Session No. 538

Risk: Assessing and Mitigating to Deliver Sustainable Safety Performance

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Introduction

There is no question that an effective safety and loss control program not only enables an organization to meet its moral and legal obligations to provide a safe and healthy workplace, but also enables an organization to deliver shareholder value and achieve financial objectives by preventing losses from occurring. In order for safety and loss control programs to become highly effective and deliver world-class performance, it is necessary to develop and implement safety management processes which seek to systematically identify and mitigate risks. Organizations which have been effective in integrating risk management (assessment and mitigation) methodology into their safety management processes are progressive in their approach to safety management, and are more likely to deliver sustainable safety performance.

This paper will outline the basic concepts of risk, and provide a practical approach to proactively identify, assess, and mitigate risks. Additionally, this paper will outline 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) defined 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 of harm and the severity of harm. While risk is typically associated with harm or damage, utilizing risk assessment methodology enables risk to be viewed in a positive context and therefore allows organizations to proactively identify and control future potential losses. To understand risk assessment methodology requires a basic

knowledge of the concepts of risk and risk terminology. Table 1 below provides some basic risk terminology and their definitions.

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 practical (ALARP).
ALARP (As Low As Reasonably Practical)	The point at which the cost involved to reduce risk further would be substantially disproportionate to the benefit gained.

Table 1. Key Risk Terminology

Inherent Risk

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

The fact remains that risk is an ever-present variable in everything we do. Some degree of risk will always be present in any system, as risk can never be totally eliminated. While it is possible to substantially reduce risk, a zero risk quantity can never be achieved.

Hazard versus Risk

Many people confuse the concepts of hazard and risk, particularly within the context of health and safety. 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.

Risk, on the other hand, is the chance that the adverse effects of an identified hazard will occur. For example, while the chemical mentioned above may have hazardous properties, if the chemical is handled safely under controlled conditions, then the risk to human health or the environment might be extremely low.

While hazard identification is certainly an important component for any safety program, it is important to understand that merely identifying hazards is not the same as determining the risk associated with those hazards. In order to determine the risks associated with identified hazards, a risk assessment process that measures the risk is required.

Residual Risk

Residual risk, also known as net risk, is the level of risk that remains in the system at the time of assessment after mitigating controls have been implemented to reduce risk. For example, if a company takes steps to reduce risks associated with a particular machine by installing point-of-operation guarding, the machine operator should face a lower level of residual risk upon future measurement. However, even though this guarding may reduce the risk of the operator being injured due to contact with the machinery point of operation, there remains a possibility that these types of incidents may still occur under certain circumstances. The term for this remaining risk is residual risk.

To effectively manage and reduce residual risk requires the identified risk to be assessed and measured. In fact, insightful risk assessment is so crucial to risk management and continuous safety improvement efforts that it is required in many countries around the world. While not intended to be an all inclusive list, some examples of countries which require risk assessment include:

- Australia – AS/NZ 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)
- United Kingdom – Health and Safety at Work Act of 1974

At this time, in the United States, risk assessment is not required; however risk assessment 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 a primary responsibility for any safety program and safety practitioner is to help others better understand the risks they face, and make informed judgments on acceptability of risks. Ultimately, this helps to improve 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 the level of risk is determined through quantitative or qualitative analysis. A sound risk assessment methodology will typically include these process steps:

1. Identify the hazards and risks associated with the work system or process.
2. Measure and evaluate the frequency of exposure, severity of the consequence should a loss occur, and the probability of occurrence.
3. Analyze the risks associated with the work system and determine appropriate ways to control the hazards and reduce the 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 the mitigating controls and periodically observe to identify potential new risk exposures.

The goal of the risk assessment process, and the subsequent mitigating 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

Clearly there are differences in how risks are perceived by individuals, various companies, and even different industries. Several factors can influence the diverse interpretation or perception of risk and may include:

- Management commitment to safety.
- The safety culture of a company.
- Varying criteria for determining what risks are acceptable.
- Personal experiences dealing with/working around the risk.
- Social/cultural background and beliefs.
- The ability (or lack of) to exercise control over a particular risk.
- Inaccurate assessment of risks (which may lead people to overestimate very low risk or under- estimate very high risk).

With all the factors that can and do influence risk perceptions, how do we really know when something is safe? Fortunately, Lowrance (1976) has provided us with an answer. Lowrance defined safety as a judgment of the acceptability of risk, and defined risk as the probability and severity of harm. Therefore, *"a thing is safe if its risks are judged to be acceptable"*.

A closer examination of Lowrance's definition reveals three process steps that must be conducted before a risk can be determined to be acceptable. First, there must be a determination or identification of the risks associated with a particular hazard or work process. Second, there must be a judgment or assessment of these risks. This is typically performed through a qualitative or quantitative risk assessment process. Third, there must be a determination of whether the risk is acceptable or unacceptable. The qualitative or quantitative criteria utilized to assess and measure the risk aids with the determination of what is an acceptable risk.

When determining what is an acceptable risk, it is necessary to recognize that acceptability is a moving target. As knowledge about a particular risk increases, so does the capability to make a more informed judgment or determination of the acceptability of that risk. Therefore what is determined to be an acceptable risk today may become an unacceptable risk in the future. When the risk assessment process is utilized as a continuous improvement process, residual risks can be reduced over time and deliver improvements in safety performance which can be sustained over time.

ALARP (As Low As Reasonably Practical)

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 practical (ALARP) it must be possible to demonstrate that the cost involved in reducing the risk further would be substantially disproportionate to the benefit gained. The ALARP principle arises from the fact that infinite time, effort, and money could be spent attempting 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 utilized to determine acceptability. There are four steps in the risk management decision making process which enable organizations to determine which risks are acceptable or as low as reasonably practical (ALARP). The risk management process steps are represented graphically in Exhibit 1 below. The risk management process steps are listed in decreasing order of effectiveness to reduce and mitigate risks to levels as low as reasonably practical. The four steps of the risk management process are defined as follows:

- Avoid the risk – Seek to eliminate the risk exposure whenever possible. This is not always easy to do, and in many cases cannot be accomplished due to technology constraints, cost constraints, or inherent risks in the work system.
- Mitigate the risk – Evaluate whether all reasonable and cost effective measures have been implemented to prevent a loss from occurring. Take action to implement additional controls to reduce the risk if all reasonable and cost effective controls have not been put into practice.
- Transfer the risk – This is done by contractually transferring the work process or activity to an expert, or by transferring the financial impact of a loss through the purchase of an insurance policy.
- Accept the risk – The risk has been determined to be acceptable as the probability of a hazard-related incident occurring and the severity of harm or damage that may result are as low as reasonably practical (ALARP). In the situation being considered, the cost involved to reduce the risk further would be significantly disproportionate to the benefit gained.

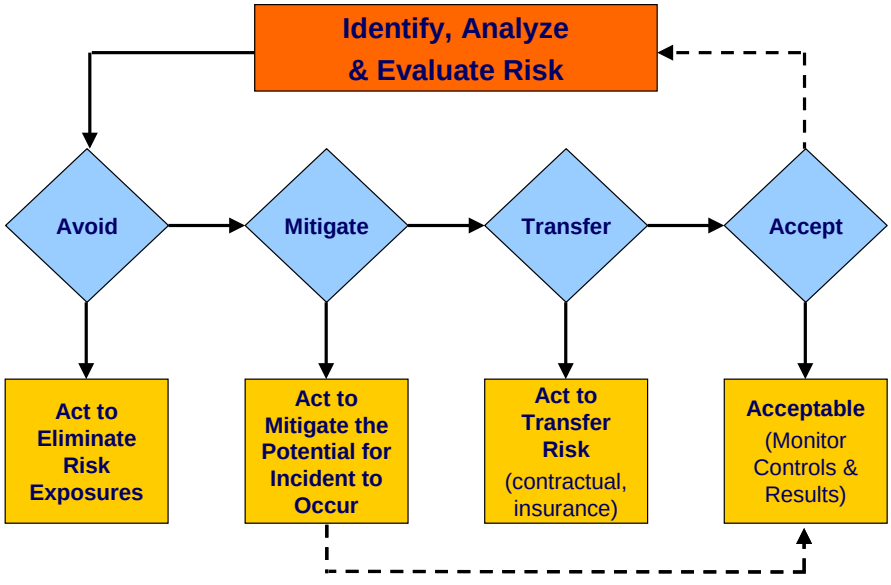


Exhibit 1. Risk Management Decision-Making Process Map

When utilizing the risk management decision-making process to evaluate risk, and the risk is determined to be unacceptable, actions to avoid, mitigate or transfer the risk are required to reduce the risk to an acceptable level.

Risk Mitigation

To effectively treat or mitigate risk, combinations of effective controls should be considered for implementation by applying the hierarchy of controls concept. The concept of the hierarchy of controls prescribes a hierarchical order of effectiveness (from most to least effective) for risk reduction controls, and states that this order must be taken into account when selecting and implementing controls to reduce risk.

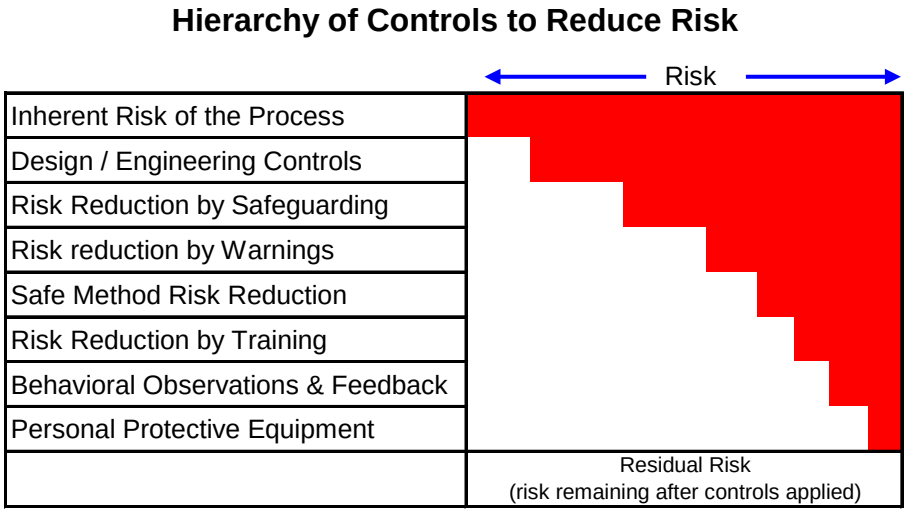
Hierarchy of Controls

Initial risk assessments provide a baseline of the risk present in work systems at the time of measurement. When unacceptable risk levels are identified (through risk assessment) that require mitigation, a risk reduction process should be applied to reduce the risk.

The risk reduction process outlined by ANSI/AHIA Z10-2005 Occupational Health and Safety Management Systems recommends a hierarchical pattern of controls (interventions) based on the relative effectiveness of the controls, as follows:

- Elimination. Elimination of the hazard or reduction of the risk by design provides the highest degree of risk reduction.
- Substitution. Substituting a high risk hazard (i.e. processes, operations, equipment, etc.) with a less hazardous one can also provide significant levels of risk reduction.
- Engineering Controls. Applying engineering controls to safeguard hazards can also significantly impact the degree of risk reduction and residual risk in the system.
- Warnings. Instituting warnings (i.e. signs, labels, audible alarms, etc.) can help to alert people to the existence of and proximity to hazards and risk.
- Administrative Controls. Administrative controls include procedural and training controls. As the hierarchy of controls illustrates, administrative controls are less effective than the Elimination, Substitution and Engineering Controls. Examples of administrative controls would include training for workers and supervisors, safe work methods, safety rules, disciplinary programs, close supervision, etc.
- Personal Protective Equipment (PPE). Personal Protective Equipment includes controls such as safety glasses, hearing protection, protective eye wear, safety harnesses/lanyards, gloves, respirators, etc. Because the use of PPE is intended to mitigate severity should a harmful event occur, the hierarchy of controls considers PPE to be the least effective type of control. As such, PPE should be the last avenue of protection after the previous methods have been considered.

While applying the hierarchy of controls is critical to ensure the most effective controls will provide the intended risk reductions, there must be recognition that some inherent risk will always exist in any work system. Regardless of what safeguarding system is implemented, it is still necessary to look closely at organizational forces, the knowledge and training of users and supervisors, as well as the behaviors and errors of users that can degrade or bypass the engineering controls (Liberty Mutual 2009). Exhibit 2 illustrates the concepts of the hierarchy of controls and the impact of combining controls in reducing residual risk in work systems.



Adapted from ANSI B11 TR3

Exhibit 2. Hierarchy of Controls to Reduce Risk

Aligning Risk Assessment with Business Processes

How an organization views and approaches safety is an important consideration when aligning risk reduction methodology to business process. Some traditional safety approaches tend to focus on the reduction of incident frequency and/or incident severity (i.e. fewer costs, lost time, etc.). While this is certainly a valid approach to reduce incident frequency and severity rates, it is also a reactive approach to safety management in the sense that the focus is predominately on risks that have actually resulted in incidents, and these risk exposures are being addressed after incidents have already occurred.

Effective integration of risk reduction methodologies requires a more proactive approach - one that looks to identify and assess significant risk exposures that have the potential to result in the occurrence of an incident. Accomplishing this requires an organization to move beyond traditional reactive approaches to safety, and turn the focus on measuring and mitigating inherent risk which occurs in work systems and processes. By examining work systems to identify potential breakdowns within the system that can create risk, organizations can ultimately measure and control process inputs which can lead to an unintended output - an incident which causes harm.

High-performing organizations continually and energetically challenge tightly held assumptions about how things are done, whether they are evaluating manufacturing, logistics and distribution work systems or risk reduction ("Take Safety to a New Level" 2010). To effectively integrate risk reduction and mitigation techniques into an organization's work systems requires leadership commitment, the ability to communicate risks using the language of the business, and a standard methodology for measuring and evaluating risks.

Engaging Leadership within the Organization

Successful risk improvement initiatives which deliver sustainable business results all have one common fundamental element – Leadership Commitment. Companies which have been successful with integrating Total Quality Management (TQM) systems, LEAN Manufacturing programs, Six Sigma quality process control systems and other business improvement processes into the culture of the organization, had to begin by engaging leadership early in the process to obtaining buy in to the changes required to drive continuous improvement.

Leadership demonstrates their commitment by removing the real (time and resources) and perceived (attitudes come from the top down) barriers that impede performance. An effective way to engage leadership is to establish "The What," which is a vision for the future state of safety within the organization. The vision statement establishes the safety values of the organization and serves and the framework for building a culture of "this is the way we operate." Refer to Exhibit 3 below for an example of a safety vision statement utilized by ABC Company.

"The What" – Safety Vision
ABC Company Zero Harm Charter
At ABC Company we are committed to achieving Zero Harm. This means zero injuries and zero environmental damage. • 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.

Exhibit 3. "The What"

"The How" – Safety Policy
ABC Company Safety Policy
ABC is 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. • 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.

Exhibit 4. "The How"

Once leadership has bought into "The What", a roadmap for "How" the vision will be achieved requires leadership endorsement. "The How" is generally an organization's safety policy statement which establishes the framework for development of an effective safety management system to deliver sustainable performance improvements. The safety policy in Exhibit 4 above establishes a minimum performance standard to comply with regulatory requirements, continuously improve processes, and proactively identify and measure risks. Additionally, this policy statement requires the engagement of employees at all levels of the organization and sets the expectation for transfer of best practices.

The vision statement in Exhibit 3 above sets the expectation that risks will be identified and evaluated in the decision making process as the leadership of ABC Company has endorsed the value statement "We think first of Zero Harm". This value statement enables a risk assessment

process which identifies and measures opportunities to reduce inherent risk to be integrated in to the organizations' work systems.

Using the Business Language to Manage Risk

An organization's success in integrating any new process or methodology ultimately depends on how well the organization understands and adopts the new process or methodology. Aligning with existing business processes and using the business language established within the organization will facilitate this integration. The same applies when integrating risk assessment methodology into the safety management system.

ABC Company recognized that its traditional safety management process had reached maturity as safety performance began to plateau. In order to drive continuous improvement in safety performance, the risk management department at ABC Company sought to integrate safety management processes with the organization's continuous improvement processes — LEAN and Six Sigma. It was necessary to take this integrated approach as the risk management department was competing for the same resources that were being used in Six Sigma and LEAN process improvement projects while working to implement a strategic initiative to deploy a standardized process for conducting risk assessments.

The risk manager at ABC Company was trained in Six Sigma and LEAN, and realized the risk assessment process aligns very well with the Six Sigma DMAIC problem solving methodology used by many businesses. DMAIC is an acronym for the five phases of process improvement utilized in Six Sigma - Define, Measure, Analyze, Improve and Control. In order to demonstrate the value proposition for implementing risk assessment methodology at ABC Company, the risk manager developed a graphic (Exhibit 5) showing the alignment of risk assessment with the Six Sigma DMAIC methodology. This graphic was integrated into safety training presentations to educate the organization in the principals of risk assessment and risk management methodologies.

Exhibit 5. DMAIC Risk Management Model

The acceptance and use of risk assessment methodology at ABC Company increased as a result of the integration of risk assessment with existing process improvement methodology utilized by the business. Development of the DMAIC Risk Management Model enabled safety processes to be measured more effectively by proactively measuring risk exposures in existing work systems instead of measuring the frequency and severity of incidents. ABC Company utilizes a risk assessment process which provides a qualitative measurement of the frequency and severity of risk exposures and the probability of occurrence. The DMAIC process enabled the ABC Company Risk Manager to measure safety process drivers in a language the business understood.

Indentifying and Assessing Risk

Effective risk assessment processes enable the organization to measure risks qualitatively and quantitatively. Risk assessment processes are generally considered to be effective if:

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

There are numerous risk assessment processes and database technology solutions available to conduct risk assessments. ABC Company utilized various risk assessment processes at different levels of the organization to measure and manage business risks as well as health and safety risks.

ABC Company utilized a risk management process which was 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. The AS/NZS 4360 standard is equivalent to ISO 31000 Risk Management Standard, and outlines a process for conducting qualitative risk assessment which utilizes a five-by-five matrix to evaluate the consequence and probability of each identified risk exposure. Exhibit 6 provides an illustration of the qualitative measurement of risk utilizing a five-by-five matrix as outlined in ISO 31000 Risk Management Standard.

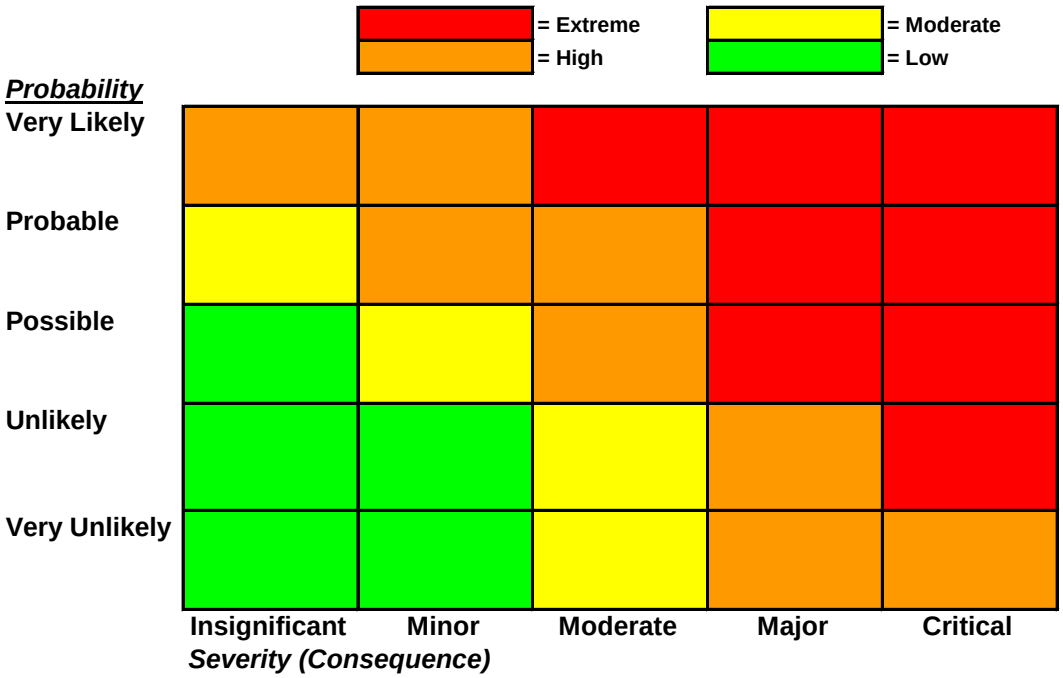


Exhibit 6. Qualitative Risk Assessment Matrix

Effectively implementing risk assessment methodology and measuring safety and health risks within the organization required front-line employees to be involved and engaged in the risk-assessment process. ABC Company selected R3™ because it is easy to understand, it utilizes consistent criteria to measure and quantify risks, it is able to be used by front-line employees, it requires a cross-functional team approach, and it aligns well with Six Sigma and LEAN continuous improvement processes. R3™ enables a risk improvement team to perform a baseline of the current state of the work system being evaluated, measure risk exposures quantitatively and qualitatively, evaluate the effectiveness of existing mitigating controls and develop a list of proactive improvement actions which will reduce risk. Additionally, R3™ provides a measurement of the future state of a work process once additional mitigating controls have been implemented. This approach enabled ABC Company to prioritize limited resources to systematically reduce and control risks by continuously working in the areas with the greatest risk concerns.

ABC Company developed a training program to teach front line employees how to conduct and document risk assessments using the R3™ process. These assessments are performed by a team of employees which includes front-line employees involved in the work process and other interested parties such as the engineering department, maintenance, and safety and health professionals. When conducting risk assessments, the team observed the work system which was identified as requiring improvement; documented the process steps and conducted a baseline assessment to identify and measure the potential risk exposures within the work system. Next the team developed mitigating controls to reduce risk and conducted a subsequent assessment to measure the effectiveness of the recommended improvements. Once the additional mitigating controls have been identified, the risk assessment is reviewed with leadership, and an action plan to implement the recommendations developed. The sample R3™ assessment conducted by ABC

Company in Exhibit 6 below indicates a 57% reduction in residual risk (R3™) could be achieved if all the recommended improvements are effectively implemented. This represents a significant improvement in the work system risk versus the baseline, and clearly shows the residual risk which remains in the work system The R3™ process required the team of employees to identify risk concerns for each work system, determine the number of employees exposed to each risk concern, and then identify and evaluate the effectiveness of existing risk mitigation controls. As illustrated by the example in Exhibit 7, the team assessed each risk concern using a five point rating scale to rate the Frequency, Likelihood and Severity of each risk concern to calculate a baseline risk score or index of inherent risk.

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**

Exhibit 7. Example Baseline Risk Assessment

Mitigating Risk

Next the team made judgments of risk acceptability to identify risk concerns which required further mitigation. When risk scores indicated the baseline risk was not acceptable, the team developed recommendations for additional mitigating controls to reduce risk and then conducted a subsequent assessment to measure the effectiveness of the recommended improvements. Once the additional mitigating controls have been identified, the risk assessment is reviewed with leadership, and an action plan to implement the recommendations developed. Exhibit 8 below illustrates an example subsequent risk assessment once the team's recommended risk mitigation controls were implemented.

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%**

Exhibit 8. Example Subsequent Risk Assessment after Risk Mitigation

The sample R3™ assessment conducted by ABC Company in Exhibit 9 below indicates a 50% reduction in residual risk (R3™) could be achieved if all the recommended improvements are effectively implemented. This represents a significant improvement in reduction of risk in the work system as compared with the baseline of the inherent risk, and this clearly shows the residual risk which remains in the work system once risk has been reduced to as low as reasonably practicable (ALARP).

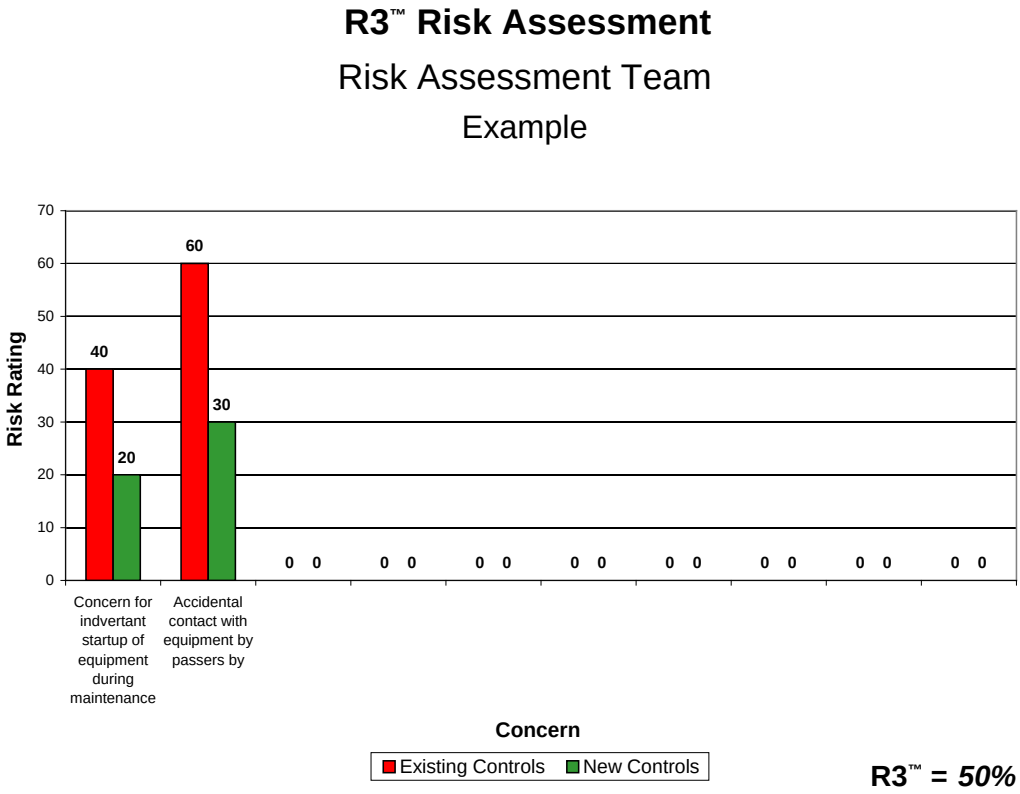


Exhibit 9. Example R3 Residual Risk Reduction Results

ABC Company has embraced the use of risk assessment methodology and continues to find meaningful ways to utilize risk assessments to evaluate and assess its work systems. Most recently, ABC Company integrated the requirement for risk assessments to be conducted prior to sign-off and approval of certain capital expenditure projects. This integrated approach has enabled ABC Company to not only reduce the risk of injuries in its work systems, but has also enabled ABC Company to actively demonstrate its commitment to Zero Harm, and build an organizational culture where Zero Harm is the way things are done.

Summary

To deliver sustainable safety performance, it is necessary to work proactively to identify and evaluate risk exposures and hazards before an incident which causes harm can occur. Organizations which have been effective in integrating risk management methodology into their safety management processes are progressive in their approach to safety management and realize the benefits of managing risks which are inherent in any work system will deliver the desired results. When applied as an on-going process, risk assessment methodology can help organizations redefine the nature, extent and level of risk that is acceptable for their business model and deliver world class levels of performance.

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