Session No. 635

A Canadian Perspective on Applying ISO 31000 (ANSI Z690) Risk Management Principles (RMP)

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Introduction

Hazard identification and control is one of the primary driving forces for current SHE programs and management systems. The assessment of identified hazards is the road map that guides SHE professionals through the myriad of regulated and recommended control strategies that need to be considered and implemented by an organization. The term "Hazard" is defined as a source of potential harm, which triggers the expectation that exposure to these sources, need to be controlled, mitigated or eliminated (ANSI/ASSE 2011b, p.11). The control measures that will be selected to minimize this exposure are often based upon the existence of the hazard as opposed to the level, or likelihood, of hazard exposure.

Risk management, which includes risk identification, assessment and treatment, is one of the cornerstones of modern business management. The use of a "risk-based" approach to guide strategic planning and decision-making processes is a philosophy that has been adopted by high risk (critical hazard) industries and organizations focused on becoming industry leaders. The basis of this approach is to identify credible risk sources that will be encountered by the organization so that appropriate risk treatment (control) strategies can be adopted. What is a "credible" risk and what is an "appropriate" risk treatment is based upon the risk objectives (principles) of the organization and the level of risk that can be tolerated (e.g. the company risk evaluation criteria). The risk management principles and framework needed to adopt this approach is captured in ISO 31000:2009 – Risk Management Principles and Guidelines which has now been promulgated in both Canada (CAN/CSA 31000:2011) and the USA (ANSI/ASSE Z690.2-2011).

While the adoption of a risk-based approach to manage the activities and operations conducted by a business is logical, there are challenges that need to be considered prior to implementation. Will this change in philosophy be defendable within a regulatory environment that still uses a "hazard- based" approach to control sources of potential harm or loss? What are the organizational barriers to adopting a risk-based approach? What level(s) of risk can be tolerated (ALARA or ALARP)? How will the risk management principles be applied throughout the organization? To address these challenges, the basic principles of a risk management system will be reviewed and examples of how to apply these principles will be provided.

The "Hazard – Based" Approach

Every organization has experienced "unsafe" conditions or work practices that left unchecked could result in personal harm or damage to the assets of the company. The purpose of the hazard assessment is to identify and evaluate those conditions that could harm workers at a workplace. This is the directive that is provided to employers in the Alberta Occupational Health and Safety Code 2009 Explanation Guide (pg 2-2); similar expectations are established in other Canadian jurisdictions at the provincial and federal levels. Canadian employers are expected to identify the situations or conditions that could harm their workers or other personnel under their control, and to document these results.

How are hazard sources determined? A company can use a checklist method that asks questions about the type of activities and operations being performed in order to determine the hazards that may be encountered; examples of this method include Safe Work Permits, Field Level Hazard Assessments, JSAs, Preliminary Hazard Assessments (PHA)/ HazIds, etc. A gap analysis of organizational activities to the Occupational Health and Safety requirements within each jurisdiction of operation can also provide a baseline list of hazards that need to be controlled. A broader approach that can be used to identify hazard sources is the PEME chart (Exhibit 1) in combination with an affinity or fish bone diagram or other categorization method (e.g. the energy source theory); this approach will require the use of internal subject matter experts to brainstorm a list of possible sources of harm that need to be considered.

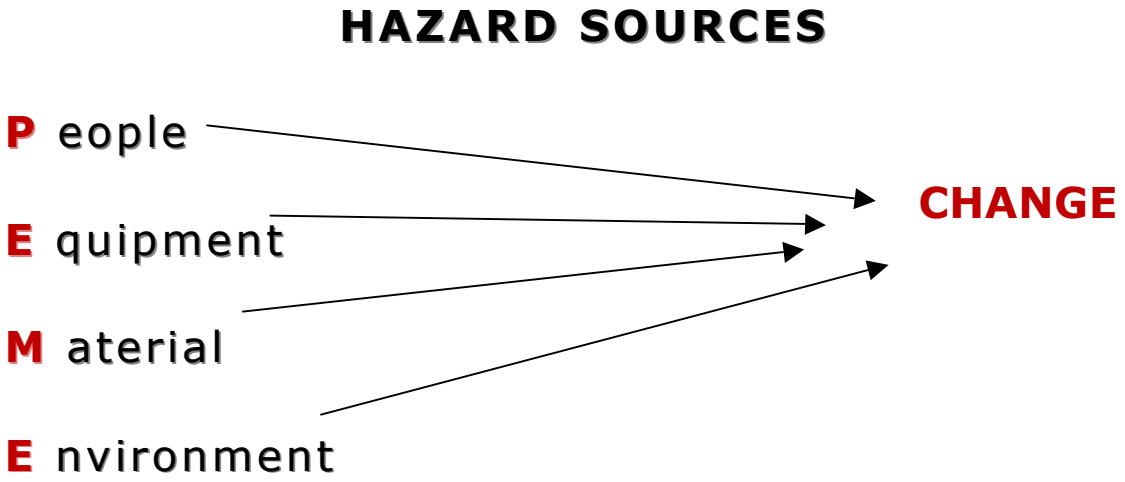

Exhibit 1. Hazard Source Identification using PEME

Once the foreseeable hazards have been determined, the organization is then required to determine the strategies that will be used to eliminate or control exposure to these sources of harm. The controls measures that need to be used are often described in excruciating detail in a corresponding legislative or industry standard. While the company has the ability to choose which control measure(s) or strategies will be implemented, internal documentation and written external guidance that can support the rationalization of these decisions may be vague or nonexistent. As the regulatory environment strengthens, a company will often adopt all of the protective measures prescribed to ensure their "due diligence" is met.

Bruce K. Lyon and Bruce Hollcroft in their article " Risk Assessments: Top 10 Pitfalls and Tips for Improvement" state that in the US, many organizations have relied on checklist-and-hazard-inspections methods that focus on regulatory compliance, and prescribed hazards and conditions to evaluate workplace safety and health. Unfortunately, such methods do not provide a true measure of risk (PS Dec 2012, p.29). What is risk? The terms hazard and risk have been interchanged over the years to the point that these concepts are thought to be synonymous. In this author's experience, this would be equivalent to proclaiming a group of trees to be a forest.

The "RISK – Based" Approach

The term "Risk" is defined as the effect of uncertainty on objectives (ANSI/ASSE 2011b, p.8). The notes included to explain this definition state that:

- Effects are positive or negative deviations from what is expected.
- Uncertainty refers to the lack of information, understanding or knowledge of an event, its consequence, or likelihood, and
- Objectives may include strategic, financial, production, operational, SHE goals that apply at different levels of the organization, e.g. corporate, business unit, project, product or process driven.

OHSAS 18001:2007 (Occupational Health and Safety Management Systems – Requirements) defines risk as the combination of the likelihood of an occurrence of a hazardous event or exposure(s) and the severity of injury or ill health that can be caused by the event or exposure(s) (BSI 2007, p.4)

Regardless of the reference standard that is used, the definition for risk has the same components; control and mitigate sources of harm or loss (risk factors or hazard sources) based upon the level of foreseeable risk potential. To adopt this approach requires an organization to accept that hazard sources can be evaluated and prioritized based upon company specific risk goals, tolerance (ALARA) and criterion. To facilitate organizational acceptance it is prudent to review current and proposed SHE regulatory requirements to determine if there is a progression towards risk-based legislation.

Risk - Based Legislation

The important things an employer needs to decide when assessing a worksite is whether a hazard is significant and whether satisfactory precautions have been taken so that the chances of worker injury are eliminated or made extremely unlikely. This statement from the Alberta Occupational Health and Safety Code 2009 Explanation Guide (Pg 2-2) suggests that an employer may use a process or method to determine if a hazard actually poses a level of harm that requires control. It also suggests that measures chosen to manage the hazard source may be acceptable if they have reduced worker exposure to a level "as low as reasonably achievable".

The term"as low as reasonably achievable (ALARA)" has begun to appear in Canadian legislation, examples include the:

- **Alberta OHS Code 2009** – Part 2 – Hazard Assessment, Elimination and Control: If a hazard cannot be eliminated or controlled (through engineered controls), the employer must use administrative controls that control the hazard to a level as low as reasonably achievable.
- **BC OHS Regulations 2012**: Part 5 - Chemical Agents and Biological Agents: "as low as reasonably achievable" or "ALARA" means, in reference to a substance, that measures must be taken to keep a worker's exposure to a level as low as is reasonably achievable.
- **Manitoba WHS Regulations 2011:** Part 2 – General Safety Duties – Eliminating or control of risks: Where there is a risk to the safety or health of a worker, the employer must, if reasonably practicable, eliminate it through (a) the design of the workplace; (b) the design of the work process; or (c) the use of engineering controls. To the extent risk remains after taking the measures (described above), implement safe work procedures that reduce the remaining risk as much as reasonably practicable.

While the ALARA term is not common in regulations promulgated by OSHA, the requirement to identify, evaluate (assess) and control hazards is integral to the Process Safety Management of Highly Hazardous Chemicals Standard (1910.119) and the proposed Injury and Illness Prevention Program (I2P2).

Using ALARA or ALARP

The acceptance of risk tolerance within an organization will be driven by the willingness of internal (management, supervisors, workers) and external stakeholders (industry and union representatives, regulators) to embrace the concept of ALARA (as low as reasonably achievable) or ALARP (as low as reasonably practicable). The preliminary review of OHS legislation in Canada suggests that the rationalization of the actions taken to treat or control risk (hazard) sources is acceptable. In the UK, this approach to risk assessment is part of the legislative requirements established by the Health and Safety Executive.

This progression towards accepting the concept of risk tolerance, however, should not be mistaken as risk avoidance. The ALARP triangle, which has been adopted by many organizations and a growing number of regulators, depicts the expectations that justification for control selection, implementation and/or rejection is still required for all risk levels. The challenge now faced by a company that wishes to adopt the risk-based approach is how to migrate from a reactive hazard driven program to a system that proactively manages risk potential.

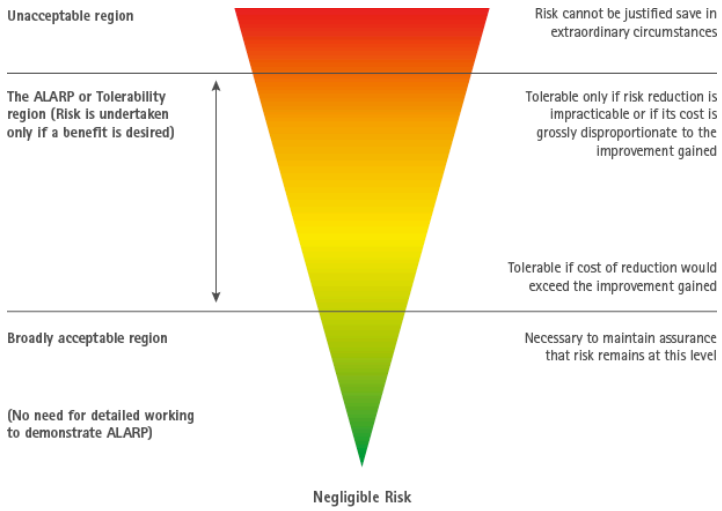

Exhibit 2. The ALARP or Risk Tolerance Triangle retrieved from http://www.ep-consult.co.uk/service/hse-risk-assessment/safety-case-development.

Risk Management System

There are three components that need to be addressed in a risk management system. These include establishing risk principles that need to be followed; creating a framework for the system (Plan-Do-Check-Act); and standardizing the process that will be used to identify, assess and treat the foreseeable risks that will be encountered by the company.

Risk Principles

As with any company policy or program, senior leaders need to endorse and embrace the following principles if a risk based management system is to succeed.

- Integrate into organizational processes and decision-making;
- Create value for the company internally and externally;
- Customize to the risk goals and tolerance of the company;
- Standardize so that the approach is systematic, structured and timely;
- Clearly address how to deal with uncertainty;
- Be transparent and inclusive;
- Consider human and cultural factors;
- Create a robust system that is responsive to change;
- Commit to continual improvement initiatives.
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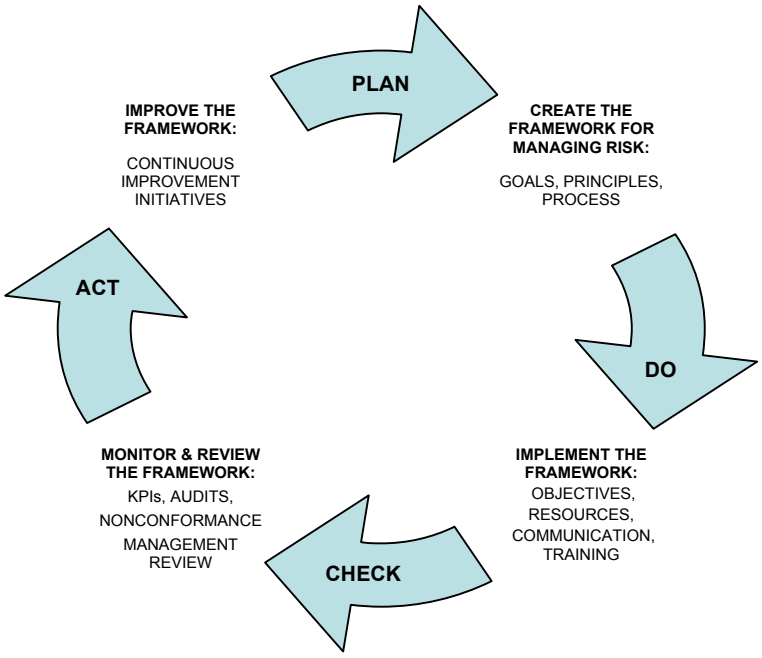
Framework of a Risk Management System

If the PLAN-DO-CHECK-ACT model is followed, then the framework for this system may already exist within a company. The key components to align within an existing management system include:



COMPANY MANDATE AND MANAGEMENT COMMITTMENT

Exhibit 3. The Risk Management Framework.

The Risk Management Process

As outlined in ISO 31000:2009 (ANSI/ASSE Z690.2-2011) – Risk Management Principles and Guidelines, the key components of this process should include:

1. Communicate/Consult with Stakeholders (BU/Work group managers, SMEs, Union reps, etc).
2. Establish Risk Management Goals and Responsibilities.
   - Consider Internal and External factors
   - Consider company culture, resources & capability
3. Define the Risk Criteria to be used in Company Risk Assessments.
   - What will be measured: Frequency of occurrence, likelihood of occurrence, consequences/severity.
   - Risk Tolerance: ALARA or ALARP
   - Criteria for taking Action
4. Determine and Apply Risk Assessment Methods / Techniques.
   - Risk Identification
   - Risk Analysis
   - Risk Evaluation (Prioritization)
5. Determine Risk Treatment (Control) Options.
   - Avoidance, Elimination, Substitution, Engineering, Administrative, PPE
6. Establish Monitor and Review Requirements.
   - When Changes Occur within a company
   - New and emerging risks are identified (external or internal).
   - Management Review

- Trend Analysis
- Verification that Risk Treatment Options are effective

Establish Risk Management Goals

The risk management goals and objectives that are developed, in consultation with key stakeholders, are the foundation on which the Risk Management Process is built. It is at this stage that the risk principles, policy and tolerance of the organization is applied and communicated for implementation. Stakeholders who participate in this process need to consider both external and internal factors and influences.

External factors that should be considered include social, cultural & political influences, legal requirements, economic and technology environments. Key drivers (market and customer share), trends (industry standards, best practices) and value systems (perceptions) of external stakeholders will also be influential in how a company decides to manage its risk sources. Internal factors that should be considered include the organizational structure, culture (relationships), capabilities and resources. Without the ability to fulfill the risk goals and objectives that are established, the process will fail and the initiative to implement a risk management system will collapse.

Examples of risk management goals can often be found in SH&E policies or company mission statements. These may start with high-level goals such as requiring risk identification and assessment to be integrated into all planning, construction and operational activities. The measurable objectives that may be needed to obtain this goal could include integrating a risk questionnaire or evaluation requirement into the Management of Change process or Project Management (Construction) manual. The completion of the required risk reviews (evaluations), using the methods approved by the company can now be evaluated and monitored to verify that the corporate risk goal is being met.

One goal that needs to be established in all risk management systems is the risk tolerance of the organization and the evaluation criteria that will be used to determine and justify the position taken by the company.

Creating a Custom Risk Analysis Criteria

The creation of a risk analysis framework that reflects the external and internal factors considered during the goal setting process is the core of the risk assessment process. Without a standardized approach to determine the significance of the risk source(s) that have been identified, the risk assessment activity will fall into disarray. Personnel assigned the responsibility to conduct risk assessments will be forced to apply their historical experiences and perceptions. This can create information that is biased or lacking justification and will simply fail to meet the basic risk principles of standardization and consistency.

The primary advantage of using the risk based approach is to apply a method or technique that will allow the assessment team to make an informed and timely decision about whether a risk needs to be controlled (treated), and the most appropriate strategies and measures to be used (ANSI/ASSE 2011d, p.17). This requires the development of a standardized analysis criteria that

will help the assessment team determine the level of risk that exists for the activities and operations that are actually performed or encountered by company personnel. Within Canadian legislation, the use of a standardized risk (hazard) analysis method is critical to justifying the actions taken, or not taken, by a company to control individual (i.e. workers, contractors, visitors, etc.) exposure levels.

The factors (criteria) that should be considered when creating a company-specific risk analysis method include the consequences that may result from exposure to a risk (hazard) source and the probability (likelihood) that these consequences will occur. To apply this concept, a company may choose to develop a 2 or 3 factor risk matrix that is used in a qualitative, semi-quantitative or quantitative application. The two-factor risk matrix will consider the probability of occurrence (the likelihood that an event will occur) along with the consequences (severity) of the occurrence. This matrix is most effective in evaluating risk potential for short term or rarely performed activities, such as annual maintenance/turnarounds or projects at temporary work sites, where the use of the frequency factor may dilute the overall risk potential.

The three-factor matrix will separate the probability of occurrence into the frequency of exposure to a risk (hazard) source and the probability that a loss or potential loss event will occur. An example of a three factor semi-quantitative method that is commonly used in Canadian risk (hazard) assessments to meet regulatory and industry requirements is presented below in Exhibits 4, 5 and 6. A semi-quantitative risk analysis method uses numerical rating scales with descriptors that reflect the external impact on people and assets outside the company as well as internal levels of risk tolerance.

Frequency of Exposure to the Hazard (Performing the Task)

1	**Very rare** – 1 + per year/ 1 per job or task.
2	**Rare** – 1 + per month (quarter)/ 2 per job or task.
3	**Occasional** – 1+ per week/ 3 per job or task.
4	**Frequent** – 5+ per week/job (Daily) or Continuous during a task.

Exhibit 4. Frequency of Exposure Table.

Probability of Loss Occurrence (Current controls in place)

1	**Remote** – One event in the lifetime of the company or per project
2	**Possible** – One event in the past 5 years; 2 events per project
3	**Probable** – One event in the past 3 years; 3 events per project
4	**Immediate** – One event per year or more; 4 events per project

Exhibit 5. Probability of Loss Occurrence Table.

Severity/ Consequences of the Loss

Severity Category	Health or Safety	Environment Impact	Business Interruption; Other Financial	Financial Loss	Public Impact
1 Minor	• First aid • Minor injuries	Small clean-up	Minimal	Minor downtime (2 hours); < 5k damage.	Minor – limited # of individuals affected or none
2 Moderate	• Lost-time Injuries • Requires medical aid	Clean-up requires contractors, staff, partner arrangements	• Minimal • Fire with minor equipment damage	Moderate damage (5 – 20k) or down time (1 day).	Minor – families affected
3 Significant	• Chronic illness • Serious injuries • Permanent or long-term disability	Extensive, long-term clean-up of soil ground water & minor impacts to water bodies	• A few days downtime • Fire or explosion causes property damage	Major downtime (3 days) or damage (20 - 100 k).	Serious impact - small community Localized evacuation
4 Extensive	• Multiple serious injuries • Fatality	• Major soil or groundwater contamination • Major impact to water bodies	Long term outage	Extensive damage (>100k) &/or extended downtime.	Serious impact - large community Major evacuation

Exhibit 6. Consequences or Severity Definition Table.

Whether a two or three factor risk analysis is used, the level of risk for each hazard (risk) source is determined by feeding the numbers chosen by the assessment team into a formula; this is demonstrated in Exhibit 7. This process is systematically repeated for every hazard/risk source or effect that has been identified within the scope of the risk assessment being conducted. A hazard risk score or risk priority number is then used to determine the order in which each hazard/risk source will be addressed (i.e. controls determined and applied) and the level of risk that will be tolerated.

HAZARD RISK SCORE =
Likelihood (Frequency X Probability) X Severity

SEVERITY									
	4	4	8	12	16	24	32	36	48	64
	3	3	6	9	12	18	24	27	36	48
	2	2	4	6	8	12	16	18	24	32
	1	1	2	3	4	6	8	9	12	16
		1	2	3	4	6	8	9	12	16
		LIKELIHOOD (Fr x Pb)								

Risk Scores Classification:

1-9	=	**Minimal**	Acceptable **(ALARA/ALARP)**
12-16	=	**Marginal**	Acceptable with controls
18-27	=	**Serious**	Further controls suggested
32-64	=	**Critical**	Further controls required

Exhibit 7. Risk Matrix and Prioritization Table.

Applying the Risk Evaluation Criteria

The use of the three-factor method is gaining popularity in Canada due to the Partnerships in Injury Reduction - Certificate of Recognition (COR) program; this is an initiative by several provincial governments to encourage Canadian employers to implement an OHS program within their company. The program is voluntary but the financial incentives and market demand for COR certification have encouraged many employers to embrace the requirements of this program, which include conducting hazard (risk) assessments using the methodology described above. A common hazard identification and assessment method endorsed by this program, and by Canadian OHS legislation, is the Task Hazard Assessment also known as a JSA (Job Safety Analysis) or JHA (Job Hazard Assessment/Analysis). This method has traditionally used a hazard based approached and a qualitative criteria (Low, Medium, High) if risk level prioritization was required.

The move towards a risk-based approach by Canadian regulators is quickly changing how this method is applied. There is a growing expectation that quantitative measurements be used to identify the estimated (semi-quantitative) or expected risk level (quantitative part failure rates) for each hazard/risk source that is likely to be encountered, or to impact the assets of the company. The logic behind this expectation is that a company needs to clearly identify how the risk level was determined as opposed to providing a "good guess" based upon individual perceptions. To move the traditional risk evaluation criteria to a semi-quantitative method, it is important to use numerical representations based upon internal or external data that can be referenced if the assessment is questioned, such as when an incident occurs or a noncompliance order is written.

For example, the frequency of exposure should be identified by personnel who perform the work tasks, activities or operations being assessed; justification data may include job or maintenance schedules, customer or job work orders, and project or field documentation. The probability of occurrence should be determined by personnel who are exposed to the hazard/risk source being evaluated as well as individuals who have access to industry statistics and internal incident, near miss & hazard reporting information. This team approach will allow actual and potential loss data, both reported and unreported, to be considered in a manner that is similar to examining part or tool failure reports to determine the risk of part or system failure. Depending on the method that is chosen to perform the risk assessment, the probability of loss can also demonstrate control effectiveness. If controls (risk treatments) are identified prior to the risk analysis, then using internal incident or hazard reporting data can help to validate if the controls listed are working or whether loss events are continuing to occur.

Consequence risk values should be determined based upon multiple external and internal factors that were identified when the risk goals for the company were determined. The use of financial cost ranges that reflect the impact on the company can help the assessment team make timely decisions on this factor. This consideration should not be construed as assigning a dollar value to an individual's life or health, but instead should help the company and the assessment team recognize the minimum negative effect that will be incurred if adequate controls or risk treatments are absent or rejected.

The final step in the risk (hazard) assessment process is to compare the level of risk found during the analysis stage (e.g. the hazard/risk score, risk priority number) to the actionable risk level criteria that has been established by the company. The use of a numerical system can allow the assessment team to quickly determine if a risk (hazard) source requires treatment (control) and the priority for implementation.

Risk Treatment Options

While the controls required for specific hazards are still detailed within Canadian legislation, there is a transition towards expecting employers to rationalize and use the hierarchy of controls (treatment) as outlined in ISO 31000 (ANSI/ASSE Z690.2) and other standards for OHS Management Systems such as ANSI/ASSE/AHA Z10, CAN/CSAZ1000-06 and OHSAS 18001-2007. The Alberta Occupational Health and Safety Code 2009 Explanation Guide provides detailed advice on the hierarchy that employers are expected to review and use if possible. The risk treatment options that are encouraged for use, in descending order, include:

AVOIDANCE
The ultimate treatment option is to choose to not perform the task, work activity or operation.

ENGINEERED SOLUTIONS
- Elimination/Redesign: Remove or "engineer out the hazard" (e.g. design valve handles to be accessible at floor level so personnel do not need to work at heights.)
- Substitution – Use a less harmful substance (e.g. solvent replacement for Toluene/Xylene/Varsol or other harmful chemicals).
- Isolation – Contain or enclose the hazard to minimize exposure (e.g. the use of sound reducing equipment/structures, equipment guards or ventilation systems such as fume hoods or paint booths).
- Automation – Automate or mechanize the process or activity so personnel do not need to interact with the hazard (e.g. transporting hazardous substances through a pipeline).

ADMINISTRATIVE SOLUTIONS
- Develop Work Procedures, Practices and Rules to guide personnel on how to work with or near a hazard/risk source.
- Provide job/task/activity specific training.
- Implement job rotation schedules and hours of work standards to reduce fatigue and exposure times.
- Share the Risk by hiring competent personnel to perform the task.

PERSONAL PROTECTIVE EQUIPMENT
This solution is the last option that should be considered.

Selecting a Risk Assessment Technique or Tool

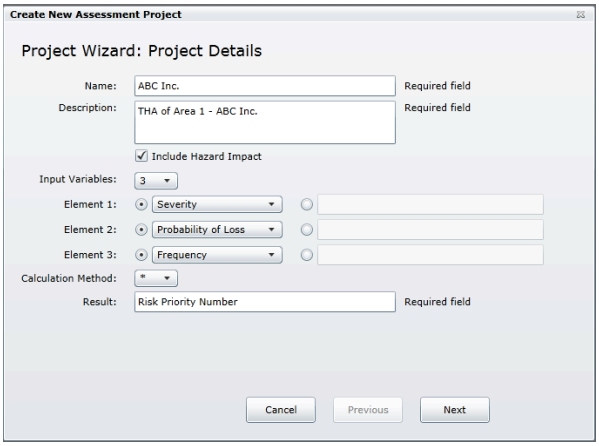
There are a variety of risk assessment techniques that can be used to achieve corporate and activity (study) specific risk objectives that have been established. ANSI/ASSE Z690.3 describes at least 31 of these techniques in Table A.1 – Applicability of Tools Used for Risk Assessment and Table A.2 – Attributes of a Selection of Risk Assessment Tools. The Task Hazard Assessment (THA or JSA/JHA) method is not specifically addressed in this standard but like many techniques that now exist, this is a hybrid with many names. The THA technique, which is a common method used in Canada to evaluate worker exposure to hazard (risk) sources, combines components of the Primary (Preliminary) Hazard Analysis, the Human Reliability Analysis and the Consequence/Probability Matrix. This suggests that the risk assessment team does not have to select only one technique to achieve the goals of a risk assessment study, and multiple tools may need to be used or combined.

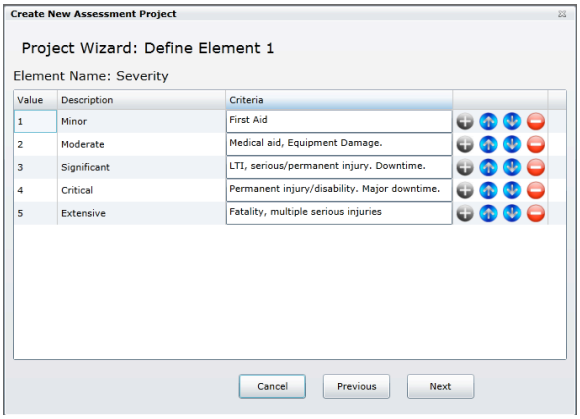
To choose the appropriate risk assessment technique(s) or to create a hybrid tool, the following questions should be reviewed and answered.

- Is the technique justifiable and is it appropriate for the situation or activity under consideration?
- Does the technique standardize the manner in which data is collected so that the results are traceable, repeatable and verifiable in the future and throughout the organization (e.g. are we comparing apples to apples)?

- Will the technique provide information that allows the assessment team to clearly understand the nature of the risk so appropriate control strategies (risk treatments) can be determined and approved for implementation?
- Will the technique allow the team to fulfill the objectives of the risk assessment study?
- Does the technique focus the team on the type and range of risks that need to be analyzed to meet the objectives of the risk assessment study?
- What expertise, resources, information or data needs to be made available to successfully use the technique?
- Does the technique support information modification or updating as needed or required (e.g. operational changes, legal or contractual requirements).

Below is an example of a Canadian software tool that was built to help employers create a customized risk assessment process that follows the principles and guidelines of ISO 31000 while incorporating the legislative requirements of the hybrid THA technique; refer to Exhibits 8 and 9. The customizable project and risk wizard provides each company with the ability to select multiple risk factor analysis methods, criteria, prioritization levels, source considerations and worksheets based upon the technique that is selected.





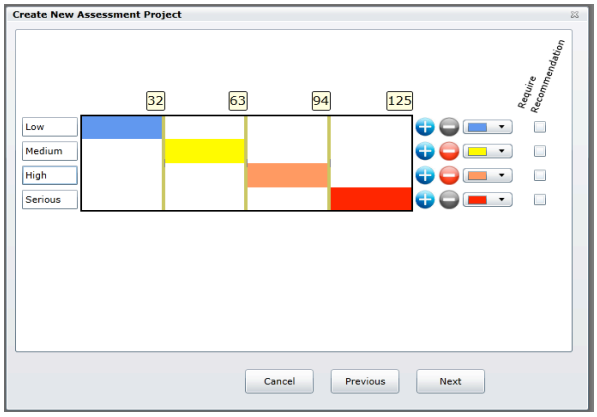


Exhibit 8. Development of the Risk Assessment Process and Analysis Criteria based upon Risk Assessment Project Objectives.

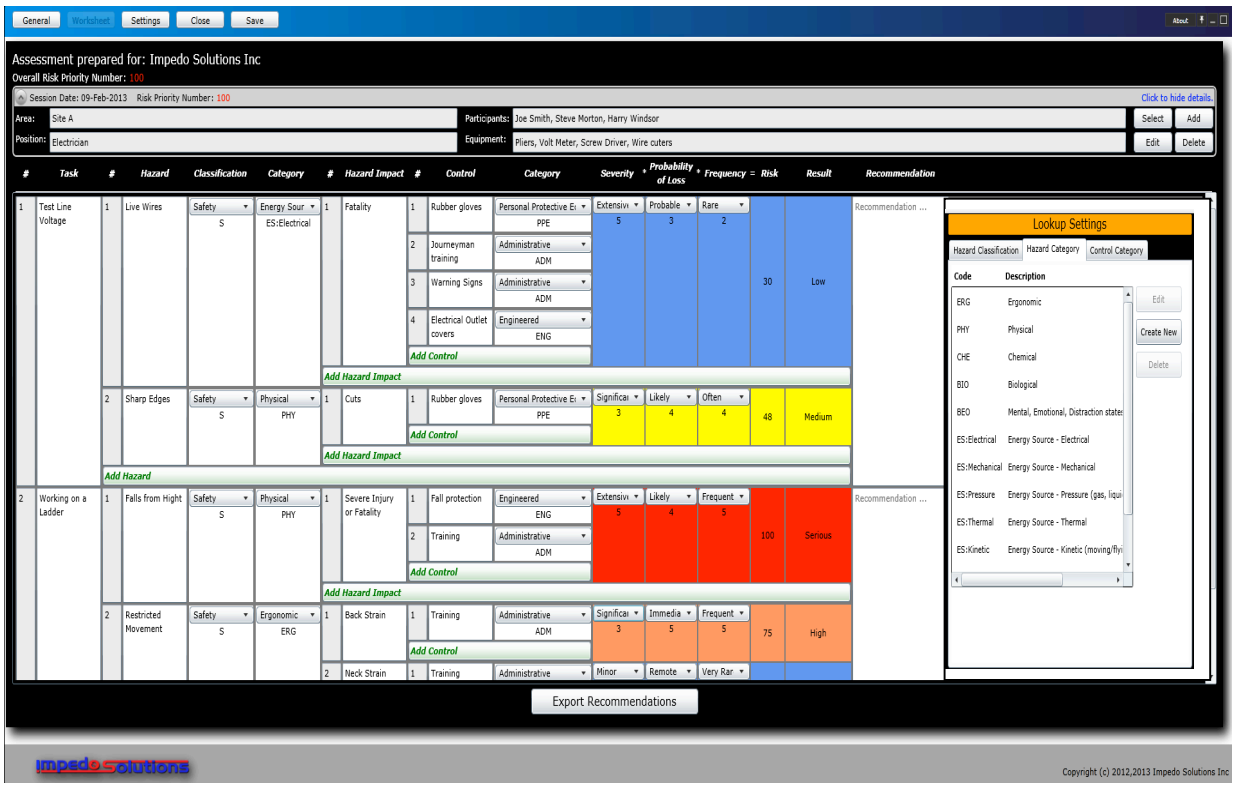


Exhibit 9. The Hybrid Task Hazard Assessment Worksheet (Technique).

Similar tools or systems are now being used by organizations to manage and enforce the principles of their risk management system; the "how to do" is no longer intangible or a barrier to implementation.

Conclusion

The successful transition from a hazard-based program to a risk managed system has been accomplished by many organizations. The risk-based approach is logical and beneficial to all stakeholders when it is applied systematically and in a consistent manner. The Risk Management Principles and Guidelines (31000) published by ISO, and adopted by Canada and the USA, provide a road map on how to accomplish this transition by:

- Clearly defining the risk principles that will guide organizational decision-making.
- Establishing a risk management system framework to guide the development (Plan), implementation (Do), verification (Check) and improvement (Act) of activities that will manage the risk principles and goals established by the company.
- Implementing a risk management process that will provide guidance to internal and external stakeholders on how to perform and record risk assessment activities so that they are consistent with corporate goals and requirements (defendable, verifiable, traceable and repeatable).
- Establishing a monitoring and review process to verify compliance and conformance with corporate risk principles, goals, processes and requirements.

SH&E professionals are in a primary position to educate stakeholders on the value of managing risks through a structured approach. It this group that needs to understand and promote the benefits of a risk based system so they can lead their organizations into the future.

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