

Hazard Identification and Risk Assessment

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Version Control Table

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Introduction

Research – by its very nature – is inherently risky. Boundaries are pushed, with new theories and discoveries tested. As a result, individuals who conduct experiments and processes must have a solid foundation in hazard identification and risk assessment to safeguard the health and safety of those directly and indirectly involved in this work.

The word “safe” is, at times, incorrectly interpreted as freedom from risk or consequence. Hazards can be eliminated, and a thing or process can be made safer, but as long as a hazard exists, risk – no matter how unlikely a scenario – perpetually remains. Mitigation and control measures may bring risk down to a level that is considered tolerable and acceptable; however, it is not possible (or realistic) to reach a zero level of risk. It is incumbent on those responsible for research or operational work to ensure that before the work begins, the process has been reasonably evaluated for risks and the supervisor has exercised due diligence in assigning the work.

For example, imagine a pedestrian waiting to cross a busy intersection. Traffic lights regulate traffic flow and a red light means that drivers must stop. The hazard to the pedestrian is managed by the presence of the traffic light, driver licencing, motor vehicle requirements, and the *Highway Traffic Act*, all of which are risk controls that allow the pedestrian to safely cross the street when facing a green light. But what if a driver does not stop at the red light? Any pedestrian crossing the street is at risk of a vehicle not stopping. This scenario is not likely to occur, given the risk controls in place, but it is still possible. And given the consequences of being hit by a car, the pedestrian must account for a potential failure of the risk controls. Therefore, the pedestrian will probably look both ways before crossing the street and act accordingly.

A risk assessment need not be complex; however, in the context of due diligence, a formal and documented risk assessment will better ensure that everyone involved in the project or task understands the hazards and risks, and how to safely and reasonably control them.

Objective

The purpose of this document is to provide a framework for supervisors to identify hazards and evaluate risks within the scope of their responsibilities to prevent or reduce the probability and severity of occupational injuries and illnesses through an appropriate hierarchy of hazard control and risk mitigation measures.

The document will outline the differences between a hazard and a risk. It is important to note that the presence of a hazard means that a risk exists. Where a hazard exists that cannot be eliminated, risk controls are required. The goal of a risk assessment is to evaluate hazards, then remove that hazard or minimize the level of its risk by adding control measures, as necessary. By doing so, you have created a safer and healthier workplace. The risk assessment will try to answer:

- What can happen and under what circumstances?
- What are the possible consequences?
- How likely are the possible consequences to occur?
- Is the risk effectively controlled, or is further action necessary?

Risk assessments are often conducted before new processes or activities are introduced, when hazards are identified, or when changes are introduced to the workplace.

This document was developed with *CSA Z1002-12 – Occupational Health and Safety – Hazard Identification and Elimination and Risk Assessment and Control* and the *Canadian Centre for Occupational Health and Safety – Risk Assessment* as primary reference points.

Responsibilities

Through [Procedure 14-1 – Internal Responsibility Procedure for Health and Safety Issues](#), the University of Ottawa has established a responsibility framework for all members of the uOttawa community, most notably officers, directors, supervisors, professors, workers, students, visitors, volunteers, and learners.

Supervisors

A supervisor has several legal obligations under applicable health and safety legislation, including: ensuring that workers comply with the [Occupational Health and Safety Act](#) and Procedure 14-1; informing workers about hazards; and providing instruction on preventative procedures. The list below summarizes some of the supervisor's duties from Procedure 14-1 with respect to hazard identification and risk assessment.

- stay informed of the health and safety needs of workers under their authority;
- initiate the necessary preventive measures to control hazards associated with activities under their authority;
- identify hazards, assess their risk and incorporate preventive and control measures into all functions and activities that present a risk of some incident or accident with health-related consequences;
- ensure the safety of people or workplace areas under their authority;
- before commencing new work or a new task, ensure that health and safety orientation, instruction, and information are provided by a competent person to people under their authority;

In the context of this document, the competent supervisor is the person primarily responsible for identifying and documenting hazards, assessing the risks involved in the work task, and implementing controls. The competent supervisor is responsible for communicating the results of their hazard identification and risk assessment in a clear, formal, and straightforward manner to the worker(s). The competent supervisor must then monitor and reassess the hazard identification and risk assessment when new information becomes available that affects the work and not less frequently than annually.

Workers

Workers are also responsible for health and safety when performing their duties. The list below summarizes some of the worker's legal duties from Procedure 14-1 with respect to hazard identification and risk assessment.

- work in compliance with the provisions of the applicable health and safety legislation and all health and safety procedures and practices that are made known to them;
- report all known health and safety hazards or any violation of the applicable health and safety legislation or University procedures to their supervisor;
- not use or operate any equipment, machine, device, item or work method in a manner that endangers themselves or other workers;

In the context of this document, a worker has the duty to report known hazards to their supervisor and comply with the results of the risk assessment process conducted by the supervisor. A worker has a right to [refuse work](#) if there is reason to believe that their working conditions endanger them or another worker.

Preparing for a Risk Assessment

There are varying levels of risk assessment, from preliminary to detailed. People conduct risk assessments every day, even though they may not be consciously aware of doing so (e.g., pedestrians crossing the street).

Before beginning a risk assessment, the supervisor must establish the proper context, including:

- Scope – the extent or lifecycle of the thing, process, or operation, including the physical work area and the types of hazards assessed.
- Parameters – the scales used to assess the process, such as:
 - Probability of occurrence (e.g., rare/unlikely/possible/likely/certain)
 - Severity of occurrence (e.g., insignificant/minor/moderate/major/catastrophic)
- Stakeholders – those involved in the risk assessment, including those who are internal and external to the process.
- Risk criteria – a definition of the situations that require further risk reduction to improve worker protection. The criteria must be derived from applicable legislation and include input from the relevant stakeholders.

Whether as part of a structured program or conducted informally, a risk assessment will follow the following process:

- Identification of hazard(s);
- Elimination of hazard(s);
- Analysis of risks of the remaining hazard(s);
- Evaluation of risks of the remaining hazard(s).

Conducting a Risk Assessment

Hazards

The first step in assessing risk is to identify the hazards. The process to identify hazards must consider the reasonably foreseeable hazards or situations related to the process being assessed that may cause harm to a worker. Hazards may originate from any of the following hazard categories, or any combination and interaction thereof:

- Chemical – Conditions that can lead to contamination by harmful or potentially harmful substances. Examples include toxic gases, noxious fumes, corrosive liquids or powders, etc.
- Biological – Conditions where living organisms can pose a threat to human health. Examples include blood and bodily fluids, infectious materials, viruses, etc.
- Physical – Conditions in which objects, materials, or structures can cause material or bodily harm. Examples include objects or substances that are explosive, noisy, conduct electricity (shock), or hazardous environments involving extreme hot or cold, radiation, slippery surfaces, low ceilings, etc.
- Biomechanical – Conditions that cause biomechanical (body and movement) stress on workers. Examples include workbench height, chair design, workstation set-up, etc.

- Psychosocial – Conditions that can affect the thoughts, behaviour, and mental well-being of workers. Examples include stress from using equipment without proper training or instruction, or from being coerced into using defective tools or materials; burnout or depression from constant exposure to high-stress situations, etc.

It is important to consider all available information about the hazard. This includes all aspects of operations, including the physical components of equipment, the surrounding environment, foreseeable human factors (including misuse and worker shortcuts), cognitive limitations on the use of equipment or execution of the process, and all relevant phases of the process and/or operation. Information may also be available from Safety Data Sheet (SDS), manufacturers literature, information from reputable organizations, results of workplace sampling (e.g., direct, air, etc.), workplace inspection reports, records of workplace incidents, including information about the type and frequency of the occurrence, illnesses, injuries, near misses, interviewing workers, etc.

When identifying hazards, the assessor (i.e., the supervisor) must account for how a particular hazard may potentially harm a worker. For example, some of the factors that affect the degree of the hazard are:

- Amount (e.g., volume, concentration, intensity, etc.) of the hazard that can cause harm.
- Route of entry (e.g., inhalation, absorption, ingestion, injection).
- Frequency and duration of exposure.
- Manner of interaction.

The supervisor must also consider the potential combination of hazards and how they might interact and affect each other, which may create an entirely different hazard (e.g., $A + B = C$ rather than $A + B = AB$).

The faculty health, safety and risk managers can provide supervisors with additional hazard criteria for the specific situation.

Hazard Elimination

Once hazards have been identified, the preferred means of control is to eliminate the hazard. Only once hazards have been identified can action be taken to eliminate them. For the purposes of a risk assessment, it is assumed that when the hazard, or combination of hazards, is present, harm to a worker will eventually occur if measures are not taken to eliminate or further control the hazard(s). While the supervisor should strive to eliminate hazards to provide the greatest level of protection from harm, this is not always possible or reasonable. The level of acceptable risk is determined by analysing, then evaluating, risks. From this evaluation, the supervisor can identify and then apply the appropriate controls to mitigate the hazard.

Risk analysis

Risk analysis is the process of developing an understanding of the risk that helps to improve and focus the evaluation of the risk. The supervisor will likely identify multiple hazards; therefore, the risk of harm should be prioritized, namely by identifying the risks that have the greatest potential for harm and/or that are likely to occur most frequently. The supervisor should always prioritize action on situations involving dangerous circumstances, with work suspended until interim (or permanent) controls can be implemented.

The risk analysis should include:

- a description of the hazard or the hazardous situation;
- the methods of interaction, including the circumstances under which interaction with the hazard can occur. The supervisor can determine this by reviewing anticipated worker tasks, procedures, incident history, conducting observation tours, consulting with operators and other workers, etc.;
- the frequency and conditions of exposure to the hazard;
- the severity of a potential exposure;
- the duration of exposure to the hazard;
- the environment in which the work is conducted;
- the education and training workers have received;
- the method in which a reasonable person would react in a particular situation;

It is important to remember that the assessment must take into account not only the current state of the workplace but any potential situations as well.

The hazards and risk should be documented, with an example included below:

Task	Hazard	Risk	Probability	Severity	Risk Level
Delivering products to customers	Drivers work alone	May be unable to call for help if needed	2	3	6
	Driver occasionally have to work long hours	Fatigue, short rest time between shifts	3	4	12
	Drivers are often in congested traffic	Increased chance of collision. Longer working hours.	3	2	6
	Drivers must lift boxes when delivering products	Injury to back from lifting, reaching, carrying, etc.	4	3	12

A supervisor may use the following scales to complete the table and quantify probability and severity, thus reducing the subjective nature of the estimate. The corresponding value would be added to the risk identified based on the descriptor.

Probability	Value	Descriptor
Almost certain	5	Anticipated to occur <i>often</i> during entire project.
Likely	4	Anticipated to occur <i>several times</i> during entire project.
Possible	3	Reasonably anticipated to occur <i>at some time</i> during entire project.
Unlikely	2	Not anticipated to occur during entire project but <i>possible</i> .
Rare	1	<i>Not anticipated</i> during entire project.

Severity	Value	Descriptor
Catastrophic	5	Results in death, total loss or shutdown of system, significant release into the environment affecting the public or regulatory intervention.

Severity	Value	Descriptor
Major	4	Results in permanent impairment, serious lost-time injury, loss or shutdown of part of system, large on-site release into environment.
Moderate	3	Short-term lost-time injury, short-term interruption in use of system, recoverable release into environment.
Minor	2	Minor injury, minor damage to system, minor confined release into the environment.
Insignificant	1	Very minor injury, with consequence less serious than Minor .

Risk level is assessed as probability x severity; therefore, if a risk is **likely (4)** to occur and would result in **major (4)** consequences, that would yield a **risk level of 16**. In the truck driver example above, drivers frequently lift boxes (rated as 4) and are therefore exposed to injury (rated as 3) for a total risk level of 12.

The risk matrix below places the truck driver lifting boxes in the middle of the risk scale, meaning that further risk control is likely required. The greater the risk level, the greater the urgency and attention required to address the issue.

		Probability				
		Rare (1)	Unlikely (2)	Possible (3)	Likely (4)	Certain (5)
Severity	Insignificant (1)	1	2	3	4	5
	Minor (2)	2	4	6	8	10
	Moderate (3)	3	6	9	12	15
	Major (4)	4	8	12	16	20
	Catastrophic (5)	5	10	15	20	25

Table 1 - Risk Matrix

Risk Evaluation

Once risks have been analyzed and estimated, the supervisor can conduct a risk evaluation. The risk evaluation aims to formalize decisions about whether a particular work activity should be conducted, which risks need to be further controlled, and the priority for addressing the risks. The treatment of risks may fit into one of four categories:

- Avoidance – taking action to exit (or avoid) the activity that gives rise to the risk(s).
- Reduction – reducing the risk probability, consequence, or both.
- Transfer – reducing risk probability or consequence by transferring or sharing a portion of the risk.
- Acceptance – taking no action to affect probability or consequence.

The evaluation decision must be based on the individual situation, including the available risk controls in place.

Risk Control

Risk control actions follow a hierarchy, with the **elimination** of the hazard to the reasonable extent possible being the most preferred. If the hazard does not exist, it cannot cause harm. Where the removal of the hazard is not possible, **substitution** of the hazard with a less-hazardous alternative is the next best option.

Although eliminating the hazard is desirable, it is understood that work may need to involve hazardous materials or hazardous conditions; therefore, hazard elimination and substitution are not always feasible or realistic. Nonetheless, hazard controls still follow a hierarchy (refer to Figure 1). **Engineering controls**, or controls implemented at the source of the hazard, are the next most desirable and are typically the next most effective, as they usually do not require further intervention by the end user; the control exists indefinitely. Some examples of engineering controls include interlock devices, dual operation controls, fume hoods, etc.

If the implementation of engineering controls is not feasible or practical, the next-most-desirable control measures are **administrative controls**. In other words, the way the work is conducted is augmented or modified to reduce the extent of the hazard or exposure to it. Some examples of administrative controls include reducing the time that a worker is exposed to the hazard, changing the work practices, training programs, etc.

If none of the above hazard control options can be implemented, **personal protective equipment (PPE)** is a reasonable hazard control option. Remember that PPE does not actually remove or reduce the hazard – it only protects against the hazard for those individuals wearing properly selected and fitted PPE. As a result, PPE is the least-desired control method, although it can still be effective. Some examples of personal protective equipment are hearing protection, protective eyewear, fall arrest harnesses, respiratory protection, and protective footwear.

A combination of hazard control measures may be required to achieve a reasonable level of worker protection. For example, a worker conducting work inside a fume hood may also be required to wear respiratory protection due to the acute toxicity of certain hazardous substances. Regardless of the hazard control measure proposed, it must protect the worker and be reasonable.

It should be noted that hazard controls have the potential to fail – even under properly designed and implemented processes – or may even introduce new hazards. If the hazard control fails, it will be less effective in reducing the probability and/or severity of harm. When selecting risk controls, the failure or deterioration of hazard controls must be considered along with the possibility that the failure may introduce new hazards. Supervisors must regularly assess the effectiveness of hazard controls to ensure that they remain effective.

Figure 1 depicts the hierarchy of hazard controls.

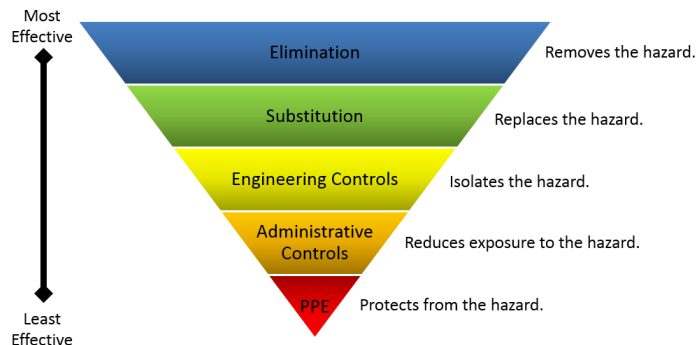


Figure 1 - Hierarchy of Hazard Control

Supervisor Tools

Supervisors have tools at their disposal to help them identify hazards and assess risks.

Job Safety Analysis (JSA)

A job safety analysis is a process that reviews job methods and uncovers hazards that may have been overlooked in the design and layout of a facility or building, and in the design of the machinery, equipment, tools, workstations, and processes. Additionally, hazards may have been created or developed after production, occupancy, or may have resulted and evolved from changes in work practices or personnel.¹ The major benefit of the JSA comes once it is complete: it clearly outlines the hazards and control measures of the activity, which can be easily communicated and shared with others performing the work.

The JSA provides supervisors with an opportunity to review work practices and the individual tasks conducted by those they supervise. Workers are encouraged to participate in the JSA process. For new personnel, there is no better guide for training than a well-prepared JSA.

A JSA involves the following steps:

- **Selecting the job.** Activities selected for a JSA are typically broad and encompass a multitude of steps or sequences that come together as part of a larger goal. Narrowly defined tasks are generally not suitable for a JSA. The job(s) selected should be those with potential for injury – either documented or speculative. Examples of factors to guide job selection include those that feature injury frequency (including no-lost time occurrences), potential incident severity, new processes, etc.
- **Breaking the job down into steps.** Once the job is selected, the job is broken down into a sequence of steps required to accomplish the goal. Each step describes the work done and is most often reviewed by an experienced and competent worker. The focus at this stage should be on what is done, not how it is done.
- **Identifying hazards and potential incident causes.** After listing the activity sequence, the supervisor identifies hazards (with how the work is done), including those directly related to the work and those related to the environment. The common question that should be asked at each stage of the job is “can an injury/illness occur”? If there is a hazard, the hazard category (e.g., chemical – contact with XYZ, exposure to ABC, etc.) should be documented. Once completed, the supervisor should revisit the hazards with the worker who was observed, as well as other personnel performing or familiar with the task, to ensure an accurate recording of the task.
- **Developing solutions and implementing corrective actions.** The last step of a JSA is to develop hazard control measures to eliminate or mitigate the hazards. Examples of controls may include physical barriers, a new way to perform the job, changing the conditions that created the hazard, reducing frequency or exposure to the hazard, providing protective equipment, etc. Each corrective action may introduce other, unintentional hazards that require their own controls, which is why the process must be reviewed regularly to ensure that control measures are suitable and reasonable.

A sample, blank JSA form is [available online](#).

¹ Accident Prevention Manual for Business and Industry – Administration and Programs. National Safety Council; pp. 207

Project Risk Assessment (PRA)

Much like operational work, a research project involves inherent risks. The project may be the first of its kind, may involve new components or steps, or may be upscaled or downscaled. The intent of the project risk assessment is like that of a job safety analysis; however, instead of focussing on the job or task, the PRA focusses on the steps and expected outcomes of the specific project. Like a JSA, the supervisor identifies the hazards at each step of the project, but also incorporates the probability of the hazard causing harm (assess the risk). The supervisor can then implement controls.

A sample PRA form is [available online](#).

Pre-Start Health and Safety Review (PSR)

A pre-start health and safety review is an in-depth examination of an apparatus, structure, protective element, or process identified in the table of Section 7 of *Regulation 851 – Industrial Establishments*. The PSR is undertaken to identify any existing or potential non-compliance with the applicable provisions of the regulation. PSRs apply to specific circumstances (i.e., those workplaces defined as *factories*) and ensure a timely, professional review that identifies specific hazards and ensures that such hazards are removed or controlled before the apparatus or process is started. PSRs are generally conducted by professional engineers, who produce formal reports outlining all areas of non-compliance. The report will include the measures necessary to achieve compliance.

The University of Ottawa is not a factory; however, in certain circumstances, it may prove beneficial to have an apparatus, structure, protective element or process undergo a pre-start health and safety review as a matter of due diligence.

You can find additional information on pre-start health and safety reviews in the Ministry of Labour, Training and Skills Development [Guidelines for Pre-Start Health and Safety Reviews](#) and from the faculty health, safety and risk manager or the Office of Risk Management.

Record Retention and Monitoring

All managers, supervisors, principal investigators and/or lab managers must maintain a record of their hazard identification and risk assessments, including those conducted in the formats described (e.g., job safety analysis, project risk assessments, etc.) or those conducted using alternate formats.

The supervisor is encouraged to share the completed hazard identification and risk assessment with their faculty health, safety and risk manager. Managers/supervisors must regularly review their assessments to ensure that it remains valid and appropriate for the circumstances.

Resources

Additional information is available from the following resources:

- [Canadian Centre for Occupational Health and Safety – Risk Assessment](#)
- *CSA Z1002-12 – Occupational Health and Safety – Hazard Identification and Elimination and Risk Assessment and Control* (available from the Office of Risk Management).
- *CSA 31000-10 – Risk Management – Principles and Guidelines* (available from the Office of Risk Management).

Definitions

Adapted from *CSA Z1002-12 – Occupational health and safety – Hazard identification and elimination and risk assessment and control*.

Competent person – means a person who,

- a) Is qualified because of knowledge, training, and experience to organize the work and its performance;
- b) Is familiar with this *Act* and the regulations that apply to the work; and
- c) Has knowledge of any potential or actual danger to health or safety in the workplace.

Dangerous circumstances – means a situation in which,

- a) a provision of the *Occupational Health and Safety Act* or related regulations is contravened;
- b) the contravention poses a danger or a hazard to a worker; and
- c) the danger or hazard is such that any delay in controlling it may seriously endanger a worker.

Hazard – the inherent property of something that may be a potential source of harm to a worker.

Hazard identification – the process of finding, listing, and characterizing hazards.

Risk – the combination of the likelihood of the occurrence of harm and the severity of that harm, commonly expressed as $\text{Risk} = \text{Likelihood} \times \text{Consequence}$

Risk analysis – a process for comprehending the nature of hazards and determining the level of risk

Risk assessment – the overall process of hazard identification, risk analysis, and risk evaluation

Risk estimation – a process used to assign values to the likelihood and consequences of a risk

Risk evaluation – the process of comparing an estimated risk against given risk criteria to determine the significance of the risk

Supervisor – means a person who has charge of a workplace or authority over a worker or another person. Depending on the workplace relationship, a supervisor may include, for example, the president, vice-presidents, directors, deans, managers or principal investigators. The determination as to whether a person is a supervisor does not depend on that person's job title. It depends on whether the person is responsible for a location (for example, an office or laboratory) where the work is performed on a paid or unpaid basis or whether the person gives direction to complete the work performed by workers, students, visitors, volunteers or learners.

Worker – means any of the following:

- A person who performs work or supplies services for monetary compensation. This means a University employee and includes a person who performs work or supplies services for monetary compensation. Students hired by the University to perform paid work-study program duties or co-operative education placement duties for the University are considered workers

- A high school student who performs work or supplies services for no monetary compensation under a work experience program authorized by the school board that operates the school in which the student is enrolled
- A person who performs work or supplies services for no monetary compensation under a program approved by a college of applied arts and technology, university or other post-secondary institution.
- Such other persons as may be prescribed who perform work or supply services to an employer for no monetary compensation.