# Study unit 5: Risk Assessment

# Introduction

The terms "hazard" and "risk" are often used interchangeably. However, in terms of risk assessment, these are two very distinct terms. A hazard is any agent that can cause harm or damage to humans, property, or the environment. Risk is defined as *the probability that exposure to a hazard will lead to a negative consequence***,** or more simply, a hazard poses no risk if there is no exposure to that hazard. An acceptable risk is a risk that is understood and tolerated usually because the cost or difficulty of implementing an effective countermeasure for the associated vulnerability exceeds the expectation of loss. "Health risk assessment" includes variations, such as the type and severity of response, with or without a probabilistic context.

# Learning Outcomes of Study Unit 5

By the end of this topic you should be able to:

5.1 Explain the concept of risk assessment

5.2 Identify different types of Risk Assessment

5.3 Discuss the importance of Risk assessment

5.4 Explain how assessment is done

5.5 Give the considerations in Risk assessment

5.6 Examine the ways of preventing and control of Hazards

## 5.1 The Concept of Risk Assessment

Risk assessment is a term used to describe the overall process or method where you:

* Identify hazards and risk factors that have the potential to cause harm (hazard identification).
* Analyze and evaluate the risk associated with that hazard (risk analysis, and risk evaluation).
* Determine appropriate ways to eliminate the hazard, or control the risk when the hazard cannot be eliminated (risk control).

Risk assessment consists of an objective evaluation of risk in which assumptions and uncertainties are clearly considered and presented. Part of the difficulty in risk management is that both the quantities by which risk assessment is concerned – *potential loss and probability of occurrence* – can be very difficult to measure. The chance of error in measuring these two concepts is high. Risk with a large potential loss and a low probability of occurrence is often treated differently from one with a low potential loss and a high likelihood of occurrence.

The first step in risk assessment is to establish the context this restricts the range of hazards to be considered. This is followed by identification of visible and implied hazards that may threaten the project, and determining the qualitative nature of the potential adverse consequences of each hazard. Without a potential adverse consequence, there is no hazard.

It is also necessary to identify the potential parties or assets which may be affected by the threat and the potential consequences to them if the hazard is activated.

If the consequences are dependent on dose, that is to say the amount of exposure, the relationship between dose and severity of consequence must be established, and the risk depends on the probable dose, which may depend on concentration or amplitude and duration or frequency of exposure. This is the general case for many health hazards where the mechanism of injury is toxicity or repetitive injury, particularly where the effect is cumulative.

For other hazards, the consequences may either occur or not, and the severity may be extremely variable even when the triggering conditions are the same. This is typical of many biological hazards as well as a large range of safety hazards. Exposure to a pathogen may or may not result in actual infection, and the consequences of infection may also be variable. Similarly a fall from the same place may result in minor injury or death, depending on unpredictable details. In these cases estimates must be made of reasonably likely consequences and associated probability of occurrence.

In cases where statistical records are available they may be used to evaluate risk, but in many cases there are no data or insufficient data available to be useful. Mathematical or experimental models may provide useful input.

Box 5.1: Risk Assessment

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

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

**Risk analysis** – a process for comprehending the nature of hazards and determining the level of risk. Notes:

(1) Risk analysis provides a basis for risk evaluation and decisions about risk control.

(2) Information can include current and historical data, theoretical analysis, informed opinions, and the concerns of stakeholders.

(3) Risk analysis includes risk estimation.

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

**Risk control** – actions implementing risk evaluation decisions.

Note: Risk control can involve monitoring, re-evaluation, and compliance with decisions.

## 5.2 Types of Risk Assessment

**1. Qualitative Risk Assessment**

This type of assessment is based on the personal judgment and expertise of the assessor. They will often use their own experience, but will also consult with others carrying out the activity and best practice guidance to reach their decisions. A qualitative risk assessment should be a systematic examination of what in the workplace could cause harm to people, so that decisions can be made as to whether existing precautions or control measures are adequate or whether more needs to be done to prevent harm.

A qualitative risk assessment will look at the risk of somebody being injured, and if that is high, medium or low. Just like any other type of risk assessment, any high risks will need to be addressed as a priority. Low-level risks can be looked at later, or might not need further action to be taken.

*Risk = Severity x Likelihood*

**2. Quantitative Risk Assessment**

The quantitative risk assessment is used to measure risk by assigning a numerical value. This type of risk assessment will more likely be used with major hazards, like aircraft design, complex chemical or nuclear plants.

Quantities measured could be the presence of hazards from chemicals or machinery for example, or modelling techniques and estimates.

In carrying out quantitative risk assessments, special quantitative tools and techniques will be used for hazard identification, and to estimate the severity of the consequences and the likelihood of realization of the hazards.

**3. Generic Risk Assessment**

This type of risk assessment will consider the hazards for an activity in a single assessment, where that activity may be carried out across different areas of the workplace or different sites.

A generic risk assessment will often be used for similar activities or equipment across different sites, departments or companies. It can act as a risk assessment template, covering the types of hazards and risks that are usually present for the activity.

## 5.3 Importance of Risk Assessment

Risk assessments are very important as they form an integral part of an occupational health and safety management plan. They help to:

* Create awareness of hazards and risk.
* Identify who may be at risk (e.g., employees, cleaners, visitors, contractors, the public, etc.).
* Determine whether a control program is required for a particular hazard.
* Determine if existing control measures are adequate or if more should be done.
* Prevent injuries or illnesses, especially when done at the design or planning stage.
* Prioritize hazards and control measures.
* Meet legal requirements where applicable.

Assessments should be done by a competent person or team of individuals who have a good working knowledge of the situation being studied. Include either on the team or as sources of information, the supervisors and workers who work with the process under review as these individuals are the most familiar with the operation.

## 5.4 Procedures or Process of Risk Assessment

* Identify hazards.
* Determine the likelihood of harm, such as an injury or illness occurring, and its severity.
* Consider normal operational situations as well as non-standard events such as maintenance, shutdowns, power outages, emergencies, extreme weather, etc.
* Review all available health and safety information about the hazard such as Safety Data Sheet (SDS), manufacturers literature, information from reputable organizations, results of testing, workplace inspection reports, records of workplace incidents (accidents), including information about the type and frequency of the occurrence, illnesses, injuries, near misses, etc.
* Understand the minimum legislated requirements for your jurisdiction.
* Identify actions necessary to eliminate the hazard, or control the risk using the hierarchy of risk control methods.
* Evaluate to confirm if the hazard has been eliminated or if the risk is appropriately controlled.
* Monitor to make sure the control continues to be effective.
* Keep any documents or records that may be necessary. Documentation may include detailing the process used to assess the risk, outlining any evaluations, or detailing how conclusions were made.

## 5.5 Considerations for Risk Assessment and Management

* The methods and procedures used in the processing, use, handling or storage of the substance, etc.
* The actual and the potential exposure of workers (e.g., how many workers may be exposed, what that exposure is/will be, and how often they will be exposed).
* The measures and procedures necessary to control such exposure by means of engineering controls, work practices, and hygiene practices and facilities.
* The duration and frequency of the task (how long and how often a task is done).
* The location where the task is done.
* The machinery, tools, materials, etc. that are used in the operation and how they are used (e.g., the physical state of a chemical, or lifting heavy loads for a distance).
* Any possible interactions with other activities in the area and if the task could affect others (e.g., cleaners, visitors, etc.).
* The lifecycle of the product, process or service (e.g., design, construction, uses, decommissioning).
* The education and training the workers have received.
* How a person would react in a particular situation (e.g., what would be the most common reaction by a person if the machine failed or malfunctioned).

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.

By determining the level of risk associated with the hazard, the employer, and the health and safety committee (where appropriate), can decide whether a control program is required and to what level.

## 5.6 Hazard Prevention and Control

Effective controls protect workers from workplace hazards; help avoid injuries, illnesses, and incidents; minimize or eliminate safety and health risks; and help employers provide workers with safe and healthful working conditions. *To effectively control and prevent hazards, employers should:*

* Involve workers, who often have the best understanding of the conditions that create hazards and insights into how they can be controlled.
* Identify and evaluate options for controlling hazards, using a "hierarchy of controls."
* Use a hazard control plan to guide the selection and implementation of controls, and implement controls according to the plan.
* Develop plans with measures to protect workers during emergencies and non-routine activities.
* Evaluate the effectiveness of existing controls to determine whether they continue to provide protection, or whether different controls may be more effective. Review new technologies for their potential to be more protective, more reliable, or less costly.

### 5.6.1 Specific Hazard Control and Investigative Process

***Action item 1: Identify control options***

A wealth of information exists to help employers investigate options for controlling identified hazards. Before selecting any control options, it is essential to solicit workers' input on their feasibility and effectiveness.

How to accomplish it

Collect, organize, and review information with workers to determine what types of hazards may be present and which workers may be exposed or potentially exposed. Information available in the workplace may include:

* Review sources such as OSHA standards and guidance, industry consensus standards, National Institute for Occupational Safety and Health (NIOSH) publications, manufacturers' literature, and engineering reports to identify potential control measures. Keep current on relevant information from trade or professional associations.
* Investigate control measures used in other workplaces and determine whether they would be effective at your workplace.
* Get input from workers who may be able to suggest and evaluate solutions based on their knowledge of the facility, equipment, and work processes.
* For complex hazards, consult with safety and health experts, including OSHA's On-site Consultation Program.

***Action item 2: Select controls***

Employers should select the controls that are the most feasible, effective, and permanent.

How to accomplish it

* Eliminate or control all serious hazards (hazards that are causing or are likely to cause death or serious physical harm) immediately.
* Use interim controls while you develop and implement longer-term solutions.
* Select controls according to a hierarchy that emphasizes engineering solutions (including elimination or substitution) first, followed by safe work practices, administrative controls, and finally personal protective equipment.
* Avoid selecting controls that may directly or indirectly introduce new hazards. Examples include exhausting contaminated air into occupied work spaces or using hearing protection that makes it difficult to hear backup alarms.
* Review and discuss control options with workers to ensure that controls are feasible and effective.
* Use a combination of control options when no single method fully protects workers.

***Action item 3: Develop and update a hazard control plan***

A hazard control plan describes how the selected controls will be implemented. An effective plan will address serious hazards first. Interim controls may be necessary, but the overall goal is to ensure effective long-term control of hazards. It is important to track progress toward completing the control plan and periodically (at least annually and when conditions, processes or equipment change) verify that controls remain effective.

How to accomplish it

* List the hazards needing controls in order of priority.
* Assign responsibility for installing or implementing the controls to a specific person or persons with the power or ability to implement the controls.
* Establish a target completion date.
* Plan how you will track progress toward completion.
* Plan how you will verify the effectiveness of controls after they are installed or implemented.

***Action item 4: Select controls to protect workers during no routine operations and emergencies***

The hazard control plan should include provisions to protect workers during non-routine operations and foreseeable emergencies. Depending on your workplace, these could include fires and explosions; chemical releases; hazardous material spills; unplanned equipment shutdowns; infrequent maintenance activities; natural and weather disasters; workplace violence; terrorist or criminal attacks; disease outbreaks (e.g., pandemic influenza); or medical emergencies. *Non routine tasks, or tasks workers don't normally do, should be approached with particular caution*. Prior to initiating such work, review job hazard analyses and job safety analyses with any workers involved and notify others about the nature of the work, work schedule, and any necessary precautions.

How to accomplish it

* Develop procedures to control hazards that may arise during non-routine operations (e.g., removing machine guarding during maintenance and repair).
* Develop or modify plans to control hazards that may arise in emergency situations.
* Procure any equipment needed to control emergency-related hazards.
* Assign responsibilities for implementing the emergency plan.
* Conduct emergency drills to ensure that procedures and equipment provide adequate protection during emergency situations.

**Action item 5: Implement selected controls in the workplace**

Once hazard prevention and control measures have been identified, they should be implemented according to the hazard control plan.

How to accomplish it

* Implement hazard control measures according to the priorities established in the hazard control plan.
* When resources are limited, implement measures on a "worst-first" basis, according to the hazard ranking priorities (risk) established during hazard identification and assessment. (Note, however, that regardless of limited resources, employers have an obligation to protect workers from recognized, serious hazards.)
* Promptly implement any measures that are easy and inexpensive—e.g., general housekeeping, removal of obvious tripping hazards such as electrical cords, basic lighting—regardless of the level of hazard they involve.

***Action item 6: Follow up to confirm that controls are effective***

To ensure that control measures are and remain effective, employers should track progress in implementing controls, inspect and evaluate controls once they are installed, and follow routine preventive maintenance practices.

How to accomplish it

Track progress and verify implementation by asking the following questions:

* Have all control measures been implemented according to the hazard control plan?
* Have engineering controls been properly installed and tested?
* Have workers been appropriately trained so that they understand the controls, including how to operate engineering controls, safe work practices, and PPE use requirements?
* Are controls being used correctly and consistently?
* Conduct regular inspections (and industrial hygiene monitoring, if indicated) to confirm that engineering controls are operating as designed.
* Evaluate control measures to determine if they are effective or need to be modified. Involve workers in the evaluation of the controls. If controls are not effective, identify, select, and implement further control measures that will provide adequate protection.
* Confirm that work practices, administrative controls, and personal protective equipment use policies are being followed.
* Conduct routine preventive maintenance of equipment, facilities, and controls to help prevent incidents due to equipment failure.

### 5.6.2 Hazard Control Program

 A hazard control program consists of all steps necessary to protect workers from exposure to a substance or system, the training and the procedures required to monitor worker exposure and their health to hazards such as chemicals, materials or substance, or other types of hazards such as noise and vibration. A written workplace hazard control program should outline which methods are being used to control the exposure and how these controls will be monitored for effectiveness



**Figure 5.1: Hierarchy of Control**

**Source:** [**https://www.safetyandhealthmagazine.com/articles/16790-the-hierarchy-of-controls**](https://www.safetyandhealthmagazine.com/articles/16790-the-hierarchy-of-controls)

**CONTROL METHODS**

***1. ELIMINATION***

Elimination is the process of removing the hazard from the workplace. It is the most effective way to control a risk because the hazard is no longer present. It is the preferred way to control a hazard and should be used whenever possible. For example, if employees must work high above the ground, the hazard can be eliminated by moving the piece they are working on to ground level to eliminate the need to work at heights.

***2. SUBSTITUTION***

Substitution occurs when a new chemical or substance that is less hazardous is used instead of another chemical. It is sometimes grouped with elimination because, in effect, you are removing the first substance or hazard from the workplace. The goal, obviously, is to choose a new chemical that is less hazardous than the original, for example, replacing lead-based paint with titanium white. To be an effective control, the new product must not produce another hazard. Because airborne dust can be hazardous, if a product can be purchased with a larger particle size, the smaller product may effectively be substituted with the larger product.

***3. ENGINEERING CONTROLS***

Engineering controls are methods that are built into the design of a plant, equipment or process to minimize the hazard. Engineering controls are a very reliable way to control worker exposures as long as the controls are designed, used and maintained properly. The basic types of engineering controls are:

* Process control.
* Enclosure and/or isolation of emission source.
* Ventilation.

Process Control

Process control involves changing the way a job activity or process is done to reduce the risk. Monitoring should be done before and as well as after the change is implemented to make sure the changes did result in lower exposures.

Examples of process changes include to:

* Use wet methods rather than dry when drilling or grinding. "Wet method" means that water is sprayed over a dusty surface to keep dust levels down or material is mixed with water to prevent dust from being created.
* Use electric motors rather than diesel ones to eliminate diesel exhaust emissions.
* Instead of conventional spray painting, try to dip, paint with a brush, or use "airless" spray paint methods. These methods will reduce the amount of paint that is released into the air.
* Decrease the temperature of a process so that less vapor is released.
* Use automation - the less workers have to handle or use the materials, the less potential there is for exposure.
* Use mechanical transportation rather than manual methods.

Enclosure and Isolation

These methods aim to keep the chemical "in" and the worker "out" (or vice versa).

*An enclosure* keeps a selected hazard "physically" away from the worker. Enclosed equipment, for example, is tightly sealed and it is typically only opened for cleaning or maintenance. Other examples include "glove boxes" (where a chemical is in a ventilated and enclosed space and the employee works with the material by using gloves that are built in), abrasive blasting cabinets, or remote-control devices. Care must be taken when the enclosure is opened for maintenance as exposure could occur if adequate precautions are not taken. The enclosure itself must be well maintained to prevent leaks.

*Isolation* places the hazardous process "geographically" away from the majority of the workers. Common isolation techniques are to create a contaminant-free booth either around the equipment or around the employee workstations.

Ventilation

Ventilation is a method of control that strategically "adds" and "removes" air in the work environment. Ventilation can remove or dilute an air contaminant if designed properly. Local exhaust ventilation is very adaptable to almost all chemicals and operations. It removes the contaminant at the source so it cannot disperse into the work space and it generally uses lower exhaust rates than general ventilation (general ventilation usually exchanges air in the entire room).

***4. ADMINISTRTIVE CONTROLS***

Administrative controls limit workers' exposures by scheduling shorter work times in contaminant areas or by implementing other "rules". These control measures have many limitations because the hazard itself is not actually removed or reduced. Administrative controls are not generally favored because they can be difficult to implement, maintain and are not a reliable way to reduce exposure. When necessary, methods of administrative control include:

Work Schedule

* Scheduling maintenance and other high exposure operations for times when few workers are present (such as evenings, weekends).
* Using job-rotation schedules that limit the amount of time an individual worker is exposed to a substance.
* Using a work-rest schedule that limits the length of time a worker is exposed to a hazard.

Work Practices

Work practices are also a form of administrative controls. In most workplaces, even if there are well designed and well-maintained engineering controls present, safe work practices are very important. Some elements of safe work practices include:

* Developing and implementing standard operating procedures.
* Training and education of employees about the operating procedures as well as another necessary workplace training
* Establishing and maintaining good housekeeping programs.
* Keeping equipment well maintained.
* Preparing and training for emergency response for incidents such as spills, fire or employee injury.

Education and Training

Employee education and training on how to conduct their work safely helps to minimize the risk of exposure and is a critical element of any complete workplace health and safety program. Training must cover not only how to do the job safely but it must also ensure that workers understand the hazards and risks of their job. It must also provide them with information on how to protect themselves and co-workers.

Good Housekeeping

Good housekeeping is essential to prevent the accumulation of hazardous or toxic materials (e.g., build-up of dust or contaminant on ledges, or beams), or hazardous conditions (e.g., poor stockpiling).

Personal Hygiene Practices and Facilities

Personal hygiene practices are another effective way to reduce the amount of a hazardous material absorbed, ingested or inhaled by a worker. They are particularly effective if the contaminant(s) can accumulate on the skin, clothing or hair.

Examples of personal hygiene practices include:

* Washing hands after handling material and before eating, drinking or smoking.
* Avoiding touching lips, nose and eyes with contaminated hands.
* No smoking, drinking, chewing gum or eating in the work areas - these activities should be permitted only in a "clean" area.
* Not storing hazardous materials in the same refrigerator as food items.

***5. PERSONAL PROTECTIVE EQUIPMENT (PPE) CONTROLS***

 Personal protective equipment (PPE) includes items such as respirators, protective clothing such as gloves, face shields, eye protection, and footwear that serve to provide a barrier between the wearer and the chemical or material.

It is the final item on the list for a very good reason. Personal protective equipment should never be the only method used to reduce exposure except under very specific circumstances because PPE may "fail" (stop protecting the worker) with little or no warning. For example: "breakthrough" can occur with gloves, clothing, and respirator cartridges.