# RISK

# Assessing & Mitigating to Deliver Sustainable Safety Performance

By Gary H. Eaton and Donald E. Little

Through an effective safety and loss control program, an organization not only meets its moral and legal obligations to provide a safe and healthy workplace, it also delivers shareholder value and achieves financial objectives by preventing losses.

To deliver world-class performance, a company must develop and implement safety management processes that systematically identify and mitigate risks. Organizations that integrate risk management (assessment and mitigation) into their safety management processes are progressive in their approach to safety management, and are more likely to deliver sustainable safety performance.

This article outlines the basic concepts of risk, and provides a practical approach to proactively identify, assess and mitigate risks. Additionally, it explains how risk assessment methodology can be integrated with continuous improvement methodologies such as six sigma and lean to drive continuous improvement in safety performance by reducing inherent risks in work systems or business processes.

## The Concept of Risk

Lowrance (1976) defines *risk* as the probability and severity of harm. Therefore, risk is a measure or determination (derived through either quantitative or qualitative means) of the combination of the probability of occurrence and severity of harm. While risk is typically associated with harm or damage, utilizing risk assessment methodology enables one to view risk in a positive context and, therefore, allows an organization to proactively identify and control future potential losses. Understanding risk assessment methodology requires a basic knowledge of the concepts of risk and risk terminology (Table 1, p. 36).

### *Inherent Risk*

A certain amount of risk is inherent at any point in any work system's (e.g., operation, process) life cycle. This is true whether the work system is defined broadly (e.g., construction site, operating facility, call center, executive office) or more narrowly (e.g., assembly process, a piece of machinery, individual work task).

Risk is ever-present in every action. Some degree of risk is always present in any system. While risk can be substantially reduced, zero risk can never be achieved.

### *Hazard Versus Risk*

Many people confuse the concepts of *hazard* and *risk*, particularly within the context of safety and health. A hazard is a potential source of harm. For example, the hazard associated with a chemical is its intrinsic ability to cause an adverse effect.

On the other hand, risk is the chance that the adverse effects of an identified hazard will occur. For example, a chemical may have hazardous properties. However, if it is handled safely under controlled conditions, then the

**IN BRIEF**

- **Understanding the basic concepts of risk is key to proactively identifying, assessing and mitigating it.**
- **Risk assessment methodology can be integrated with continuous improvement methodologies such as six sigma and lean to drive continuous improvement in safety performance by reducing inherent risks in work systems or business processes.**

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Understanding risk assessment methodology requires a basic knowledge of the concepts of risk and risk terminology.

**Table 1**
## Key Risk Terminology

| Key risk terminology | Definition |
|---|---|
| Risk | The probability and severity of harm. |
| Harm | Physical injury or damage. |
| Hazard | A potential source of harm. |
| Residual risk | The risk which remains after protective measures have been taken. |
| Risk assessment | The process by which hazards are identified, and the level of risk is determined through quantitative or qualitative analysis. |
| Acceptable risk | That risk for which the probability and severity of harm are determined to be as low as reasonably practicable (ALARP). |
| ALARP (as low as reasonably practicable) | The point at which the cost involved to reduce risk further would be substantially disproportionate to the benefit gained. |

risk to human health or the environment may be extremely low.

Hazard identification is a vital component for any safety program. But, identifying hazards associated with them requires a risk assessment process.

### *Residual Risk*

Residual risk, also known as net risk, is the level of risk that remains in the system after controls are implemented. For example, if a company installs point-of-operation guarding, the machine operator should face a lower level of residual risk upon future assessment. However, although the guards may reduce the risk of the operator being injured due to contact with the point of operation, it remains possibile that such an incident may occur under certain circumstances. This remaining risk is called residual risk.

Such risk must be assessed and measured. In fact, insightful risk assessment is so crucial to risk management and continuous safety improvement efforts that many countries require it by standard:

- Australia: AS/NZS 4360;
- Canada: CAN/CSA ISO 31000 (recently adopted ISO 31000);
- European Union Member States: Directive 89/391/EEC;
- South Africa: South African Qualifications Authority (SAQA-244383);
- U.K.: Health and Safety at Work Act of 1974.

At this time, risk assessment is not required in the U.S.; however, it is recommended as a best practice.

### Assessing Risk

"The entirety of purpose of those responsible for safety, regardless of their titles, is to identify, evaluate, and eliminate or control hazards so that the risks deriving from those hazards are acceptable" (Manuele, 2009). Thus, an SH&E professional should help others better understand the risks they face and make informed judgments on acceptability of risks. Ultimately, this improves understanding of risk and helps define what is acceptable so that people live increasingly safer, more secure, lives.

### *Risk Assessment Methodology*

Risk assessment is the process by which hazards are identified and by which the level of risk is determined through quantitative or qualitative analysis. A sound risk assessment methodology typically includes these steps:

1) Identify hazards and risks associated with the work system or process.

2) Measure and evaluate frequency of exposure and severity of consequence should a loss occur, as well as probability of occurrence.

3) Analyze risks associated with the work system and determine appropriate ways to control hazards and reduce risks to an acceptable level.

4) Develop and implement additional mitigating controls, if necessary, to reduce risks to an acceptable level.

5) Monitor the effectiveness of controls and periodically observe to identify potential new risk exposures.

The goal of the risk assessment process, and subsequent controls, is to achieve an acceptable level of risk. The risk assessment and mitigation processes are not complete until acceptable risk levels are achieved (Manuele, 2008).

### *Acceptable Risk*

Individuals, companies and industries perceive risks differently. Several factors influence these diverse perceptions, including:

- management commitment to safety;
- company safety culture;
- varying criteria for determining what risks are acceptable;
- personal experiences dealing with/working around the risk;
- social cultural background and beliefs;
- ability (or lack of) to exercise control over a particular risk;
- inaccurate risk assessment (which may lead people to overestimate very low risk or underestimate very high risk).

So, how does one really know when something is safe? Lowrance (1976) defines safety as a judgment of the acceptability of risk, and defines risk as the probability and severity of harm. Therefore, "a thing is safe if its risks are judged to be acceptable."

Close examination of this definition reveals three process steps that must be conducted before a risk can be determined acceptable.

1) Risks associated with a particular hazard or work process must be identified.

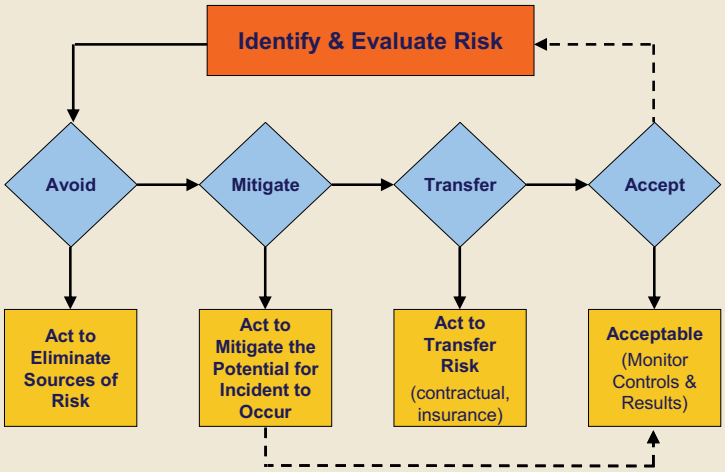
2) These risks must be assessed, typically through a qualitative or quantitative assessment process.

3) Those involved must determine whether the risk is acceptable or unacceptable. The qualitative or quantitative criteria used aid in this determination.

Acceptability is a moving target. As knowledge about a particular risk increases, so does the ability to make a more informed judgment of its acceptability. What is determined to be an acceptable risk today may become an unacceptable risk in the future. When the risk assessment process is used as a continuous improvement process, residual risk can be reduced over time and deliver improvements in safety performance that can be sustained over time.

**Figure 1**

## Risk Management Decision Making Process Map




Four steps enable organizations to determine which risks are acceptable or ALARP. They are listed in Figure 1 in decreasing order of effectiveness.

### *As Low As Reasonably Practicable Risk*

"Acceptable risk is that risk for which the probability of a hazard-related incident or exposure occurring and the severity of harm or damage that may result are as low as reasonably practicable, and tolerable in the situation being considered" (Manuele, 2009).

For a risk to be as low as reasonably practicable (ALARP), it must be possible to demonstrate that the cost involved in reducing it further would be substantially disproportionate to the benefit gained.

The ALARP principle arises from the fact that a company could spend infinite time, effort and money to continuously reduce a risk. However, ALARP should be understood as more than just a quantitative measure of benefit against detriment. ALARP is a best practice of judgment regarding the balance of risk and the societal benefit.

### Risk Management Process

Once a risk exposure has been identified and evaluated, a systematic and practical risk management decision-making process should be used to determine acceptability. Four steps enable organizations to determine which risks are acceptable or ALARP (Figure 1). These steps are listed in decreasing order of effectiveness.

1) Avoid the risk. Eliminate the exposure when possible, which is often difficult or not possible because of technology and cost constraints, or inherent risks.

2) Mitigate the risk. Evaluate whether all reasonable and cost-effective controls have been implemented. Initiate additional controls if not.

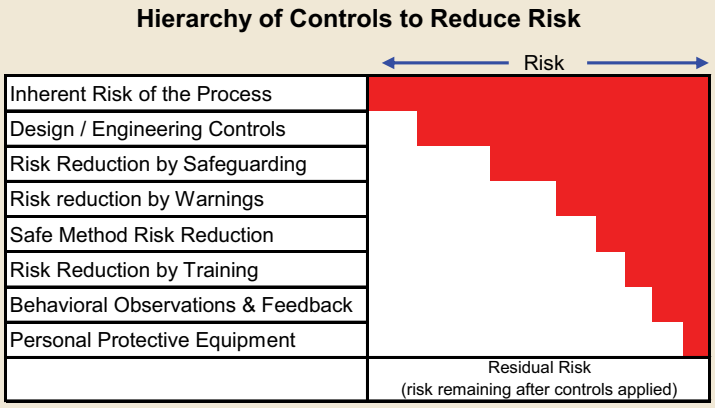
3) Transfer the risk. Contractually transfer the work process or activity to an expert, or purchase an insurance policy.

4) Accept the risk. In this situation, the risk is deemed acceptable—the probability of a hazard-related incident and the severity that may result are ALARP. The cost to further reduce the risk is significantly disproportionate to the benefit gained.

When using this process, if risks are determined to be unacceptable, actions to avoid, mitigate or

**Figure 2**

## Impact of Controls to Reduce Risk in Work Systems




***Note.*** *Adapted from ANSI B11.TR3.*

Applying the hierarchy of controls ensures that the most effective controls are implemented to reduce risk. However, since some inherent risk will remain in any work system, those involved must also assess organizational forces, employee/supervisor knowledge and training, and employee/supervisor behaviors and errors.

## Safety Vision Statement

We are committed to achieving zero harm. This means zero injuries and zero environmental damage. Our zero harm values and behaviors:

- We commit and contribute.
- We value everyone equally.
- We respect ourselves.
- We think first of zero harm.
- We continuously improve.
- We share.
- We respect the environment.

## Safety Policy Statement

We are committed to providing and maintaining a safe and healthy work environment, and to preventing injuries or illness to our employees, customers, suppliers, contractors and community—safety everywhere, every day. To achieve this, we will:

- Continuously improve safety systems.
- Monitor and measure performance.
- Sustain regulatory compliant processes.
- Provide training programs.
- Consultative and proactive approach to risk management.
- Minimize waste, conserve resources and protect the environment.
- Apply best practices.
- Recognize excellence in performance.

**Leadership demonstrates its commitment by removing the real and perceived barriers that impede performance. One way to engage leadership is to establish a vision for the organization's future state of safety.**

**Development of the DMAIC risk management model (Figure 3) enabled safety processes to be measured more proactively by measuring risk exposures instead of incident frequency and severity.**

transfer the risk are required to reduce the risk to an acceptable level.

### *Risk Mitigation*

To mitigate risk, consider a combination of controls. The hierarchy of controls prescribes an order of effectiveness (from most to least effective), and that this order must be taken into account when selecting and implementing controls to reduce risk.

### Hierarchy of Controls

Initial assessments define the risk present in work systems at the time of measurement. When unacceptable risk levels are identified, a risk reduction process should be applied. The risk reduction process outlined in ANSI/AIHA Z10-2005 recommends a hierarchical pattern of controls based on their relative effectiveness:

- Elimination. Eliminate the hazard or reduce the workplace risk by design, which provides the highest degree of risk reduction.
- Substitution. Substitute a less-hazardous process, chemical, etc., to reduce risk.
- Engineering controls. Such controls can affect the degree of risk reduction and residual risk in the system.
- Warnings. Institute warnings (e.g., signs, labels, audible alarms) to alert employees to hazards and their proximity.
- Administrative controls. Although less effective than elimination, substitution and engineering controls, these controls include worker and supervisor training, safe work methods, safety rules, disciplinary programs and close supervision.
- PPE. Protective gear includes safety glasses, hearing protection, safety harnesses/lanyards, gloves and respirators. Because PPE mitigates severity should a harmful event occur, it is considered the least effective control. Therefore, PPE should be the last avenue of protection after other methods have been considered.

Applying this hierarchy ensures that the most effective controls are implemented to reduce risk. However, those involved must remember that some inherent risk will remain in any work system, so they must still assess organizational forces, employee/supervisor knowledge and training, and employee/supervisor behaviors and errors (Liberty Mutual Group, 2009). Figure 2 (p. 37) illustrates the hierarchy of controls and the effect of combining controls to reduce residual risk.

### Aligning Risk Assessment With Business Processes

An organization's approach to safety must be considered when aligning risk reduction methodology with business processes. Some traditional safety approaches focus on reducing incident fre-

**Figure 3**

## DMAIC Risk Management Model

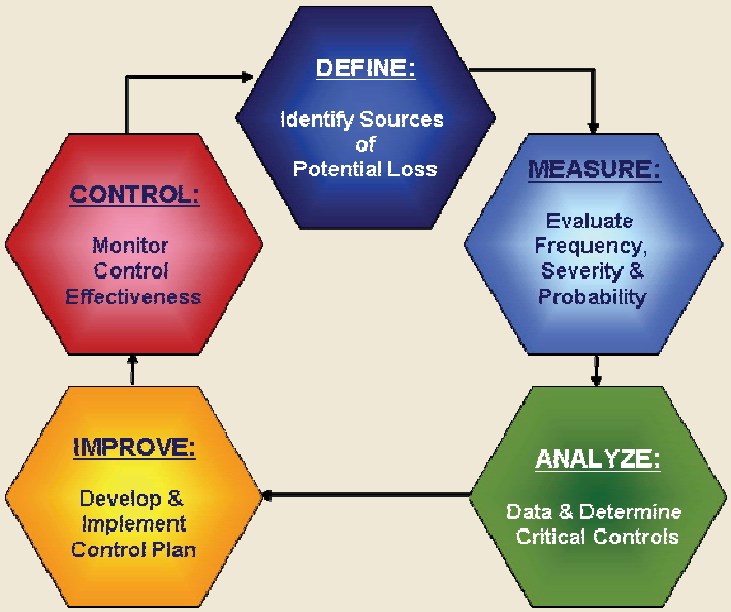
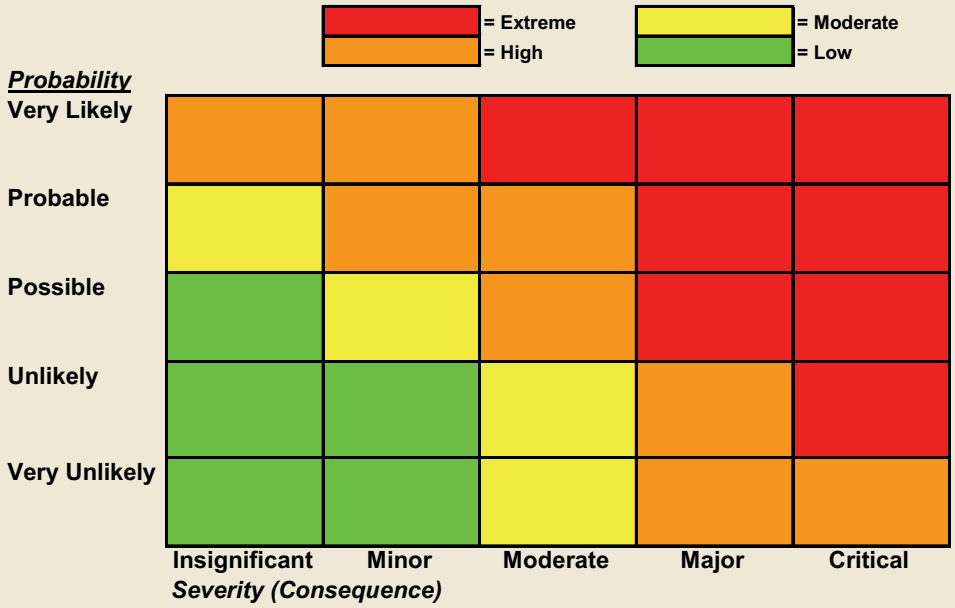


**Figure 4**

## Qualitative Risk Assessment Matrix




In this case, the company used international standards to develop a process that uses a five-by-five matrix to evaluate the consequence and probability of each identified risk exposure.

quency and/or severity (e.g., loss costs, lost time). This reactive approach focuses primarily on risks that have produced known incidents.

Effective integration of risk reduction methodologies requires a more proactive approach, one that seeks to identify and assess significant risk exposures that may result in an incident. To achieve this, an organization must focus on measuring and mitigating inherent risks that occur in work systems and processes. By identifying potential system breakdowns that can create risk, organizations can measure and control process inputs which can lead to an unintended output (e.g., a harm-causing incident).

High-performing organizations continually and energetically challenge assumptions about how things are done, whether evaluating manufacturing, logistics or work systems or risk reduction (Liberty Mutual Group, 2010). Integrating risk reduction and mitigation techniques into work systems requires leadership commitment, the ability to communicate risks using business language, and a standard methodology for measuring and evaluating risks.

### Implementing Risk Reduction Methodologies

#### *Step 1: Engage Organizational Leadership*

Risk improvement initiatives that deliver sustainable business results have one common fundamental element: leadership commitment. Companies that have successfully integrated total quality management (TQM) systems, lean manufacturing programs, six sigma quality process control systems and other business improvement processes began by engaging leadership early in the process.

Leadership demonstrates its commitment by removing the real (time and resources) and perceived (attitudes) barriers that impede performance. One way to engage leadership is to establish a vision for the organization's future state of safety. This statement establishes safety values and creates a framework for building a "this is the way we operate" culture. The sidebar on p. 38 depicts one company's safety vision statement. In this case, once CHEP leadership bought into the vision of the future state of safety, that statement was communicated broadly across the organization. The framework for developing an effective safety management system also was outlined. The safety policy statement (sidebar, p. 38) establishes the minimum performance standard to comply with regulatory requirements, continuously improve processes, and proactively identify and measure risks. Additionally, it requires engagement of employees at all levels and sets the expectation for transfer of best practices.

The vision statement sets the expectation that risks will be identified and evaluated in the decision-making process—leadership has endorsed the value statement, "We think first of zero harm." This value statement enables a risk assessment process that identifies and measures opportunities to reduce inherent risk to be integrated into work systems.

#### *Step 2: Using Business Language to Implement Risk Reduction Processes*

A company's success in integrating any new process or methodology depends on how well it understands and adopts that process or methodology. Aligning with existing processes and using business language facilitates this integration. This concept also applies when integrating risk assessment methodology into the safety management system.

CHEP recognized that its traditional safety management processes had reached maturity as safety performance began to plateau. To drive continuous improvement, the risk management department sought to integrate safety management processes with CHEP's continuous improvement processes, lean and six sigma.

The firm's risk manager was trained in six sigma and lean, and realized the risk assessment process aligns well with the six sigma DMAIC (define, measure, analyze, improve, control) problem-solving methodology. To demonstrate the value proposi-

## Figure 5
# Example Baseline Risk Assessment

**Baseline Risk Assessment**

| Concerns (Injury + Event + Causation, e.g. Head injury from falling from ladder when foot slipped) | Existing Controls | No. of Employees Exposed | Frequency (Rate Frequency of Activity) | Likelihood (Rate Likelihood of Concern) | Severity (Rate Severity of Concern) | Risk |
|---|---|---|---|---|---|---|
| Concern for indvertant startup of equipment during maintenance | Operators and maintenance personnel trained and certified in Equipment operation. Radio communication between maintenance operators. Isolation switches and E-Stop cord operable and available. LOTO procedures in place. | 2 | 2 | 4 | 5 | 40 |
| Accidental contact with equipment by passers by | Operators and maintenance personnel trained and certified in Equipment operation. Isolation switches and E-Stop cord operable and available. Machine guarding at point of operation. LOTO procedures in place. | 2 | 3 | 4 | 5 | 60 |
| | | | | | Risk Index | 100 |

**The team used a five-point scale (Figure 5) to rate frequency, likelihood and severity in order to calculate a baseline risk score or index of inherent risk. Once traditional controls are identified, the risk assessment is reviewed with leadership, and an action plan is developed (Figure 6).**

tion for implementing risk assessment methodology, the risk manager developed a graphic (Figure 3, p. 38 ) to show the alignment of risk assessment with the DMAIC methodology. This graphic was integrated into safety training presentations to educate the organization in the principles of risk assessment and risk management methodologies.

Acceptance and use of risk assessment methodology increased as a result of its integration with existing process improvement methodologies. Development of the DMAIC risk management model enabled safety processes to be measured more proactively by measuring risk exposures instead of incident frequency and severity. CHEP uses a risk assessment process that provides a qualitative measurement of the frequency and severity of risk exposures and the probability of occurrence.

### *Step 3: Indentifying & Assessing Risk*

Risk assessment processes enable an organization to measure risks qualitatively and quantitatively. Risk assessment processes are considered effective if:

- Quantitative and qualitative criteria are established to measure risk.
- Effectiveness of existing mitigating controls is evaluated.
- Those most familiar with the work systems and work processes perform the assessment.
- Risk assessments are documented using a common or standard format that enables future assessments to be benchmarked against a baseline assessment.
- New controls identified by the risk assessment team are implemented.

Numerous risk assessment processes and database technology solutions are available to conduct risk assessments.

CHEP used various processes at different levels to measure and manage business risks as well as SH&E risks. The company used a risk management process aligned with the Australian/New Zealand standard for risk management (AS/NZS 4360) to measure and evaluate risks and to establish acceptable risk guidelines for the organization. AS/NZS 4360 (equivalent to ISO 31000) outlines a process that uses a five-by-five matrix to evaluate the consequence and probability of each identified risk exposure (Figure 4, p. 39).

To effectively measure safety and health risks, frontline employees were involved and engaged in the risk assessment process. CHEP used the Liberty Mutual Residual Risk Reduction (R3) methodology, which employs cross-functional teams that work within the systems being assessed to identify, evaluate and reduce risk in work systems (Tolbert, 2005).

This methodology uses consistent criteria to measure and quantify risks; enables baseline assessment; and helps a team measure risk exposures quantitatively and qualitatively, evaluate existing controls, and develop a list of proactive improvement actions. It also allows the team to measure the future state of a work process once additional controls have been implemented. This helps a company allocate limited resources.

Frontline employees were trained to conduct and document risk assessments. These employees were part of a team that includes representatives from engineering, maintenance and SH&E. When conducting risk assessments, the team observed the work system that needed improvement; documented the process steps; and conducted a baseline assessment to identify and measure potential risk exposures within the work system.

The team had to identify risk concerns for each work system; determine the number of employees exposed to each risk; and identify and evaluate the effectiveness of controls. As Figure 5 shows, the team used a five-point scale to rate frequency,

## Figure 6
# Example Subsequent Risk Asessment After Risk Mitigation

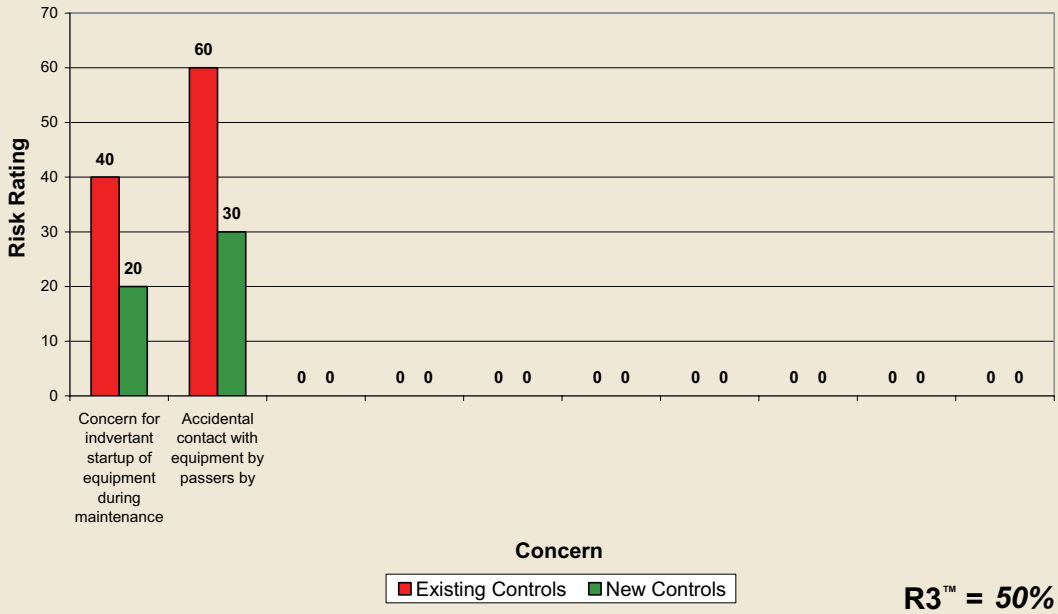
**Subsequent Risk Assessment**

| Concerns (Injury + Event + Causation, e.g. Head injury from falling from ladder when foot slipped) | Existing Controls | No. of Employees Exposed | Frequency (Rate Frequency of Activity) | Likelihood (Rate Likelihood of Concern) | Severity (Rate Severity of Concern) | Risk |
|---|---|---|---|---|---|---|
| Concern for indvertant startup of equipment during maintenance | Install operator security protocol on touch screen monitors - defined by zones. Conduct touch screen monitor training at point of operation. Create Safe Work Procedures for Operators and Maintenance. | 2 | 2 | 2 | 5 | 20 |
| Accidental contact with equipment by passers by | Install operator security protocol on touch screen monitors - defined by zones. Label areas which are restricted to authorized personnel. Impelement an intelock inspection system to ensure interlocks on perimeter guarding are functioning properly. | 2 | 3 | 2 | 5 | 30 |
| | | | | | Risk Index | 50 |

Residual Risk Reduction (R3) = 50%

**Figure 7**

## Example R3 Residual Risk Reduction Results




**R3™ = *50%***

This sample assessment indicates that a 50% reduction in residual risk could be achieved if all recommended improvements are effectively implemented. This is a significant improvement compared to the baseline risk, and shows that residual risk has been reduced to ALARP.

likelihood and severity in order to calculate a baseline risk score or index of inherent risk.

### *Step 4: Mitigating Risk*

Next, the team determined risk acceptability to identify issues that required further mitigation. When risk scores indicated that the baseline risk was not acceptable, the team developed recommendations for additional controls, then conducted a subsequent assessment to measure the effectiveness of the controls. Once traditional controls are identified, the risk assessment is reviewed with leadership, and an action plan is developed (Figure 6).

Figure 7 illustrates a sample assessment conducted; it indicates that a 50% reduction in residual risk could be achieved if all recommended improvements are effectively implemented. This is a significant improvement compared to the baseline risk, and shows that residual risk has been reduced to ALARP.

CHEP has embraced risk assessment methodology and continues to find meaningful ways to use it to evaluate and assess its work systems. CHEP now requires that risk assessments be conducted before capital expenditure projects are approved. As a result, the company has reduced the risk of injuries in its work systems and actively demonstrates its commitment to zero harm. This helps build a culture where zero harm is the way things are done.

### Conclusion

To deliver sustainable safety performance, a company must proactively identify and evaluate risk exposures and hazards before a harm-causing incident occurs. When applied as an ongoing process, risk assessment can help an organization redefine the nature, extent and level of risk that is acceptable for its business model, and deliver world-class levels of performance across the organization. **PS**

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