goes over a berm, typically a serious injury or fatality will result. If an electrician makes contact with 4,160 V in a processing plant, the resultant injuries will be awful. Therefore, modern safety systems look at fatal incident prevention differently. Companies are now expected to have both critical injury prevention programs as well as standard health and safety programs. The new paradigm was well stated in International Council on Mining and Metals conference presentations by both Goldcorp and Newmont mining companies (Krause 2012; Newmont Mining 2012). This recent shift in focus of major mining companies initially drew the concern that fatal injury prevention would allow the total incident rate to trend upward. Interestingly, the major mining companies have learned that total reportable incidents and serious injury rates have improved. Fatal injury prevention should always be a focus, but programs that incorporate both safe work procedures and critical safe work procedures see favorable downward trends. The application of work procedures alone is not enough. Oversight of implementation is required at the field level.



Adapted from the National Mining Association

Figure 4 Heinrich theory and the serious injury paradigm

HAZARD IDENTIFICATION AND FIELD-LEVEL RISK ASSESSMENT

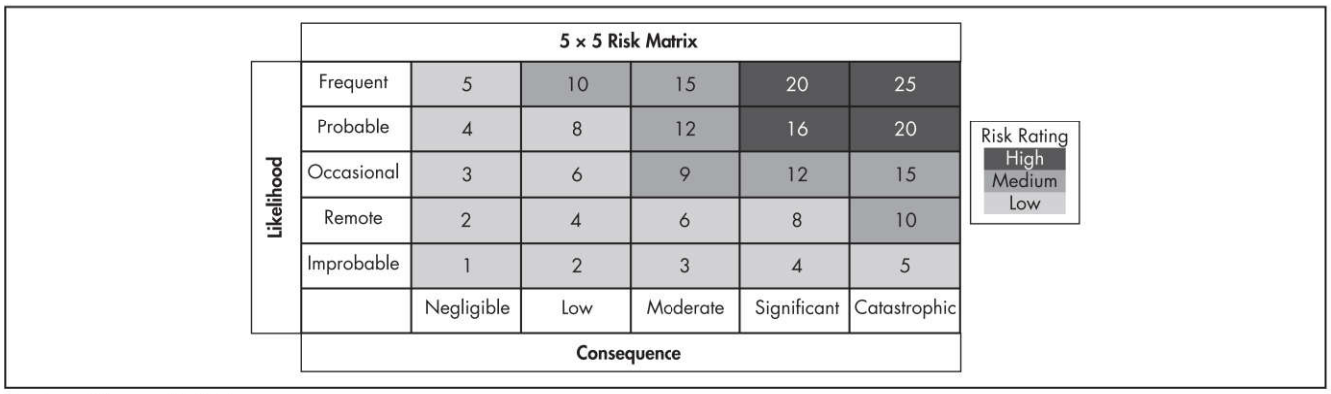
To prevent serious incidents and fatalities, one must first understand the high-risk tasks. Then processes must be put in place to eliminate or mitigate the risk. A sound risk management process should contain the following elements:

- **Hazard identification.** Identify hazards that exist, define their characteristics, and assign severity of probability that harm will occur.
- **Risk assessment.** Identify tangible and intangible risks and impacts of a certain task, function, or work environment.
- **Critical control identification and implementation.** Determine appropriate and feasible risk controls using the hierarchy of controls (elimination, substitution, engineering, administrative, PPE).
- **Communication of the risks and controls.** Engage employees and field supervisors in hazard identification and control implementation. Ensure that all employees understand the controls and the expectation that controls are used.
- **Verification and auditing of controls.** Develop a plan for field verification of controls to ensure effectiveness and audit to ensure that controls are being used appropriately. Use accountability as appropriate where not in use.

Leaders have a responsibility to evaluate tasks and determine the level of risk for these tasks by identifying the hazards and developing controls to eliminate or mitigate the risk. A risk matrix, such as the example in Figure 5, can be used to assist with the determination of risk level. Risk level is determined by multiplying the likelihood of occurrence by the consequence. Pure risk should be determined without consideration for controls. Mitigated risk is then determined with consideration of controls. Likelihood and consequence categories are further defined based on company criteria. High numbers in the matrix reflect the need to implement controls.

CRITICAL CONTROL IDENTIFICATION AND IMPLEMENTATION

A critical control is a safeguard that is crucial to preventing an event or mitigating the consequences of an event. The absence or failure of a critical control would significantly increase the risk despite the existence of other controls. In addition, a control that prevents more than one unwanted event or mitigates more than one consequence is normally classified as critical. A control is an act, object (engineered), or system (combination



Courtesy of Freeport-McMoRan
Figure 5 Risk matrix

of an act and an object) intended to prevent or mitigate an unwanted event.

When implementing a new control, consider the following questions:

- Is it an action, object, or system?
- Does it prevent or mitigate an unwanted event?
- Is performance specified, observable, measurable, and auditable?

If the answer to any of these questions is no, then it is not a control.

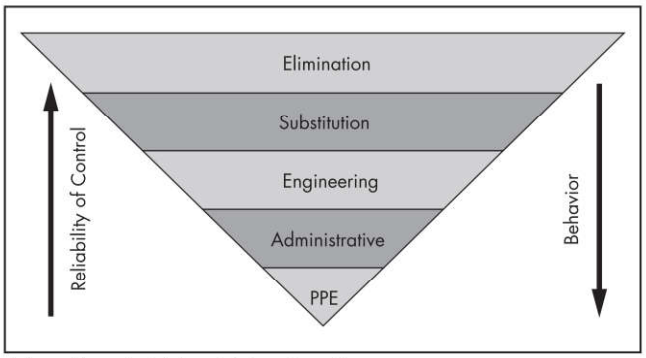
When determining critical controls, consider these questions:

- Is the control crucial to preventing the event or minimizing the consequences of the event?
- Is it the only control, or is it backed up by another control in the event the first fails?
- Would the control's absence or failure significantly increase the risk despite the existence of the other controls?
- Does the control address multiple consequences of the unwanted event? (In other words, if it appears in several places on the risk assessment, or on several risk assessments, this may indicate that it is critical.)

Although each of these risk-reduction strategies can be effective, the hierarchy of controls should be used (elimination, substitution, engineering, administrative, PPE) to find controls that rely less on human behavior and thus reduce the potential for failure. As shown in Figure 6, as one moves up the hierarchy, there is reduced reliance on behavior and therefore more reliability of the controls. Continuous improvement efforts should be focused on reducing the dependency on human behavior for the control of significant risks.

Communication of Risks and Controls

After these hazards, risks, and controls are identified, steps must be taken to ensure that the employees doing the work understand them. Each job should start with a "job briefing" in which the sequences of work and safety controls are discussed. Employees should confirm that they understand the hazards, risks, and controls. Each person is expected to check that controls are in place prior to starting work. This can be accomplished through audits, prejob planning, task monitoring, and reevaluating the task periodically. If controls are not in place, the expectation should be to stop the work and reassess before continuing.



Adapted from the National Safety Council
Figure 6 Hierarchy of controls

Verification and Field Auditing of Controls

Leaders must make oversight of high-risk tasks a daily priority. If several jobs are occurring, those with the highest risks should be visited the most frequently. In some cases, there may be a need to assign dedicated resources to monitor the task, be it supervision or safety personnel. Critical risk audits should be conducted on a regular basis based on the risk level and the level of reliability of controls. Tasks with lower risks can be audited less frequently. Task with higher reliability controls, such as engineered controls, can be audited less frequently as well. Tasks that rely more heavily on PPE controls and employee actions (administrative and PPE) should have frequent oversight. For tasks where a critical control is missing or inadequate, work should not continue until it is corrected. Action plans should be established and followed up by management following the company's tracking process.

SYSTEM EVALUATIONS AND AUDITING

An HSE audit is very personal. Individuals' responsibilities, actions, and accountabilities are fundamental to safety success; thus, all associated processes need to be scored. In so doing, each person's commitments, or lack thereof, can be determined. Both internal and/or external audits can be used,

and in some cases, cross-departmental oversight can be implemented. The latter process allows work groups to compare their efforts to those of their colleagues. Using the premise that "the best way to learn is to teach" suggests that workers are most likely to improve themselves if they are asked to evaluate others doing similar tasks. It is difficult for a person to insist someone else improve in one area if he or she would not be willing to do the same. Regardless of the psychology of an audit, the expectation is relatively simple. Each element of a health and safety system needs to have a corresponding checklist. There is no limit how deep this should go. Questions to consider include: Are all levels of competency intact? Do the necessary resources match up? Are regulatory requirements at the forefront? Does a culture that promotes "zero harm" exist? A comprehensive audit will capture the answers. Because the work environment is in constant change, the same audit must encourage both sustainability and continuous improvement. Organizations know the risks, the value of their workers, and the economic well-being or products and operations they bring to the world. The purpose is clear, and self-evaluation is a must.

REFERENCES

ISO 45001. 2018. *Occupational Health and Safety Management Systems*. Geneva: International Organization for Standardization.

Krause, T. 2012. Eliminating fatalities. In *Proceedings of the International Council on Mining and Metals*. London: International Council on Mining and Metals. p. 10.

MSHA (Mine Safety and Health Administration). 1986. *Report on 30 CFR Part 50*. PC-704. Arlington, VA: U.S Department of Labor, MSHA.

Newmont Mining. 2012. Vital behaviors. In *Proceedings of the International Council on Mining and Metals*. London: ICMM. pp. 2, 5.

OHSAS 18001. 2002. *Occupational Health and Safety Management.* London: British Standards Institution.

OSHA (Occupational Safety and Health Administration). 2001. 29 CFR 1904.7. *Recording and Reporting Occupational Injuries and Illnesses, General Recording Criteria.* Washington, DC: OSHA.