



Occupational Safety and Health in the Extractive Industry

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SAFETY TRAINING WITH
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¹ Faculty of Engineering of the University of Porto

² National Laboratory of Energy and Geology

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Work Safety and Safety Culture



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Chapter 1 — Work Safety and Safety Culture

[Chapter 2](#) [2.1.1](#) [2.1.8](#) [Chapter 3](#) [Chapter 5](#)

Chapter overview

The following overview presents the actual sequence of the chapter and the pedagogical function of each section.

Section	Pedagogical function
Before you begin	Clarify the guiding question, learning objectives, competences, key concepts and expected output.
Learning pathway	Explain the Learn–Observe–Decide–Apply–Communicate–Reflect pathway and the evidence to be collected.
Core technical content	Build a shared vocabulary, apply preventive principles to the mining context, and link control, culture and learning.
Apply — integrative activity	Analyse a dynamic-risk case and justify the preventive decision.
Quick self-assessment	Check understanding of the concepts and the ability to apply them.
Practical summary	Consolidate the essential principles and confirm the chapter's final output.

Before you begin

Guiding question ...

Why do occupational accidents and occupational diseases continue to occur when legislation, technology, training and safety procedures are already in place?

Learning objectives

- Distinguish between accidents, incidents and near misses, recognising their preventive value.
- Distinguish between hazard, risk, triggering event, exposure, consequence and control measure.
- Interpret basic occupational accident indicators and understand the difference between reactive and proactive indicators.
- Recognise principles of safety culture, reporting and recording, and preventive behaviour.
- Recognise that some safety risks are linked to occupational hygiene risks, with the detailed study of agents provided in [Chapter 2 — Fundamentals of Occupational Hygiene](#).
- Relate occupational safety risks, safety culture, and reporting and recording to typical tasks in the extractive industry.
- Apply the hierarchy of controls to simple situations, prioritising collective protective measures and elimination at source.

Competences to be developed

- Observe a work situation and identify unsafe conditions.
- Report a hazard objectively: what was observed, where it occurred, what the risk is and what immediate action is required.
- Select preventive measures proportionate to the risk.
- Use checklists, simple matrices and structured records to support risk assessment.
- Work as part of a group to analyse an occupational task and propose improvements.

Expected output

By the end of the chapter, the learner should produce a structured preventive analysis of a situation in the extractive industry, identifying the hazard, exposure, triggering event, risk, consequences, control measures, preventive decision, required reporting and evidence to be recorded in the digital portfolio.

Key concepts

Concept	Operational definition for this chapter
Incident	A work-related occurrence that caused or could have caused injury, ill health or other harm.
Accident	An incident that results in harm. When the harm affects a person, classification as an occupational accident must comply with the legislation applicable in the country concerned.
Near miss	An incident that caused no harm but had the potential to do so.
Hazard	A source, condition or situation with the potential to cause harm.
Triggering event	An event, failure or change in conditions that may cause a hazard to materialise and give rise to an occurrence.
Risk	The combination of the probability of an event occurring and the severity of its consequences.
Exposure	Contact between a worker and a hazard, with varying intensity, frequency and duration.
Control	A measure intended to eliminate the hazard or reduce the risk.
Personal protective equipment (PPE) / collective protective measures	Personal protective equipment / collective protective measures.

Learning pathway

Stage	What the learner does	Resources
Learn	Reads essential concepts on occupational safety, safety culture, reporting and recording, and control.	Core text, glossary and summaries.
Observe	Analyses examples, images, videos, practical cases and simulated situations.	Task descriptions.
Decide	Classifies situations, identifies hazards, selects control measures and prioritises risks.	Guiding questions and mini-activities.
Apply	Completes checklists, calculates simple indicators, analyses a task and prepares an improvement proposal.	Worksheets, risk matrix and group work.
Communicate	Reports hazards, occurrences, decisions and measures objectively.	Structured records, a brief safety meeting and the digital portfolio.
Reflect	Records what has been learned, justifies decisions and identifies areas for improvement.	Forum and digital portfolio.

Guidance for independent study

To support the observation, reporting and recording of hazards or occurrences, use the form provided in [A.1 — Reporting and analysis of a hazard or occurrence](#). The activities, examples and self-assessment items specific to this chapter remain integrated into the following sections.

1.1 Safety and safety culture

1.1.1 Purposes of Occupational Safety and Health

The primary purpose of Occupational Safety and Health (OSH) is to protect workers' lives, health, and physical and mental integrity by preventing accidents, occupational diseases and other forms of harm associated with work. This purpose is not limited to individual protection; it also encompasses work organisation, equipment safety, the adequacy of procedures, the quality of the working environment, the protection of facilities, and the prevention of property or environmental damage.

In the extractive industry, this approach is particularly important because workers may be exposed to hazards associated with working faces, benches, mobile equipment traffic, slope instability, mineral dust, noise, vibration, maintenance, storage, laboratory work, adverse weather conditions, and the continuous interaction between people, machines and the natural environment. Occupational Safety and Health should therefore be understood as an integral part of the management of mining operations, rather than merely as compliance with rules or legal obligations.

The prevention of occupational accidents seeks to avoid sudden and undesirable events that may cause injury, death, property damage, production disruption or environmental impacts. This requires hazards to be identified, risks assessed, control measures defined, workers trained, task performance monitored, and hazardous situations corrected before they cause harm. Effective prevention acts before an occurrence, not only after an accident.

The prevention of occupational diseases requires equally systematic attention, often over an extended period. Unlike accidents, which tend to be immediate and visible, many occupational diseases result from repeated or prolonged exposure to chemical, physical, biological, ergonomic or psychosocial agents. Exposure to mineral dust, noise, vibration, hazardous substances, awkward postures or demanding work rates may produce effects that only become apparent after months or years. Occupational hygiene, health surveillance, exposure assessment and control of the agents present in the working environment are therefore essential.

Occupational Safety and Health also helps to prevent property and environmental damage. An accident may affect equipment, traffic routes, facilities, storage areas or processing systems. It may also cause spills, fires, emissions, contamination of soil or water, and impacts on surrounding communities.

Summary

The field of OSH performs preventive, technical, organisational, human and environmental functions. Its aim is to ensure that work is carried out under safe and healthy conditions, reducing accidents, occupational diseases, property damage and environmental impacts. This requires an active safety culture based on hazard identification, risk communication, worker participation and the continuous improvement of working conditions. These purposes are summarised in Figure 1.1.

Problems for reflection and self-assessment

Problem 1.1 — Production cannot stop

At a quarry, the production team identifies potholes, heavy dust and reduced visibility on a traffic route near an area used by mining haul trucks and light vehicles. Management acknowledges the problem but decides to defer action because “production cannot stop”. Two days later, a light vehicle nearly collides with a mining haul truck on a bend with poor visibility.

Self-assessment questions

Which purposes of Occupational Safety and Health are at stake in this situation?

- Does the situation described involve only risk to workers, or also potential property and environmental damage?
- What preventive measures could have been implemented before the near miss?
- Is the argument that “production cannot stop” compatible with an effective safety culture? Justify your answer.

- What evidence should have been recorded to support the decision to intervene on the traffic route?



Figure 1.1 - Purposes of Occupational Safety and Health: protecting people, preventing accidents and occupational diseases, controlling property and environmental damage, and promoting continuous improvement

Activity 1.1 — Individual exercise

Choose a real or simulated situation from a mine, quarry, laboratory, warehouse, maintenance workshop or crushing plant. Describe it in 8 to 10 lines and answer the following questions:

- What hazards are present?
- What harm to people, property or the environment could occur?
- What measures are already in place to control those hazards?
- What additional measures could be implemented?
- What evidence should be recorded to demonstrate that the situation was analysed?
- What is the main lesson you draw from this situation?

1.1.2 Accidents, incidents and near misses

In Occupational Safety and Health, an incident is a work-related occurrence that caused or could have caused harm. For the purposes of this chapter, accidents and near misses are two forms of incident: harm occurs in an accident; no harm occurs in a near miss, although there is the potential for it to occur.

An accident may affect people, equipment, facilities, materials, the environment or continuity of operations. When harm affects a worker, classification as an occupational accident must comply with the applicable legislation. An occurrence involving only property or environmental damage should be identified more precisely as an operational accident or a damage-causing incident.

For example, if a worker slips in a traffic area and sustains a fracture, this is an occupational accident. If a wheel loader collides with a light vehicle and causes property damage, even when no one is injured, the occurrence should also be treated as an accident. Likewise, a spill of a hazardous substance that reaches a drainage area is an occurrence with environmental impact and must be recorded, analysed and corrected.

An incident is an unplanned event that reveals a failure in safety conditions, procedures, equipment or work organisation. It may or may not cause harm. An incident should therefore be regarded as a warning sign,

because it shows that the prevention system did not function fully. In many contexts, the term incident is used broadly to include accidents and near misses, because all of them represent deviations from expected safe operation.

For example, the sudden stopping of a conveyor belt because of a maintenance failure, a person entering an mobile equipment traffic zone without authorisation, the detection of a removed machine guard, or a falling tool that strikes no one are incidents that must be reported and analysed.

A near miss is an occurrence that could have caused injury, property damage or environmental impact but, through chance, rapid intervention or slight differences in circumstances, had no consequences. It is one of the most important sources of information for prevention because it shows that the hazard was present and that harm came close to occurring.

Examples of near misses include a rock becoming detached from a bench and falling near an access route; a mining haul truck passing too close to a pedestrian; a ladder losing stability without causing a fall; or a pressurised hose coming loose without striking anyone.

The essential difference is therefore as follows: an incident is the general category; an accident is an incident involving harm; and a near miss is an incident involving no harm but with the potential to cause it.

All incidents must be reported and recorded, with minimum information on what occurred, the location, the people or property exposed, the actual or potential consequences, and the immediate action taken. The preventive use of this information, trust in the reporting system, and just culture are addressed in **Safety culture, occurrence reporting and preventive behaviour**.

Figure 1.2 presents incident as the general category and distinguishes an accident, in which harm occurs, from a near miss, in which no harm occurs but there is the potential for it to occur.

Problems for reflection and self-assessment

Problem 1.2 — Rockfall near the access route

While a team is passing alongside a bench, a rock becomes detached and falls a few metres from the workers. No one is struck, but the rock crosses the route normally used to access the working face. Some colleagues comment that “nothing happened” and that the situation is not worth recording.

Self-assessment questions

Is this situation an accident or a near miss? Explain why, in either case, it belongs to the general category of incident.

- What harm could have occurred if a worker had been passing at the moment the rock fell?
- Why must this occurrence be reported and recorded, even though no one was injured?
- What minimum information should be recorded?
- What immediate measures could be taken to prevent recurrence?

Problem 1.3 — Near miss involving a pedestrian in the loading area

During loading operations, a worker crosses a manoeuvring area without confirming visual contact with the wheel-loader operator. The operator brakes in time and there is no contact. The worker says that “it was only a scare”.

Self-assessment questions

- Should this situation be treated as a near miss? Why?
- What event could have turned this occurrence into a serious accident?
- What communication or organisational failures may be involved?
- What preventive measures could be implemented at the location?
- Why is reporting and recording this near miss important for the whole team?

ACCIDENT, INCIDENT AND NEAR MISS

ACCIDENT



Damage has occurred.

INCIDENT



There is a deviation or safety failure.

NEAR MISS



No damage occurred, but there was potential for a serious accident.



All must be **reported** to learn and prevent.

Figure 1.2 — Relationship between incident, accident and near miss

Activity 1.2 — Individual exercise

Choose a real, observed or simulated occurrence in a mine, quarry, laboratory, workshop, warehouse or traffic area. Describe the occurrence in 8 to 10 lines and answer the following questions:

- What happened?
- Where and when did it happen?
- Should the occurrence be classified as an accident, incident or near miss?
- Was there any harm? If so, what type of harm?
- If there was no harm, what consequences could have occurred?
- What hazard was present?
- Who or what was exposed?
- What immediate action should be taken?
- What preventive measures could prevent recurrence?
- What is the main lesson that should be drawn from this situation?

1.1.3 Hazard, risk, exposure, triggering event and consequence

Risk assessment requires an understanding of the relationship between five fundamental concepts: hazard, risk, exposure, triggering event and consequence. These concepts form part of the same preventive analysis chain and help explain how a work situation may cause harm.

A hazard is any source, situation, condition, substance, form of energy, item of equipment, behaviour or characteristic of the working environment with the potential to cause injury, disease, property damage or

environmental impact. Examples of hazards include an unstable bench, a moving machine, an electrical installation in poor condition, mineral dust, high noise levels, a flammable substance, a damaged ladder, or a traffic route with no separation between equipment and pedestrians.

Exposure occurs when a person, item of equipment, facility or environmental receptor is in contact with a hazard or within its area of influence. A hazard may exist without creating significant risk if there is no exposure. For example, an unstable working face is a hazard. If the area is restricted, signposted and free from workers or equipment, exposure is low. If there is traffic near the base of the face, exposure increases and the risk becomes more significant.

A triggering event is an event, failure or change in conditions that allows the hazard to materialise and give rise to an occurrence. On an unstable bench, it may be heavy rain, vibration generated by equipment, or a progressive loss of stability because scaling has not been carried out. Improper entry into the rockfall zone does not trigger instability; it increases the exposure of people and equipment to its consequences. In an area containing fuel, the triggering event may be an ignition source, a spill or a containment failure.

Risk results from the combination of the likelihood of a hazardous event occurring and the severity of its consequences. Risk is therefore not the same as hazard. It depends on the existing hazard, exposure, the possibility of a triggering event occurring, and the severity of the expected harm. For example, the noise generated by a crusher is a hazard. The risk depends on the noise level, exposure duration, distance from the source, the control measures in place, and the effective use of hearing protection.

A consequence is the harm or effect that may result if the risk materialises. It may take different forms: minor injury, serious injury, death, occupational disease, disability, damage to equipment, production disruption, fire, explosion, environmental contamination or impact on communities. Rockfall may cause crushing injuries, fractures, death, damage to machinery or blockage of the working face. Prolonged exposure to mineral dust may cause chronic respiratory disease.

These concepts must be analysed together. There is a hazard; someone or something becomes exposed; a triggering event may occur; the combination gives rise to a risk; and, if the risk materialises, consequences arise. This sequence shows where prevention can intervene: eliminating the hazard, reducing exposure, preventing the triggering event, reducing the likelihood of occurrence, or reducing the severity of the consequences.

For example, at a working face, the hazard may be an unstable face; exposure occurs when workers or equipment remain in the rockfall zone; the triggering event may be vibration from a machine or heavy rainfall; the risk is blocks falling onto people or equipment; and the consequence may be serious injury, death or property damage. Preventive measures may include inspections, face scaling, restricting access, signage, keeping workers away, and access control.

Context note

In this e-book, risk is addressed as it applies to Occupational Safety and Health, primarily as the possibility of harm resulting from exposure to a hazard. According to ISO 31000, risk can be understood more broadly as the effect of uncertainty on objectives. The assessment should therefore consider not only immediate injuries or damage, but also operational, environmental, legal and organisational objectives.

Summary

A hazard indicates the source of harm; exposure indicates contact with that source; the triggering event explains how the occurrence may begin; risk expresses the likelihood and severity of harm; and the consequence describes the possible outcome. The integration of these concepts forms the basis of risk assessment and preventive decision-making. [Figure 1.3](#) summarises this analysis chain and the main points for preventive intervention.

Problems for reflection and self-assessment

Problem 1.4 — Unstable working face

Before work starts, an operator observes recent cracks in a working face. The area has not yet been signposted, and a wheel loader is scheduled to operate near the base of the face. During the morning, it starts to rain.

Self-assessment questions

- What is the main hazard in this situation?
- Who or what is exposed to the hazard?
- What triggering event could turn this situation into an occurrence?
- What is the specific risk?
- What consequences may result if the risk materialises?
- What preventive measures could reduce exposure?
- What immediate action should be taken before work starts?

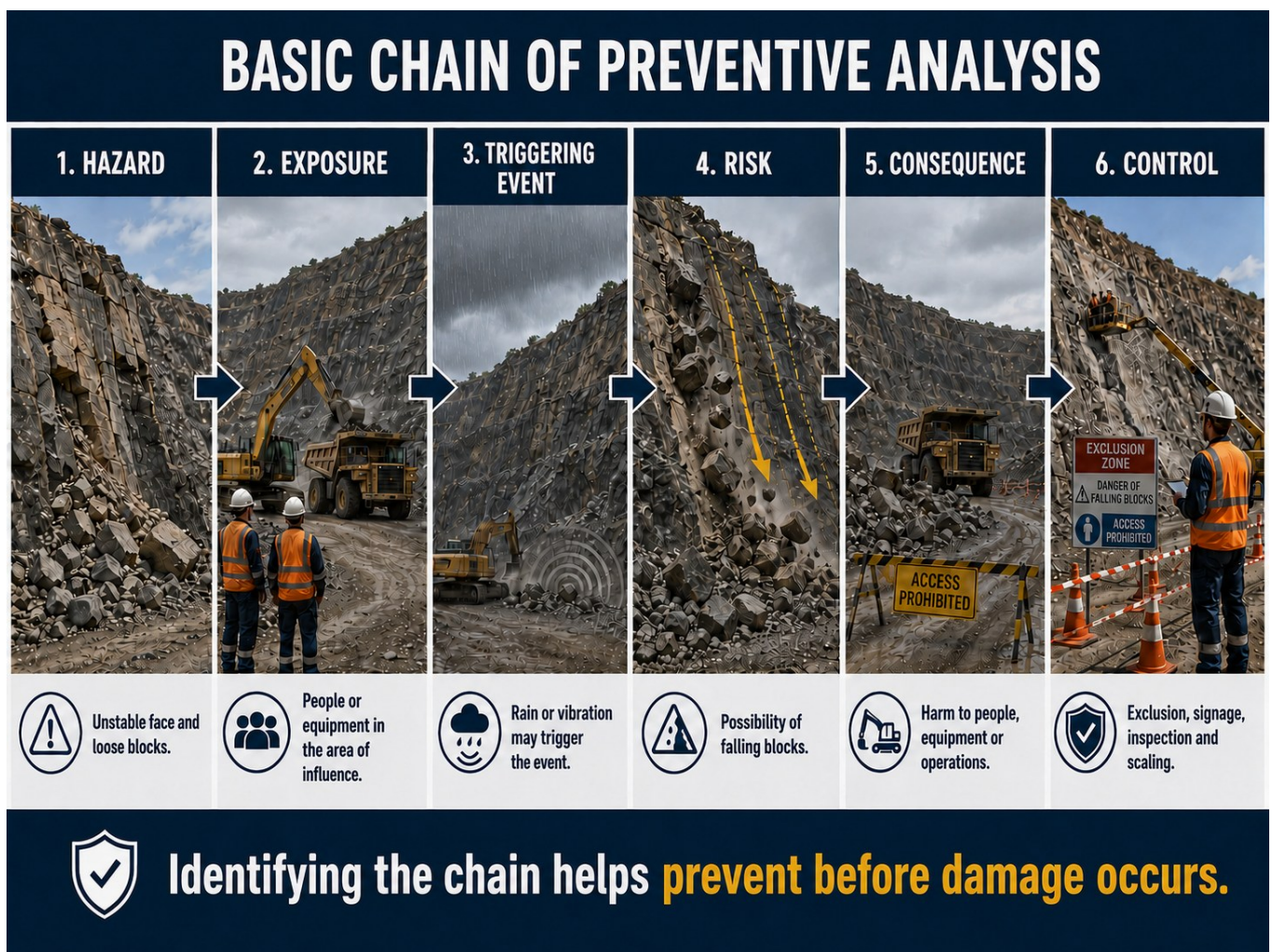


Figure 1.3 — Hazard–exposure–triggering event–risk–consequence–control chain

Activity 1.3 — Individual exercise

Choose a specific task in a mine, quarry, laboratory, warehouse, maintenance workshop or crushing plant. It may be a task that you have observed, experienced or encountered in the course.

Complete the following analysis:

- Task or situation analysed:

- Location:
- Hazard identified:
- Who or what is exposed:
- Possible triggering event:
- Associated risk:
- Foreseeable consequence:
- Existing preventive measure:
- Additional preventive measure proposed:
- Which element of the preventive chain was most important to control in this situation?

1.1.4 Unsafe acts, unsafe conditions, active failures and latent conditions

When analysing accidents, incidents and near misses, it is useful to distinguish between unsafe acts, unsafe conditions, active failures and latent conditions. These concepts help to explain why an occurrence rarely results from a single cause. In most cases, an accident arises from a combination of behaviours, workplace conditions, technical failures, inadequate procedures, training deficiencies, insufficient supervision and organisational weaknesses.

An unsafe act is an action, omission or behaviour that increases the likelihood of harm occurring. It may result from lack of knowledge, overconfidence, haste, fatigue, pressure to meet production targets, insufficient training, lack of supervision or the normalisation of unsafe practices. Examples of unsafe acts include entering a restricted area, walking through an equipment movement area without authorisation, failing to use the specified PPE, removing a machine guard, operating equipment without authorisation, improvising tools or carrying out maintenance without locking out the energy sources.

An unsafe condition is a situation in the workplace with the potential to cause harm. It may be associated with the condition of equipment, facilities, traffic routes, signage, lighting, ventilation, spatial organisation, slope stability or work procedures. Examples include slippery floors, deteriorated roads, lack of segregation between equipment and pedestrians, unstable slopes, damaged ladders, removed guards, airborne dust, high noise levels, inadequate lighting, improper fuel storage or the absence of exclusion zones near working faces and benches.

The distinction between unsafe acts and unsafe conditions is important, but it should not lead to simplistic blaming of the worker. For example, if a worker does not use hearing protection, this may constitute an unsafe act; however, it is also necessary to determine whether the protectors were available and suitable, whether training had been provided, whether noise had been assessed and whether collective protective measures had been considered. Similarly, an unsafe equipment manoeuvre may be related to absent signage, poorly designed roads, production pressure or communication failures.

Active failures occur directly at the operational front line and have an immediate or almost immediate effect on safety. They are normally associated with operators, technicians, drivers, maintenance workers or supervisors at the time the task is performed. Examples include starting a machine without checking whether people are present in the hazard zone, failing to confirm energy isolation, failing to respect an exclusion zone, driving at excessive speed or starting a task without authorisation.

Latent conditions are deeper weaknesses in the work system, generally created by organisational decisions, omissions or deficiencies. They may remain hidden for a long time and become visible only when combined with an active failure. Examples include absent or unclear procedures, insufficient preventive maintenance, inadequate training, excessive pressure to meet production targets, failure to investigate near misses, tolerance of safety deviations, poorly designed traffic routes or insufficient supervision.

The relationship between active failures and latent conditions is central to prevention. If a worker enters a rockfall zone, that decision may be an active failure; however, the absence of signage, barriers, geotechnical inspection or adequate training may reveal latent conditions. Correcting only the immediate behaviour is not sufficient if the system continues to allow the same situation to arise.

Summary

Unsafe acts are behaviours or omissions that increase risk; unsafe conditions are workplace situations with the potential to cause harm; active failures are immediate errors or deviations; and latent conditions are organisational or technical weaknesses that make an accident more likely. Effective prevention requires action at all these levels, improving behaviour, working conditions, procedures and safety management. The relationship between these four levels of analysis is shown in Figure 1.4.



Figure 1.4 — Unsafe acts, unsafe conditions, active failures and latent conditions

Problems for reflection and self-assessment

Problem 1.5 — Machine guard removed

At a crushing plant, the guard on a conveyor belt was removed to facilitate a maintenance intervention. After the intervention, the guard was not refitted. Operations resumed, and workers continued to move close to the equipment.

Self-assessment questions

- What is the main unsafe condition?
- What unsafe acts may arise from this condition?
- What active failure could turn this situation into an accident?
- What latent conditions may explain why the guard was not refitted?
- What safety barriers should be in place before operations restart?
- What immediate measure should the supervisor take?

Activity 1.4 — Individual exercise

Choose a real or simulated situation in a mine, quarry, crushing area, maintenance workshop, laboratory, warehouse or traffic route. Describe the situation in 8 to 10 lines and complete the following analysis:

- Situation observed:
- Unsafe act identified:
- Unsafe condition identified:
- Possible active failure:
- Possible latent condition:
- Possible consequence:
- Immediate measure to be implemented:
- Organisational or engineering measure to prevent recurrence:
- Who should be informed?
- What is the main lesson that should be drawn?

1.1.5 Safe design and prevention through design

Prevention through design means considering safety before work begins, before equipment is installed, before a road is built, before a bench is used, before the production process becomes operational or before a task is assigned to workers.

In practice, safe design seeks to eliminate hazards or reduce risks at the design, planning, selection, organisation or adaptation stage for workplaces, equipment, processes, materials, access routes, traffic routes and working methods.

This approach is very important because many unsafe situations do not result solely from individual worker behaviour. Workers often operate within a system that has already been poorly designed: narrow roads, platforms without guardrails, machines without adequate guarding, maintenance points that are difficult to access, traffic areas without segregation between pedestrians and equipment, insufficient ventilation, inadequate lighting, confusing signage or procedures that are too difficult to follow.

In such cases, simply telling the worker to “pay more attention” does not address the underlying problem. Genuine prevention requires improvements to work design and to the conditions under which work is carried out.

What does prevention through design mean?

Prevention through design should be put into practice by asking questions before the task is carried out, the equipment is installed or the process becomes operational. For example:

- Can this hazard be eliminated at the planning stage?
- Is the selected equipment suitable for the work and the environment in which it will operate?
- Can the worker perform the task without entering a hazardous position?
- Can maintenance be carried out without removing guards or entering hazard zones?
- Is safe access available to the workstation?
- Are pedestrians and mobile equipment physically separated?
- Does the lighting allow hazards to be seen clearly?
- Is the ventilation sufficient to control dust, gases or fumes?
- Does the road have adequate width, gradient, drainage and safety berms?
- Is there sufficient space to manoeuvre without risk of collision, crushing or overturning?
- Were emergency measures considered from the outset?

These questions help to show that safety should not be added only at the end as a corrective measure. Safety should form part of the way in which work is designed (Table 1.1).

Table 1.1 — Prevention through design

Situation	Limited corrective measure	Prevention through design
Pedestrians travel alongside mining haul trucks	Install a warning sign	Create a segregated pedestrian route with a physical barrier
A worker climbs onto a machine without safe access	Tell the worker to be careful	Install suitable steps, a platform and handholds
Dust at the crushing plant	Distribute masks	Enclose emission points and install local exhaust ventilation and wet suppression
Fall risk at a bench	Install a warning sign	Provide a safety berm, a physical boundary and a restricted area
Maintenance requires entry into a hazardous area	Reinforce the procedure	Modify the access, provide secure lockout and locate maintenance points outside the hazardous area
High noise levels near equipment	Provide hearing protectors	Purchase quieter equipment, enclose the source or move the workstation away

The difference between correcting problems afterwards and prevention through design

When a risk is identified only after an accident, near miss or worker complaint has occurred, the organisation tends to take corrective action. It may add signage, issue an instruction, reinforce the use of PPE or remind workers to be more careful.

These measures may be necessary, but they are not always sufficient. If the problem lies in the way the workplace, equipment or process was designed, the solution must also address that level.

Prevention through design is therefore closely linked to the hierarchy of controls. Wherever possible, the aim should be to eliminate the hazard, replace a hazardous solution with a safer one, or introduce engineering and collective protective measures before relying solely on administrative controls or PPE. The contrast between correcting problems afterwards and prevention through design is shown in [Figure 1.5](#).

Application to the mining context

In the extractive industry, safe design is particularly important because many activities involve high-energy systems, large equipment, heavy-vehicle traffic, dust, noise, vibration, explosives, slopes, benches, working faces, confined spaces, work at height and underground environments.

Some examples of application are:

Working faces and benches

- Bench height, slope angle, platform width, the presence of safety berms, drainage and the safe distance from the crest should be designed to reduce the risks of rockfall, equipment falling, overturning and workers being exposed to unstable areas.

Mobile mobile equipment traffic

- Internal roads should be designed with adequate width, a gradient compatible with the equipment, passing bays, right-of-way rules, segregation between pedestrians and machines, safety berms, signage, lighting and dust control. A poorly designed road increases the risk of collision, a pedestrian being struck and overturning.

Crushing and screening

- Safety should be considered when positioning feeders, crushers, screens, conveyor belts, access platforms, cleaning points, blockage areas, guards, emergency stops, local exhaust ventilation and the isolation of moving parts. The aim is to prevent workers from having to approach hazardous areas to operate, clean or clear blockages from equipment.

Maintenance

- The design should enable maintenance to be carried out safely. This means providing sufficient space, suitable access, anchor points, platforms, lighting, energy isolation, accessible lubrication points and the ability to

replace components without hazardous postures or unnecessary exposure to moving parts, suspended loads or stored energy.

Underground mine

- In an underground mine, safe design covers mine roadway geometry, ground support, ventilation, refuge chambers, lighting, traffic circuits, segregation between equipment and workers, communication points, evacuation routes and the control of hazardous atmospheres.

Storage of materials and hazardous products

- Warehouses should be organised to prevent falling materials, incompatible mixtures, spills, fires, chemical exposure, blocked exits and the unsafe movement of forklift trucks or other equipment.

CORRECT AFTERWARDS VS PREVENT THROUGH DESIGN

CORRECT AFTERWARDS



 **Signage alone**

 **More attention**

 **PPE**

PREVENT THROUGH DESIGN



 **Physical separation**

 **Safe access**

 **Control at source**

 **Good design makes the safe option simpler than the dangerous option.**

Figure 1.5 — Correcting problems afterwards or prevention through design

Simple principles of safe design

Several simple principles can be used to apply prevention through design:

Eliminate the hazard whenever possible

- The best solution is to remove the hazard from the task. For example, avoid requiring a worker to enter a rockfall zone, eliminate the need for manual cleaning close to moving parts, or replace a task at height with a solution that can be carried out from ground level.

Separate people from energy sources

- Whenever mobile equipment, moving parts, suspended loads, electricity, pressure, falling materials or a risk of ejected material are present, workers should be physically separated from the source of the hazard.

Design safe access

- Steps, platforms, walkways, guardrails, handholds, non-slip floors and traffic areas should be designed before the task is performed. Lack of safe access frequently leads to improvisation.

Make safe behaviour easier

- Good design makes the safe option easier than the unsafe option. If a worker must negotiate obstacles, climb improvised structures or remove guards to complete the task, the system has been poorly designed.

Reduce exclusive reliance on PPE

- PPE is important, but it should be the final barrier. Wherever possible, risk should be controlled through elimination, substitution, engineering controls, collective protective measures or work organisation.

Plan for maintenance and emergencies

- Equipment or a facility should not be designed only to operate under normal conditions. It should also be designed for cleaning, inspection, maintenance, repair, lockout, rescue and evacuation.

Consider the real worker

- Design should take account of the fact that workers may be tired, work under pressure, work shifts, communicate in noisy conditions, wear gloves, move in low light or operate in environments with dust, heat, mud or rain. Safety should remain robust under these real conditions.

Warning signs of poor design

Some signs indicate that a task, item of equipment or workplace may have been poorly designed from a safety perspective:

- workers need to improvise access routes;
- guards are frequently removed to allow operations to continue;
- maintenance can only be performed in hazardous positions;
- pedestrians and equipment share the same route without segregation;
- intersections have inadequate visibility;
- workers pass beneath suspended loads;
- cleaning areas are located close to moving parts;
- there is excessive dust, noise or vibration at source;
- signage is used to compensate for a serious physical deficiency;
- the task relies too heavily on individual attention;
- near misses recur at the same location;
- workers say that “it has always been done this way” or that “there is no other way to do it”.

When these signs appear, the workplace, equipment, procedure or working method should be reassessed.

Relationship with safety culture

Safe design also influences safety culture. An organisation that designs work well sends workers the message that prevention is a genuine priority. Conversely, an organisation that accepts improvised access, inadequately guarded equipment, hazardous roads or unsafe maintenance conveys the idea that production is more important than safety.

A strong safety culture does not depend solely on speeches, posters or campaigns. It also depends on the specific decisions made when purchasing equipment, organising roads, designing workstations, maintaining guards, managing working time and responding to identified hazards.

Key message

Safe design seeks to prevent workers from having to choose between performing the work and protecting themselves. Well-designed work enables safe production, reducing the need for improvisation, unnecessary exposure and exclusive reliance on individual behaviour.

Problems for reflection and self-assessment

At a quarry, workers must cross the mining haul-truck road to reach the canteen. Warning signs are present, but there is no segregated crossing or physical barrier. Is this solution sufficient? What design improvement could be implemented?

At the crushing plant, a blocked discharge chute frequently requires a worker to approach an area containing moving parts and unstable material. What design changes could reduce the risk?

In a workshop, replacing heavy components requires the use of an overhead crane, but the lifting area is also used as a pedestrian route. What design and organisational problems exist in this situation?

In an underground mine, auxiliary ventilation is frequently damaged by mobile equipment because the ventilation ducting runs close to the traffic area. How could the design of the mine roadway or installation reduce this problem?

Activity 1.5 — Individual exercise

Choose a simple task carried out in a mine, quarry, workshop, laboratory or processing plant. Examples include mobile equipment traffic, cleaning close to a conveyor belt, crusher maintenance, load handling, storage of chemicals or access to a platform.

Complete the safe design application worksheet and, at the end, write a short sentence summarising the main design improvement proposed.

Safe design application worksheet

Question	Response
What task has been selected?	
What is the main hazard?	
Does the hazard result from a behavioural failure, a design failure, or both?	
Could the hazard be eliminated or reduced at the design stage? How?	
What engineering or collective protective measure could be implemented?	
What organisational measure would be required?	
What PPE would still be required as a complementary measure?	
What evidence could be recorded in the digital portfolio?	

1.1.6 Application to the mining context

This section provides only an introductory application of safety concepts. A detailed operational analysis of the mine is presented in [Chapter 3 — Particularities of the Mining Industry](#).

The concepts of accident, incident, near miss, hazard, risk, exposure, triggering event, consequence, unsafe act, unsafe condition, active failure and latent condition become clearer when applied to specific situations in mining operations. The extractive industry has distinctive characteristics: dynamic operations, heavy-equipment traffic, constantly changing working areas, exposure to dust, noise and vibration, maintenance tasks, the use of chemical substances, material storage and constant interaction between people, machines and the natural environment.

Preventive analysis in the mining context must therefore always be grounded in operational reality. It is not enough to state that there is an “accident risk”. It is necessary to identify where the hazard is located, who is exposed, which event may trigger the occurrence, what consequences may result and which control measures should be adopted.

1.1.6.1 Working face

The working face is one of the most critical areas in a mining operation. It is the area where operations such as drilling, blasting, loading, face scaling, face inspection and preparation for the continuation of work are carried out. Hazards may be associated with rock mass instability, rockfall, the presence of mobile equipment, the use of explosives, dust, noise, vibration and workers remaining within exclusion zones.

In this context, the hazard may, for example, be an unstable face with loose blocks. Exposure occurs when workers, equipment or vehicles remain close to the potential rockfall zone. The triggering event may be heavy rain, equipment-induced vibration, loss of support or progressive instability. The presence of people or equipment at the base of the face constitutes exposure to the hazard. The risk is the possibility of blocks falling onto people or equipment. The consequence may be serious injury, death, property damage, interruption of production or the need to evacuate the area.

An accident in this area may occur when a worker is struck by blocks falling from the face. A near miss may occur when a rock falls close to a machine or into an area where a worker had passed shortly beforehand. An incident may consist of detecting unstable blocks during an inspection, even if no rockfall or damage occurs.

An unsafe act would be entering the exclusion zone without authorisation. An unsafe condition would be the absence of signage, barriers or face scaling. The active failure may be the immediate decision to travel close to the face without checking the stability conditions. The latent condition may be the absence of a regular geotechnical inspection procedure, insufficient worker training on exclusion zones or operational pressure to resume work without an adequate assessment.

Preventive measures should include inspection before work starts, face scaling, establishing exclusion zones, signage, access control, clear communication between operators and supervisors, stopping work under unsafe conditions and immediately reporting instability, cracks, loose blocks or changes observed at the face.

1.1.6.2 Bench

The bench is the platform or level on which extraction, travel, drilling, loading or inspection operations are carried out. Its geometry, width, gradient, safety berms, drainage, stability and organisation directly influence operational safety. The most common hazards include falls from height, rockfall, slope instability, travel close to the bench edge, the absence of adequate safety berms, uneven surfaces and workers and equipment operating in the same area.

For example, a bench edge without an adequate safety berm is a hazard. Exposure occurs when a machine or worker travels close to that edge. The triggering event may be an incorrect manoeuvre, a slippery surface, reduced visibility, mechanical failure, excessive speed or ground failure. The risk is the possibility of the machine falling or overturning, or of a person falling. The consequence may be serious injury, death, equipment damage, interruption of the operation or further destabilisation of the slope.

An accident may involve equipment overturning close to the edge of the bench. A near miss may involve a mining haul truck approaching the edge too closely without falling. An incident may be the identification of a deteriorated or inadequate safety berm during an inspection.

An unsafe act would be driving close to the edge without maintaining the safe distance. An unsafe condition would be the absence of a safety berm, poor road condition or inadequate drainage. The active failure may be a manoeuvre performed without visually confirming the equipment's position. The latent condition may lie in inadequate bench design, insufficient road maintenance, the absence of internal traffic rules or the lack of regular inspections.

Prevention should include suitable bench dimensions, safety berms, speed control, defined routes, road maintenance, inspection of stability conditions, signage for hazardous areas and operator training in safe travel on benches.

1.1.6.3 Mobile equipment traffic

Mobile equipment traffic is a significant source of risk in mines, quarries and processing plants. It involves mining haul trucks, wheel loaders, excavators, drill rigs, light vehicles, forklifts and, in some cases, pedestrians moving at the same time. Hazards include collisions, pedestrians being struck, overturning, blind spots, limited visibility, deteriorated roads, poorly defined junctions, excessive speed and communication failures.

On an internal road, the hazard may be heavy equipment travelling with blind spots. Exposure occurs when pedestrians, light vehicles or other equipment are on the same road or in manoeuvring areas. The triggering event may be the absence of eye contact, a radio communication failure, an unsigned junction, reversing without a spotter, excessive speed or dust that reduces visibility. The risk is a collision or a pedestrian being struck. The consequence may be serious injury, death, property damage or interruption of operations.

An accident may occur when a light vehicle is struck by a mining haul truck at a junction. A near miss may occur when a pedestrian has to move quickly to avoid being struck by a machine. An incident may be the entry of an unauthorised vehicle onto an operational mine road.

An unsafe act would be crossing an equipment route without authorisation or without eye contact with the operator. An unsafe condition would be the absence of physical segregation between pedestrians and equipment. The active failure may be a reversing manoeuvre without checking the surrounding area. The latent condition may be the absence of a traffic management plan, inadequate signage, insufficient training in internal traffic rules or poor road maintenance.

Preventive measures should include a traffic management plan, segregation between pedestrians and equipment, speed limits, signage, adequate lighting, road maintenance, right-of-way rules, radio communication, reversing alarms, mirrors, cameras, designated parking areas and controlled authorisation of access to operational areas.

1.1.6.4 Crushing

Crushing operations involve a concentration of mechanical, physical and occupational hygiene risks. Hazards include moving parts, conveyor belts, crushing and trapping points, projected material, falling objects, high noise levels, mineral dust, vibration, maintenance on energised equipment and the accumulation of material in areas that are difficult to access.

At a crushing plant, the hazard may be a moving conveyor belt without adequate guarding. Exposure occurs when a worker approaches the trapping point to clean, clear a blockage or observe the operation. The triggering event may be an attempt to remove material while the equipment is running, a missing guard, unexpected start-up or failure to isolate the energy sources. The risk is trapping, crushing or amputation. The consequence may be serious injury, death, equipment damage or shutdown of the line.

An accident may occur when a worker is caught in a conveyor belt or moving parts. A near miss may involve a hand coming close to a trapping point without actual contact. An incident may be the detection of a removed or damaged guard.

An unsafe act would be carrying out cleaning while the equipment is running. An unsafe condition would be the absence of a guard or an accessible emergency-stop device. The active failure may be starting an intervention without isolating the equipment. The latent condition may be the absence of a lockout/tagout (LOTO) procedure for energy sources, insufficient training, delayed maintenance, pressure to reduce downtime or routine tolerance of guard removal.

At the same location, the hazard may also be the emission of mineral dust. Exposure occurs when workers remain close to the crusher or conveyor belts for prolonged periods. The triggering event may be the absence of local exhaust ventilation, inadequate wet suppression, dry cleaning or the absence of enclosure. The risk is the inhalation of dust. The consequence may be respiratory irritation, chronic lung disease or occupational disease.

Prevention should include machine guards, emergency stops, lockout/tagout procedures for energy sources, prohibiting cleaning while equipment is moving, dust control at source, wet suppression, ventilation or local

exhaust ventilation, preventive maintenance, hearing protection, respiratory protection where necessary and specific training in safe operation and maintenance.

1.1.6.5 Maintenance

Maintenance is a critical activity because it frequently involves dismantling, inspection, cleaning, component replacement, work on moving parts, work with electrical, hydraulic, pneumatic, mechanical, or thermal energy, the use of tools, and exposure to oils, lubricants, fuels, dust, and chemical agents. Many serious incidents occur during maintenance tasks, particularly when there is an unexpected start-up, residual energy, or improvisation.

The hazard may be stored energy in a hydraulic system. Exposure occurs when a worker intervenes on the equipment without ensuring that this energy has been released or isolated. The triggering event may be a lockout failure, inadvertent actuation, hose rupture, the fall of a suspended component or residual pressure. The risk is crushing, fluid ejection, cuts, burns or trapping. The consequence may be serious injury, permanent disability, death or equipment damage.

An accident may occur when a machine is activated during maintenance. A near miss may occur when a component moves unexpectedly without striking the worker. An incident may be the identification of an intervention that was started without a lockout tag or a formal permit-to-work.

An unsafe act would be starting maintenance without locking out and tagging the energy sources. An unsafe condition would be the absence of lockout devices, suitable tools or a safe space for the intervention. The active failure may be failing to confirm isolation before starting the task. The latent condition may be the absence of a lockout/tagout procedure for energy sources, insufficient training, inadequate maintenance planning, a lack of spare parts, pressure to resume production or inadequate supervision.

Prevention should include planning the intervention, a permit-to-work, identifying all energy sources, lockout/tagout, releasing residual energy, verifying a zero-energy state, using suitable tools, cordoning off the area, communication between teams, supervision, and recording of the intervention.

1.1.6.6 Laboratory

A laboratory associated with mining operations may involve sample preparation, small-scale crushing or grinding, sieving, drying, weighing, chemical analysis, the use of reagents, acids, alkalis, solvents, electrical equipment, laboratory ovens, glassware, sharp materials and, in some cases, potentially contaminated samples. Hazards may be chemical, physical, biological, ergonomic or organisational.

For example, the hazard may be the handling of a corrosive acid. Exposure occurs when a worker prepares a solution, transfers the product, cleans spills or works without adequate protection. The triggering event may be a splash, container breakage, an incompatible mixture, inadequate ventilation, a labelling error or the use of an unsuitable container. The risks include chemical burns, poisoning, vapour inhalation, or a dangerous reaction. The consequences may include an eye injury, a skin burn, respiratory damage, a fire, contamination of the laboratory workbench, or the need to evacuate the area.

An accident may occur when a worker sustains a burn from a chemical splash. A near miss may be a bottle being dropped without breaking. An incident may be the detection of an unlabelled container or an unavailable Safety Data Sheet (SDS).

An unsafe act would be mouth pipetting, mixing reagents without confirming compatibility or failing to wear safety goggles. An unsafe condition would be the absence of an emergency shower, eyewash station, adequate ventilation, labelling or a dedicated chemical storage cabinet. The active failure may be transferring a reagent into an unsuitable container. The latent condition may be insufficient training, the absence of a chemical inventory, the absence of written procedures, incorrect storage or insufficient supervision.

Prevention should include a product inventory, correct labelling, accessible safety data sheets, storage according to compatibility, adequate ventilation, the use of appropriate PPE, spill procedures, training, signage, emergency equipment and safe waste disposal.

1.1.6.7 Storage

The storage of materials, fuels, lubricants, explosives, tools, parts, cylinders, chemicals, samples or waste may create significant risks when it is not properly organised. Hazards include falling materials, stack instability, chemical incompatibility, fire, explosion, spills, obstruction of evacuation routes, excessive physical exertion, trapping, environmental contamination and unauthorised access.

In a storage area, the hazard may be an unstable stack of materials. Exposure occurs when workers move, load or unload materials close to the stack. The triggering event may be excessive stacking height, an uneven base, vibration, impact from equipment, incorrect removal of material or the absence of containment. The risk is falling objects or collapse of the stack. The consequence may be crushing, fracture, property damage or obstruction of a passageway.

An accident may occur when stored material falls onto a worker. A near miss may occur when a load falls close to a person without striking them. An incident may be the detection of materials stored in front of an emergency exit.

An unsafe act would be removing material from the base of an unstable stack. An unsafe condition would be storage without a height limit, identification or segregation, or storage on an uneven floor. The active failure may be moving a load without checking its stability. The latent condition may be the absence of storage rules, insufficient inspections, lack of training in the manual or mechanical handling of loads, poor organisation of the space or a lack of suitable equipment.

Where chemicals or fuels are stored, the hazard may be incompatibility between substances, flammability or the possibility of a spill. Exposure may involve workers, soil, water or facilities. The triggering event may be packaging failure, an ignition source, inadequate ventilation or the joint storage of incompatible products. The consequence may be fire, poisoning, environmental contamination or property damage.

Prevention should include organisation by category, limits on stacking heights, inspection of shelving, segregation of incompatible products, secondary containment bunds, ventilation, signage, access control, unobstructed traffic and evacuation routes, firefighting equipment, emergency procedures and worker training.

Integration of the concepts into preventive analysis

In any operational area, the analysis should identify the hazard, exposure, triggering event, risk, consequences and control measures, as well as the acts, conditions and failures that may contribute to the occurrence. Priorities vary according to the context: stability and exclusion zones at working faces and benches; segregation in mobile equipment traffic; control of moving parts, dust and noise in crushing; energy isolation during maintenance; chemical control in the laboratory; and stability, compatibility and containment in storage. Figure 1.6 presents this integrated application.

In all these contexts, prompt reporting is essential. The identification of an unsafe condition, a near miss or a procedural failure should be reported before it causes harm. Reporting and recording a deteriorated safety berm, a removed guard, a hydraulic leak, an area with excessive dust, an unlabelled container or an unstable stack makes it possible to correct the situation and prevent accidents, occupational diseases, property damage or environmental impacts.

In summary, the fundamental concepts of Occupational Safety and Health acquire practical value when they are used to interpret real situations. Prevention in the extractive industry requires observation of the workplace, understanding of the hazard–exposure–triggering event–risk–consequence chain, identification of unsafe acts and unsafe conditions, recognition of active failures and latent conditions, and implementation of control measures before an occurrence results in harm.

APPLICATION OF OSH CONCEPTS IN THE EXTRACTIVE INDUSTRY



Figure 1.6 — Map of application to the mining context

Activity 1.6 — Individual exercise

Choose one of the seven areas analysed: working face, bench, mobile equipment traffic, crushing, maintenance, laboratory or storage. Describe a real or simulated situation and complete the following analysis template:

- Area analysed:
- Task or situation:
- Hazard identified:
- People, equipment or environment exposed:
- Possible triggering event:
- Associated risk:
- Foreseeable consequence:
- Possible unsafe act:
- Existing unsafe condition:
- Possible active failure:
- Possible latent condition:
- Immediate measure:
- Additional preventive measure:
- Evidence to be recorded:
- Key learning point:

Short activity — Classifying situations

Classify the following situations as an accident, near miss, hazard or unsafe condition:

1. A worker slips in a muddy area but does not fall because they grab a handrail.
2. A wheel loader travels close to pedestrians without physical separation or signage.
3. A worker sustains a cut to the hand during equipment maintenance.
4. Visible dust accumulates near the crusher during operation.

1.1.6.8 Additional context: mineral deposit, mining method and risk differentiation

The combined influence of the mineral deposit, mining method and operating conditions is summarised in Figure 1.7.



Figure 1.7 — Mineral deposit, mining method and risk differentiation

Mineral deposits, mining methods and risk differentiation

Risks in the mining industry do not depend solely on the equipment used or the task performed. They also depend on the type of mineral deposit, the mining method, the geometry of the excavation, rock mass characteristics, the presence of water, depth, proximity to communities and the way in which the operation is organised (Table 1.2).

The same equipment may therefore present different risks in different contexts. A wheel loader used in a surface quarry, on a wide and well-compacted floor, does not present exactly the same risks as an articulated underground loader operating in a narrow mine roadway with limited ventilation, poor visibility and a supported roof. Similarly, a bench drill rig, an underground drill rig and a pneumatic scaling tool used for local scaling share certain hazards but also require different preventive measures.

Risk assessment should therefore begin with an essential question: in what type of mineral deposit, mining method and workplace is the task being performed?

Table 1.2 — Mining contexts and most relevant OSH risks

Mining context	Main characteristics	Most relevant OSH risks
Hard-rock quarry or open-pit mine	Benchs, slopes, drilling, blasting, loading, haulage and crushing	Rockfall, slope instability, dust, noise, vibration, overturning, collision and pedestrians being struck
Underground mine	Mine roadways, ramps, stopes, ventilation, ground support and traffic in confined spaces	Rockfall, hazardous atmospheres, inadequate ventilation, collisions in mine roadways, fire, difficult evacuation and exposure to dust and fumes
Alluvial mining operation or operation in unconsolidated materials	Poorly consolidated sediments, water, unstable banks, dredging or handling of saturated material	Equipment sinking, bogging, bank instability, falling into water, localised engulfment and water contamination
Mineral deposit with a significant presence of water	Water inflows, drainage, pumping, wet surfaces and possible hydrostatic pressure	Slipping, ground instability, slope failure, electrical risk, deterioration of roads and difficult travel
Mineral deposit containing potentially reactive minerals or sulphides	Potential for acid mine drainage, chemical alteration, contaminated water and corrosion	Chemical exposure, equipment corrosion, environmental contamination, deterioration of ground support and the need for water management
Mining operation near communities	External traffic, dust, noise, vibration, heavy traffic and interaction with third parties	Road risk, community exposure to dust and noise, social conflict, complaints, infrastructure damage and the need for communication
Operations in the closure or rehabilitation phase	Legacy areas, inactive working faces, abandoned structures, old slopes and deteriorated access routes	Falls into excavations, residual instability, unauthorised access, accumulated water, abandoned materials and risks to workers and third parties

The mining method changes the risk profile

The mining method directly influences the hazards present in the workplace. In open-pit operations, risks are frequently associated with benches, slopes, safety berms, ramps, traffic routes, dust, blasting, mobile equipment and surface instability. The space available is greater, but the scale of the equipment, proximity to edges and exposure to weather conditions make the risk dynamic.

In underground mines, risks are different in nature. Space is more restricted, ventilation is essential, evacuation is more difficult, lighting is artificial, equipment travels through narrow mine roadways, and the stability of the roof and sidewalls depends on the installed ground support. In these contexts, small changes in ventilation, rock mass stability, the condition of the support or traffic conditions can quickly turn a routine task into a critical situation.

In alluvial operations or operations involving poorly consolidated materials, risks may be more closely associated with water, unstable banks, equipment sinking, localised engulfment, movement of mud and the difficulty of maintaining stable roads. In these settings, assessment of the ground and drainage is as important as analysis of the machine being used.

The mineral deposit influences prevention

Each mineral deposit has its own characteristics. Rock strength, fracturing, weathering, the presence of faults, moisture, bedding dip, particle size distribution, silica content, the presence of reactive minerals and proximity to populated areas influence risks and preventive measures.

For example:

- highly fractured rock may increase the risk of rockfall and require greater attention to scaling and ground support;
- silica-bearing rock may increase the importance of controlling respirable dust;
- an operation with significant water may require drainage, pumping, control of slippery surfaces and electrical protection;

- a mine near communities may require tighter control of dust, noise, vibration and traffic, together with external communication;
- a deep underground mine may require greater attention to ventilation, heat, gases, evacuation, communication and emergency response.

There is therefore no single risk assessment that is “the same for every mine”. There are common principles, but their application must be adapted to the geological, technical, environmental and social reality of each operation.

Implications for equipment analysis

When analysing mining equipment, four questions should always be considered:

Where is the equipment operating?

- Working face, bench, mine roadway, ramp, crushing plant, workshop, storage yard, waste dump, dumping area or an area near communities.

Which ground or rock mass conditions influence the task?

- Fractured rock, uneven ground, an unstable slope, a supported roof, the presence of water, dust, mud, loose material, a gradient or poor visibility.

Which other equipment or workers interact with the task?

- Pedestrians, operators, mining haul trucks, wheel loaders, excavators, drill rigs, trucks, conveyor belts, maintenance teams, geology and mine surveying teams, or supervisors.

Which preventive measures must be adapted to the context?

- An exclusion zone, scaling, ground support, ventilation, dust control, drainage, pedestrian segregation, road maintenance, signage, communication, speed restrictions, energy isolation or enhanced supervision.

Key message

The distinctive characteristics of the mining industry result from the combination of the mineral deposit, mining method, equipment, environment and work organisation. The same task may have different levels of risk depending on whether it is carried out on a stable bench, at a fractured working face, in an underground mine roadway, in an area with water, on a deteriorated road or in an area near communities.

Before preventive measures are selected, the specific context of the operation must therefore be understood. Effective prevention does not copy solutions automatically; it adapts them to the reality of the mineral deposit, the mining method and the specific conditions at the working face.

1.1.7 Hierarchy of controls

The hierarchy of controls is a central principle of prevention in OSH and should guide the entire course, serving as a criterion for analysis, decision-making and the selection of preventive measures in different work situations. Its purpose is to guide the choice of the most effective measures for eliminating hazards or reducing risks. Not all measures are equally effective: some act directly at the source of the hazard, whereas others depend on workers’ individual behaviour. Prevention should therefore prioritise more reliable, collective controls that are less dependent on human action.

The hierarchy of controls organises preventive measures in order of priority: elimination, substitution, engineering controls or collective protective measures, organisational or administrative controls and, lastly, PPE (Table 1.3).

Elimination is the most effective control. It involves removing the hazard from the task or workplace. Examples include removing unstable blocks through controlled face scaling before allowing access, withdrawing unsafe equipment from service, or eliminating a hazardous manual task through automation. Remote inspection may also eliminate the need for workers to enter an unstable area, thereby removing their exposure even though the underlying instability remains. When the hazard is eliminated, the associated risk disappears or is reduced very substantially.

Table 1.3 — Examples of the hierarchy of controls in a mining context

Level	Type of control	Example in a mining context
1	Elimination	Eliminate a hazardous task by changing the working method.
2	Substitution	Replace a hazardous substance with a less hazardous alternative.
3	Engineering controls / collective protective measures	Install guardrails, enclosures, local exhaust ventilation or physical separation between people and equipment.
4	Organisational / administrative controls	Procedures, training, signage, task rotation and permits-to-work.
5	PPE	Safety helmet, hearing protection, respiratory protection, gloves, safety glasses and a safety harness, where applicable.

Substitution involves replacing a hazard with a less hazardous alternative. It may involve replacing a hazardous chemical with a less harmful one, using lower-noise equipment, selecting lower-vibration tools, or replacing dry cleaning methods with wet methods to reduce dust. Substitution does not always eliminate the risk, but it can reduce its likelihood or severity.

Engineering controls and collective protective measures act on the source of the hazard, the transmission path or the separation between the hazard and workers. They include guards on moving parts, local exhaust ventilation systems, crusher enclosures, physical barriers between pedestrians and equipment, suitable berms on benches, ventilation, emergency stops, acoustic insulation and secondary containment bunds. These controls are generally more effective than solutions that depend solely on individual attention because they protect all exposed workers.

Organisational or administrative controls reduce risk through the way in which work is planned, authorised, carried out and supervised. They include safe working procedures, permits-to-work, signage, exclusion zones, task rotation, limits on exposure time, training, supervision, preventive maintenance, traffic management plans, brief pre-task safety meetings and communication rules. These controls are important, but they require consistent compliance, monitoring and updating.

PPE constitutes the final level of the hierarchy and should be used as a complementary barrier when risks cannot be eliminated or sufficiently reduced through more effective controls. It includes safety helmets, gloves, safety boots, safety glasses, hearing protection, respiratory protection, safety harnesses and high-visibility clothing. PPE is essential in many tasks, but it should not be the first or only solution. Its effectiveness depends on appropriate selection, availability, comfort, proper fit, training, maintenance and actual use.

Applying the hierarchy of controls means asking: can the hazard be eliminated? If elimination is not possible, can the hazard be substituted? Can engineering controls or collective protective measures be implemented? Which organisational controls are required? Which PPE should complement the remaining controls?

In a dusty crushing area, for example, the solution should not begin solely with issuing masks. Dust reduction at source, wet suppression, local exhaust ventilation, enclosure, appropriate cleaning and limitation of exposure should be assessed. Respiratory protection may be required, but as a complementary measure.

In summary, the hierarchy of controls enables the selection of more effective and lasting preventive measures. Priority should be given to eliminating or reducing the hazard at source, protecting workers collectively, organising work safely and using PPE as the last line of defence. The order of priority of the different classes of control is represented in [Figure 1.8](#).

HIERARCHY OF RISK CONTROLS

APPLICATION IN CRUSHING PLANTS

Apply controls in order of their effectiveness to protect people and operations.



PPE is necessary, but it should not be the first or the only response.

Figure 1.8 — Hierarchy of controls

Problems and self-assessment questions

Integrated application of the hierarchy of controls

Problem 1.10 — Maintenance of crushing equipment

During a maintenance intervention, a team needs to remove material that has accumulated near moving parts of crushing equipment. The equipment has been stopped, but lockout/tagout has not yet been applied. The area contains dust and residual noise, and other workers are moving nearby.

Self-assessment questions

- Which hazards are present in this situation?
- Which controls could eliminate or reduce the hazard before the intervention?
- Which engineering controls or collective protective measures would be required?
- Which organisational controls must be applied before the task begins?
- Which PPE should be used as complementary protection?
- What would be the correct sequence for applying the hierarchy of controls?
- Which control would be insufficient if applied on its own?

Activity 1.7 — Individual exercise

Choose a specific task at a working face, on a bench, in a traffic area, in crushing, maintenance, a laboratory or a storage area. Identify one hazard and complete the following analysis template according to the hierarchy of controls:

Task or situation analysed:

- Hazard identified:
- Associated risk:
- Possible consequence:
- Can the hazard be eliminated? How?
- If elimination is not possible, can it be substituted with a less hazardous alternative?
- Which engineering control or collective protective measure can be applied?
- Which organisational or administrative control is required?
- Which PPE should be used as a complementary measure?
- Which of the proposed controls is most effective?
- Which control depends most on individual behaviour?
- How can it be verified that the controls have been implemented and are effective?

Short activity — Selecting controls

For a situation involving dust near the crusher, propose one control at each level of the hierarchy of controls. Indicate which control should be prioritised and explain why.

1.1.8 Measure, report and learn

1.1.8.1 Safety performance and occupational accident indicators

Safety performance indicators make it possible to monitor both the outcomes that have already occurred and the preventive effort undertaken by the organisation. Without organised information, it is difficult to determine whether working conditions are improving, whether accidents are decreasing, whether preventive measures are effective, or whether some areas require priority intervention.

Occupational accident indicators (Table 1.4) make it possible to transform occurrences into information that is useful for prevention management. By analysing accidents, incidents, near misses, working days lost, hours worked, the number of exposed workers and the causes of occurrences, the organisation can identify trends, compare periods, assess the most critical sectors or tasks, and define priorities for action.

In the extractive industry, this analysis is particularly important. Mining operations involve working faces, benches, heavy mobile equipment traffic, crushing, maintenance, storage and laboratory work. Each of these areas presents specific hazards and different levels of exposure. Measuring occupational accidents makes it possible to determine, for example, whether accidents occur mainly during mobile equipment traffic, whether near misses increase in certain areas, whether maintenance tasks account for a higher number of injuries, or whether exposure to dust and noise requires additional measures.

Indicators can be classified into two broad groups: reactive indicators and proactive indicators. Reactive indicators are based on events that have already occurred, such as injury accidents, accidents involving property damage, working days lost, and incidents and near misses reported and recorded. They are useful because they enable the organisation to learn from the past, but they have a limitation: they reveal problems only after the events have occurred.

The most commonly used reactive indicators include the frequency rate, incidence rate and severity rate. The frequency rate relates the number of accidents to the number of hours worked, making it possible to determine how many accidents occur per million hours worked. It can be calculated as follows:

$$\text{Frequency rate} = \text{number of accidents} \times 1,000,000 / \text{number of hours worked}$$

The incidence rate relates the number of accidents to the average number of workers, making it possible to assess the proportion of workers affected by accidents over a given period. It may be expressed per thousand workers:

$$\text{Incidence rate} = \text{number of accidents} \times 1,000 / \text{average number of workers}$$

The severity rate relates the number of working days lost to the number of hours worked, making it possible to assess the severity of the accidents that occurred. It can be calculated as follows:

$$\text{Severity rate} = \text{number of working days lost} \times 1,000 / \text{number of hours worked}$$

These indicators should be interpreted together. An organisation may have few accidents, but those accidents may be very serious; alternatively, it may have many minor accidents but few working days lost. The analysis should therefore consider not only the number of occurrences, but also their severity, the causes involved, the locations where they occurred and the measures taken after each event.

Proactive indicators, in turn, seek to measure preventive effort before harm occurs. They include, for example, the number of inspections conducted, training activities, internal audits, safety observations, near misses analysed and followed up through corrective actions, corrective actions completed, equipment checks, safety meetings, brief pre-task safety meetings, and worker participation in hazard identification. These indicators are essential because they show whether the organisation is acting preventively.

A simple example helps to explain this difference. If a company measures only the number of injury accidents, it is looking mainly at the past. However, if it also measures the number of bench inspections conducted, the number of near misses reported and recorded, the average time taken to correct unsafe conditions and the percentage of workers trained, it begins to monitor the quality of its prevention system.

It is important to emphasise that an increase in the number of near misses reported and recorded does not always mean that safety has deteriorated. In many cases, it may indicate an improvement in the safety culture because workers have begun to report situations that were previously ignored. The problem is not having many reports and records; the problem is failing to analyse them, failing to correct the causes and failing to provide feedback to the teams.

Measurement must therefore be linked to action. Indicators that do not lead to decisions have little preventive value. After measuring, it is necessary to interpret the data, identify priorities, assign responsibilities, implement measures, verify their effectiveness and communicate the results. Only then do indicators cease to be mere numbers and become instruments of continuous improvement.

In summary, measuring occupational accidents is not merely intended to produce statistics. It serves to understand where, how and why accidents, incidents and near misses occur; to identify critical areas; to assess the effectiveness of preventive measures; and to support safer decisions. In OSH, measurement is a way of anticipating problems, directing resources and preventing personal injury, property damage and environmental impacts. **Figure 1.9** summarises the complementary nature of reactive and proactive indicators and their use in preventive decision-making.

Table 1.4 — Occupational accident indicators

Indicator	Recommended formula	Interpretation
Frequency rate	FR = (number of accidents × 1,000,000) / number of hours worked	Indicates how many accidents occur per million hours worked.
Incidence rate	IR = (number of accidents × 1,000) / average number of workers	Relates the number of accidents to the size of the working population.
Severity rate	SR = (number of working days lost × 1,000) / number of hours worked	Expresses the severity of the consequences in working days lost.
Average duration of absence	AD = number of working days lost / number of accidents	Indicates the average duration of absence resulting from an accident.

REACTIVE AND PROACTIVE INCIDENT INDICATORS



Figure 1.9 – Reactive and proactive safety performance indicators: measure to support decision-making

Problems and self-assessment questions

Frequency rate

Problem 1.6 — Comparing two operations

Operation A recorded 8 accidents in one year, with 400,000 hours worked. Operation B recorded 12 accidents over the same period, but with 1,200,000 hours worked.

Self-assessment questions

- Which operation had the higher absolute number of accidents?
- Is the absolute number of accidents sufficient to compare safety performance? Why?
- Calculate the frequency rate for each operation.
- Which operation has the higher accident frequency per million hours worked?
- What precautions should be taken when comparing operations of different sizes?
- What additional information would be required to interpret these results more accurately?
- Which preventive decisions could this indicator support?

Activity 1.8 — Individual exercise

Choose a work area — working face, bench, mobile equipment traffic, crushing, maintenance, laboratory or storage — and imagine that you are responsible for monitoring safety in that area for one month.

- Complete the following analysis template:
- Area analysed:
- Main expected hazard:
- Reactive indicator you would use:

- Reason for selecting the reactive indicator:
- Proactive indicator you would use:
- Reason for selecting the proactive indicator:
- What data would need to be collected?
- Who should collect or validate those data?
- What decision could be taken on the basis of these indicators?
- How would you communicate the results to the team?

Short activity — Calculation and interpretation

A mining operation recorded 4 accidents, 500,000 hours worked and 80 working days lost. Calculate the frequency rate and the severity rate. Then write one interpretative sentence for each indicator.

Reactive and proactive indicators

Reactive: accidents, incidents involving damage, working days lost, and near misses reported and recorded.

Proactive: training activities delivered, audits, inspections, hazards identified, corrective actions completed, and worker participation.

1.1.8.2 Safety culture, occurrence reporting and preventive behaviour

1.1.2

Safety culture comprises the values, attitudes, perceptions, practices and behaviours shared within an organisation in relation to the prevention of accidents, occupational diseases, property damage and environmental impacts. In a strong safety culture, safety is not regarded as an external obligation, a documentary formality or the exclusive responsibility of the safety professional. Instead, it is integrated into the way work is planned, carried out, supervised and improved.

In the extractive industry, this dimension is particularly important because working conditions change frequently. The working face advances, benches change, traffic routes deteriorate, equipment is subject to wear, weather conditions influence ground stability, and exposure to dust, noise and vibration may vary throughout the operation. Written procedures alone are therefore insufficient. Everyone involved must understand the hazards, recognise changes in working conditions and act before an unsafe situation develops into an accident.

An effective safety culture depends on three complementary dimensions: management commitment, worker participation and continuous learning. Management commitment is demonstrated when safety is considered in decisions concerning planning, production, maintenance, equipment procurement, team organisation and the setting of deadlines. Worker participation is essential because workers observe actual working conditions every day and can identify hazards that may not appear in formal documents. Continuous learning occurs when accidents, incidents, near misses, inspections and safety observations are analysed in order to improve the prevention system.

Reporting and recording are among the most important expressions of safety culture. They involve reporting an occurrence, an unsafe condition, a near miss, an equipment failure, an exposure situation or any deviation that could compromise safety and health. Reporting and recording should be simple, quick and accessible, allowing situations such as a deteriorated berm, a removed guard, excessive dust, a hydraulic leak, a poorly signposted area, a damaged tool, an unlabelled container or a near collision to be reported.

Reporting and recording are valuable because they make early action possible. When an unsafe condition is reported before it causes harm, the organisation gains time to correct the situation. When a near miss is analysed, weaknesses that could lead to a serious accident can be identified. When workers stop reporting and recording because they fear blame, believe it will waste time or receive no feedback, the organisation loses an essential source of preventive information.

Reporting and recording should therefore be associated with a just culture. A just culture does not mean an absence of accountability; rather, it distinguishes between human error, system failure, at-risk behaviour and deliberate violation of critical rules. The primary objective should not be to find someone to blame, but to understand what happened, why it happened, which barriers failed and which measures should be adopted to prevent recurrence.

Preventive behaviour results from this culture. Before starting a task, workers should check the conditions at the location, confirm that they have the necessary equipment, respect exclusion zones, maintain communication with the team, use PPE correctly, stop work when a serious hazard is identified, and report and record deviations. Similarly, a manager who demonstrates preventive behaviour plans the task, ensures that resources are available, listens to workers, corrects unsafe conditions, monitors the implementation of measures, and values reporting and recording.

It is important to emphasise that preventive behaviour does not depend solely on individual willingness. It is influenced by working conditions, training, the clarity of procedures, production pressure, equipment availability, the quality of supervision and the messages conveyed by the organisation. If production is systematically prioritised over safety, workers may feel pressured to accept risks. If the organisation demonstrates that stopping an unsafe task is the correct decision, prevention is reinforced.

In summary, safety culture is reflected in the way the organisation thinks, decides and acts in relation to risk. Reporting and recording transform workers' observations into preventive information. Preventive behaviour makes it possible to apply that information in day-to-day work. When safety culture, reporting and recording, and preventive behaviour are aligned, safety ceases to be merely a set of rules and becomes a continuous practice of anticipation, reporting, responsible decision-making and improvement of working conditions. This relationship between culture, reporting and recording, trust and learning is represented in Figure 1.10.



Figure 1.10— Safety culture: reporting, trust and learning

Problems and self-assessment questions

Reporting and recording occurrences and unsafe conditions

Problem 1.7 — “It is not worth reporting and recording”

An operator observes a hydraulic leak on a piece of equipment and a deteriorated berm on a traffic route. The operator decides not to report and record them because they believe that “nobody will do anything” and because similar problems reported in the past received no response.

Self-assessment questions

- Which barriers to reporting and recording are present in this situation?
- What consequences could result from the failure to report and record these conditions?
- Why should reporting and recording be simple, quick and accessible?
- What minimum information should be included in the report and record concerning the hydraulic leak and the deteriorated berm?
- What actions could the organisation take to restore workers’ trust in the reporting and recording system?

Activity 1.9 — Individual exercise

Choose a real or simulated situation at a working face, on a bench, in a traffic area, in crushing, maintenance, a laboratory or a storage area. Describe the situation and complete the following analysis template:

- Situation observed:
- What behaviour was adopted?
- Was that behaviour preventive or unsafe?
- Which working condition influenced that behaviour?
- Was reporting and recording required? Why?
- What information should have been reported?
- How should management respond?
- What immediate measure should be taken?
- Which continuous improvement measure could be implemented?
- What is the main lesson learned from this situation?

1.1.8.3 Basic investigation of accidents and near misses

The investigation of accidents and near misses is an essential stage of prevention in Occupational Safety and Health. Its primary objective is not to find someone to blame, but to understand what happened, why it happened, which causes and conditions allowed it to occur, which barriers failed, and which measures should be adopted to prevent its recurrence. Every accident, incident or near miss should be treated as an opportunity for learning and improvement.

The investigation should begin as soon as possible, immediately after the occurrence or after a situation with a high potential for harm has been identified. The more time that passes, the greater the likelihood that evidence will be lost, details forgotten, or conditions at the location altered. Even when no injuries occur, near misses should be reported and analysed, particularly when they could have had serious consequences.

The first step is to ensure the immediate safety of people and the location. If there are casualties, first aid should be provided and the emergency response activated. At the same time, the area should be made safe, preventing further exposure to hazards such as slope instability, moving equipment, residual energy, spilled substances, fire, dust, gases or electrical hazards. Whenever necessary, work should be stopped until safe conditions have been established.

Once the situation has been brought under control, it is important to preserve evidence. Photographs, simple sketches, equipment positions, weather conditions, the condition of traffic routes, existing signage, PPE used,

applicable procedures and initial witness accounts can help to explain the occurrence. Evidence gathering should distinguish facts from opinions and avoid premature conclusions.

The investigation should reconstruct the sequence of events by answering basic questions: what happened? Where? When? Who was involved or exposed? What task was being carried out? Which equipment, materials or substances were present? What conditions existed at the location? What immediate action was taken?

Immediate causes and root causes should then be identified. Immediate causes are close to the occurrence, such as an inappropriate manoeuvre, entry into a prohibited area, absence of PPE, a removed guard or defective equipment. Root causes are deeper and may involve inadequate training, failures in supervision, poor maintenance, production pressure, unclear procedures, poor organisation of work or weaknesses in the safety culture.

Simple tools can support this analysis, including the 5 Whys; the what, why, where, when, who, how and how much questions (5W2H); the cause-and-effect diagram; and causal tree analysis. These tools help to prevent the investigation from stopping at the first apparent explanation.

The investigation should lead to corrective and preventive measures that are proportionate to the risk and address the identified causes. Each measure should specify what will be done, who is responsible, the deadline, how implementation will be verified and how effectiveness will be assessed.

Finally, lessons learned should be communicated to the relevant people through meetings, brief pre-task safety meetings, procedure revisions, checklist updates, or training. In this way, the investigation ceases to be merely a response to what happened and becomes an active tool for prevention and continuous improvement. The main stages of this investigation process are summarised in Figure 1.11.



Figure 1.11— Basic investigation of accidents and near misses

Problems and self-assessment questions

Problem 1.8 — “The worker was to blame”

During a maintenance operation, a worker cuts their hand while using an unsuitable tool. Management quickly concludes that the worker “was not careful” and closes the analysis without checking whether suitable tools were available, whether there was a written procedure or whether the worker had received training.

Self-assessment questions

- Does the investigation described seek to understand the occurrence, or does it merely assign blame?
- What information was not analysed?
- Why is it insufficient to conclude that the accident resulted solely from a lack of care?
- Which organisational factors could have contributed to the occurrence?
- What is the difference between holding someone accountable and assigning blame?
- What lesson could be learned if the investigation were more complete?

Problem 1.9 — Generic measure with no person responsible

Following a near collision with a pedestrian on an internal road, the measure stated in the report is: “workers should pay more attention”. No person responsible or deadline is specified, and no changes are made to signage, pedestrian segregation, visibility or the traffic management plan.

Self-assessment questions

- Is the proposed measure sufficient? Justify your answer.
- Which causes of the occurrence remain uncontrolled?
- Which technical or organisational measures could be more effective?
- Why is it important to specify the person responsible and the deadline?
- How can it be verified that the measure was actually implemented?
- What example of a specific, measurable, achievable, relevant and time-bound (SMART) corrective action could be applied?

Activity 1.10 — Individual exercise

Choose an accident, incident or near miss that is real, simulated or described in the course. Complete the following basic investigation template:

- Type of occurrence: accident, incident or near miss.
- Location of the occurrence.
- Task being carried out.
- People, equipment or environment exposed.
- What happened?
- What immediate action was taken?
- What evidence should be collected?
- Which facts are known?
- Which questions remain?
- Probable immediate cause.
- Possible root cause or causes.
- Analysis tool that could be used.
- Immediate corrective measure.
- Preventive measure to avoid recurrence.
- Person responsible and deadline.
- How should the lesson learned be communicated to the team?

1.1.9 Essential preventive responsibilities and clear, factual hazard reporting

Without prejudice to the responsibilities established in the legislation applicable in each country, prevention requires the functions of all parties involved to be clearly defined. The employer should organise work under safe and healthy conditions, provide adequate resources, and ensure that risks are assessed and controlled. Workers should comply with the established procedures, use preventive resources correctly, and report hazards, incidents and relevant changes in working conditions. The designated worker or the person responsible for safety should support hazard identification, risk analysis, occurrence investigation and the monitoring of control measures.

Clear, factual hazard reporting should answer at least four questions: what was observed, where it occurred, who may be exposed and what immediate action is required. The minimum information to be reported is summarised in Table 1.5 and illustrated in Figure 1.12.

Table 1.5 — Minimum structure for clear, factual hazard reporting

Reporting question	Expected response
What did I see?	Describe the hazard, unsafe condition, near miss or deviation observed.
Where did it occur?	Indicate the location, working face, bench, road, crushing area, workshop, laboratory or storage area.
Who is exposed?	Identify workers, pedestrians, operators, maintenance personnel, third parties or communities.
What immediate action is required?	Stop, signpost, isolate, report and record, correct, review the plan or apply an interim control measure.

1. What did I see?

- Hydraulic leak
- Degraded berm

2. Where did it occur?

- Internal traffic route

3. Who is exposed?

- Workers
- Pedestrians
- Equipment

4. What immediate action is needed?

- Signpost
- Isolate
- Report
- Correct

A good report is clear, concise, objective and action-oriented.

Figure 1.12 — Clear, factual hazard reporting

Problems and self-assessment questions

Problem 1.11 — Hazard without a triggering event

When analysing a bench, the learner identifies the hazard “geotechnical instability” but cannot explain how that hazard could develop into an occurrence. The learner merely writes: “there is a risk of an accident”.

Self-assessment questions

- What is the hazard identified?
- Why is the statement “there is a risk of an accident” too general?
- Which triggering events could be associated with bench instability?
- How can rain, vibration and the absence of scaling trigger a rockfall, and how does unauthorised approach increase exposure?
- How does identifying the triggering event help in selecting preventive measures?

1.2 Apply — integrative activity

Mining example

After several days of rain, an internal mine road used by mining haul trucks has ruts, mud and areas of reduced traction. Operations continue without the traffic management plan being reviewed. An operator reports vehicle instability while travelling downhill under load, but the situation is not formally reported and recorded.

The structured analysis of the case is summarised in [Table 1.6](#).

Table 1.6 — Analysis of dynamic risk on a deteriorated mine road after rain

Element	Application to the case
Hazard	Deteriorated mine road, with ruts, mud, accumulated water, reduced traction and potentially weakened berms.
Exposure	Mining haul trucks, light vehicles, operators, pedestrians and equipment using the road.
Triggering event	Loss of traction, lateral skidding, reduced braking effectiveness, road-edge failure or sudden deviation from the line of travel.
Risk	Collision, overturning, vehicle leaving the road, pedestrian collision or traffic obstruction.
Consequences	Serious or fatal injury, property damage, disruption to operations and possible environmental impact.
Control measures	Stop traffic and mark the area; inspect the road; improve drainage and repair ruts; reinforce berms; reduce speed; establish an alternative route; segregate pedestrians; and report and record the condition.

In this case, the road should be treated as a changed operating condition. Operations should stop for reassessment, including checks on the condition of the road, the need for remedial road works or maintenance, the suitability of the speed limit, signage, segregation of pedestrians and equipment, and the possible establishment of an alternative route.

From site observation to preventive decision-making

To turn observation into preventive action, it is useful to organise the analysis into six elements: hazard, exposure, triggering event, risk, consequence and control measure. This structure makes it possible to identify the source of harm, who or what is exposed, what may initiate the occurrence, the risk resulting from that combination, the possible consequences and the measures that should be applied.

Preventive measures under changing conditions

In mining environments, preventive measures should be reviewed whenever conditions change. Prevention follows a simple sequence: observe, report, decide and act ([Figure 1.13](#)).

The essential measures include:

- Inspecting the site before the task and whenever relevant changes occur, such as rain, dust, vibration, blasting, the presence of water or deterioration of roads.
- Immediately reporting and recording deviations, signs of instability, communication failures, deterioration of access routes or unauthorised proximity of pedestrians to equipment.
- Reviewing the work, traffic management or access plan when actual conditions no longer correspond to those anticipated.
- Segregating pedestrians, mobile equipment and loading, unloading, drilling, crushing or maintenance areas.
- Controlling speed on deteriorated roads, or where there is dust, mud, a gradient, reduced visibility or heavy traffic.
- Maintaining roads through grading, drainage, rut repair, berm reinforcement, cleaning and signage.
- Ensuring effective communication between operators, site workers, supervisors and the designated worker, particularly during manoeuvres, in areas with blind spots or under conditions of reduced visibility.

When any of these measures cannot be ensured, the task should be stopped and reassessed before work resumes.

This case should be used to train the links between prompt reporting, safety culture, preventive decision-making, proactive indicators and the hierarchy of controls. The sequence of observation, analysis, decision-making and control is summarised in **Figure 1.13**.



Figure 1.13 — Integrative case: dynamic risk on a deteriorated mine road after rain

1.3 Quick self-assessment

Purposes of Occupational Safety and Health

Short questions

- What is the primary purpose of Occupational Safety and Health?
- What is the difference between preventing occupational accidents and preventing occupational diseases?
- Why should prevention act before harm occurs?
- Why should collective protective measures take priority over personal protective equipment?
- How does worker participation help to improve safety?

Accidents, incidents and near misses

Short questions

- What distinguishes an occupational accident from a near miss?
- Can an accident occur without anyone being injured? Give an example.
- Why should a near miss be recorded?
- What type of information should be included in an initial occurrence report and record?
- Why is prompt reporting essential to prevention?
- What is the difference between reporting and recording to learn and reporting and recording to assign blame?
- Why does an active safety culture depend on occurrence reporting?

Hazard, risk, exposure, triggering event and consequence

Short questions

- What is a hazard?
- What distinguishes a hazard from a risk?
- Why is exposure essential to understanding risk?
- What is meant by a triggering event?
- What does consequence mean in risk assessment?
- Which elements should be identified to describe a risk situation correctly?
- How do these concepts help in selecting appropriate preventive measures?

Unsafe acts, unsafe conditions, active failures and latent conditions

Short questions

- What is an unsafe act?
- What is an unsafe condition?
- What is the difference between an unsafe act and an unsafe condition?
- What characterises an active failure?
- What characterises a latent condition?
- Why is it insufficient to conclude that an accident occurred solely because of “human error”?
- Why should prevention address both immediate and organisational causes?

Safe design and prevention through design

Short questions

- What does prevention through design mean?
- Why is signage alone not always sufficient to control a risk?
- Give an example of a design measure applicable to mobile equipment traffic.
- What is the relationship between safe design and the hierarchy of controls?
- Why should maintenance be considered at the design stage of equipment or an installation?

Hierarchy of controls

Short questions

- What is the purpose of the hierarchy of controls?
- What is the most effective level in the hierarchy of controls?
- What does eliminating a hazard mean?
- What does replacing a hazard with a less hazardous alternative mean?
- What are engineering controls?
- What are organisational or administrative controls?
- Why is PPE considered the last line of defence?

Safety performance and occupational accident indicators

Short questions

- Why is it important to measure occupational accidents?
- What is the difference between the absolute number of accidents and the frequency rate?
- What is the purpose of the incidence rate?
- What is the purpose of the severity rate?
- Why should indicators be interpreted together?
- What are proactive indicators?
- What does it mean to turn data into preventive action?

Safety culture, occurrence reporting and preventive behaviour

Short questions

- What is meant by safety culture?
- Why are reporting and recording essential to prevention?
- What does just culture mean?
- Which organisational factors influence preventive behaviour?
- How can management positively reinforce reporting, recording and prevention?
- Why can stopping an unsafe task be the correct decision?
- Why does a strong safety culture depend on trust?

Basic investigation of accidents and near misses

Short questions

- What is the primary purpose of investigating accidents and near misses?
- Which actions should be taken immediately after an occurrence?
- What types of evidence should be preserved?
- What are immediate causes?
- What are root causes?
- What is the 5 Whys technique used for?
- What are the what, why, where, when, who, how and how much questions (5W2H) used for?
- What characteristics should an effective corrective action have?

1.4 Practical summary

Accidents, incidents and near misses should be analysed as opportunities for prevention and learning. Hazard, exposure, triggering event, risk and consequence form the basic chain of preventive analysis. Safety culture depends on prompt reporting, clear communication, investigation without simplistic blame and continuous improvement. Indicators are useful when they support decisions, prioritisation and correction, rather than merely producing statistics.

The hierarchy of controls should prioritise elimination, substitution, engineering controls and collective protective measures before relying solely on PPE.

In the mining context, prevention should consider ground conditions, equipment, people, organisation, the environment and changing operational conditions.

Fundamentals of occupational hygiene



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Chapter 2 — Fundamentals of Occupational Hygiene

Chapter 1 Chapter 3 4.1.3 4.1.7 Chapter 4 Chapter 5 Chapter 6 Chapter 9

Chapter overview

Section	Pedagogical function
Before you begin	Clarify the guiding question, purpose, objectives, competences and key concepts.
Learning pathway	Explain the Learn–Observe–Decide–Apply–Reflect pathway and the evidence to be collected.
Core technical content	Anticipate, recognise, evaluate and control chemical, physical, biological, ergonomic and psychosocial exposures.
Apply — integrative activity	Complete the short exposure assessment worksheet and justify the preventive decision.
Quick self-assessment	Check understanding of the essential concepts and decisions.
Practical summary	Consolidate the key ideas and transfer them to real work situations.

Before you begin

Question to be answered

Why can a worker become ill or lose functional capacity even when no visible accident has occurred?

Purpose of the chapter

This chapter introduces the fundamentals of occupational hygiene as applied to the extractive industry. Its aim is to help the learner recognise workplace agents and conditions that may affect workers' health, even when they do not produce immediate effects. Reading this chapter should support the observation of tasks.

Learning objectives

- Distinguish between occupational safety and occupational hygiene, understanding their complementary roles in prevention.
- Explain the fundamental stages of occupational hygiene: anticipate, recognise, evaluate and control.
- Identify chemical agents, mineral dusts, noise, vibration, biological agents, ergonomic factors and psychosocial factors.
- Recognise routes of exposure, exposed workers, acute effects and chronic effects.
- Relate exposure sources to mining tasks such as drilling, crushing, haulage, maintenance, laboratory work, ventilation and storage.
- Select controls at source, collective protective measures, organisational controls and PPE as a complement.
- Use a simple worksheet to transform the observation of a task into an exposure and prevention assessment.
- Prepare evidence for the digital portfolio and for classroom discussion.

Competences to be developed

- Observe a task and identify workplace agents.
- Describe the source, route of exposure, people exposed, likely effects and control measures.
- Report an exposure factually, without relying solely on the worker's individual perception.
- Apply the hierarchy of controls to chemical, physical, biological, ergonomic and psychosocial agents.
- Recognise warning signs that justify stopping, measuring, reporting and recording the situation, or reassessing the task.

Key concepts

Concept	Operational definition for this chapter
Occupational hygiene	The field of OSH dedicated to anticipating, recognising, evaluating and controlling workplace agents and conditions that may affect health.
Chemical agent	A substance or mixture present as dust, fume, gas, vapour, liquid, solid or aerosol, with the potential to cause harm.
Physical agent	A physical factor in the environment, such as noise or vibration, whose intensity and duration may affect health, safety and well-being.
Biological agent	A microorganism, parasite, toxin or biological material capable of causing infection, allergy or another adverse effect.
Exposure	Contact between a worker and an agent, considering the route, intensity, duration and frequency.
Control at source	A measure that eliminates or reduces the agent at the point where it is generated, before it reaches workers.
Monitoring	Technical, documentary or operational verification of exposure and of the effectiveness of controls.
PPE	Personal protective equipment used as a complement, not as a substitute for technical and collective protective measures.

Learning pathway

Stage	What the learner does	Output or evidence
Learn	Reads the essential concepts of occupational hygiene and identifies categories of agents.	Reading notes and a personal glossary.
Observe	Analyses tasks, images, videos or accounts, looking for sources of exposure.	List of agents, sources and exposed workers.
Decide	Determines whether the task may continue, may continue subject to specified controls, or must be stopped for assessment.	Justified response to the decision questions.
Apply	Completes exposure assessment worksheets and selects control measures.	Activity worksheet or group work.
Reflect	Records what was learned and identifies measures transferable to other mining contexts.	Entry in the digital portfolio.

Supporting materials

To structure the assessment of an occupational exposure and record the available evidence, use **A.2 — Occupational exposure analysis**. The matrices, examples, integrative activity and self-assessment remain within the chapter.

2.1 What is occupational hygiene?

2.1.1 Concept and purpose

Occupational hygiene is the field of Occupational Safety and Health (OSH) dedicated to anticipating, recognising, evaluating and controlling workplace agents and conditions that may affect workers' health. Whereas occupational safety focuses primarily on preventing accidents and sudden occurrences, occupational hygiene focuses mainly on preventing occupational diseases and other adverse effects that may result from repeated, prolonged or poorly controlled exposures.

In the extractive industry, this field is particularly important because many exposures are not immediately visible. A worker may be exposed to mineral dusts, noise, vibration, chemical substances, biological agents or adverse workplace conditions without experiencing immediate effects. Over time, however, these exposures may contribute to respiratory diseases, hearing loss, musculoskeletal disorders, toxic effects, infections, fatigue or reduced ability to work.

The practice of occupational hygiene is organised into four essential stages. Anticipation involves predicting which agents may be present before starting a task, introducing new equipment, changing a process or using a new substance. Recognition involves identifying exposure sources, exposed workers, routes of entry into the body and the actual conditions under which the work is performed. Evaluation enables the intensity, duration and frequency of exposure to be understood and may involve direct observation, consultation of safety data sheets, work records, workplace exposure measurements or personal exposure measurements. Control involves implementing measures to eliminate or reduce exposure, giving priority to action at source and collective protective measures. The relationship between the four stages of occupational hygiene and the decision on whether the task may continue is summarised in Figure 2.1.



Figure 2.1— Occupational hygiene in the extractive industry: anticipate, recognise, evaluate and control

In the mining context, occupational hygiene should be present at every stage of the activity: drilling, blasting, loading, haulage, crushing, maintenance, laboratory work, storage and logistics support. In each of these situations, the following questions should be asked: which agents may be present? Who is exposed? For how long? By what route may exposure occur? What effects may arise? Which measures can reduce the risk? The main elements that determine occupational exposure — source, route of exposure, duration, frequency and intensity — are presented in Figure 2.2.

Applying the hierarchy of controls presented in **Chapter 1 — Work Safety and Safety Culture** the priority in occupational hygiene is to act on exposure. Wherever possible, the agent should be reduced at source, hazardous products or methods should be replaced, and ventilation, local exhaust ventilation, enclosure, wet suppression, acoustic isolation, vibration reduction and workplace redesign should be applied before relying on PPE as a complement.

This section introduces the general logic of occupational hygiene. The following sections examine in greater detail three groups of agents that are particularly relevant to the extractive industry: chemical agents, such as dusts, fumes, gases, fuels, lubricants, solvents and reagents; physical agents, particularly noise and vibration; and biological agents associated with contaminated water, waste, vectors, animals, sanitary facilities, canteens, accommodation and laboratories.

In summary, occupational hygiene makes exposures visible that often go unnoticed. Its purpose is to protect workers' health, prevent occupational diseases, support risk assessment and provide a basis for control measures suited to the realities of the extractive industry.



Figure 2.2— Occupational exposure: source, route, duration, frequency and intensity

2.1.2 Fundamental stages of occupational hygiene

Table 2.1 summarises the four fundamental stages of occupational hygiene and the questions that should guide the analysis of an exposure situation.

Table 2.1 — Fundamental stages of occupational hygiene

Stage	Guiding question	Expected outcome
Anticipate	Which agents may be present before the task is started or changed?	Prediction of exposure sources and critical situations.
Recognise	Which agents are present at the workplace, in what form and during which tasks?	Identification of sources, routes of exposure and exposed workers.
Evaluate	What are the intensity, duration and frequency of exposure?	Characterisation of exposure and identification of the need for measurement or monitoring.
Control	How can exposure be eliminated or reduced?	Selection of controls at source, collective protective measures, organisational controls and complementary PPE.

Problem for reflection — Exposure without immediate effects

In a crushing area, several workers report mild respiratory discomfort and eye irritation at the end of the shift. As no accidents or sudden injuries have occurred, the situation is not treated as a priority. There have been no recent dust measurements, and reported symptoms are not systematically recorded.

Questions:

- Why should this situation be analysed through occupational hygiene?
- What effects may arise after repeated or prolonged exposures?
- What information should be collected to assess the situation?

Activity 2.1 — Practical application

Choose a specific task at a working face, in a crushing area, during maintenance, in a laboratory, in a warehouse or in a mobile equipment traffic area. Analyse the task using the fundamentals of occupational hygiene: task, agent, source, exposed workers, route of exposure, possible effects, recommended assessment or measurement, control measure at source, collective or organisational measure, complementary PPE, evidence to be recorded and main lesson learned.

2.1.3 Mineral dusts and chemical agents

2.1.3.1 Chemical agents in the mining context

Chemical agents are substances or mixtures which, because of their physicochemical or toxicological properties, or the way in which they are used, may pose a risk to workers' safety and health. They may be present as dusts, fumes, gases, vapours, fibres, aerosols, liquids or solids. In the extractive industry, they occur in a range of activities, including drilling, blasting, crushing, haulage, maintenance, storage, refuelling, laboratory work and mineral processing.

Relevant examples in the mining context include mineral dusts, respirable crystalline silica (RCS), welding fume, blasting fumes, diesel exhaust emissions, solvents, acids, alkalis, fuels, lubricants, oils, greases, laboratory reagents and cleaning or degreasing products. The presence of these agents does not automatically mean that harm will occur, but it requires an assessment of the substance's hazardous properties, the conditions of use and workers' exposure.

Exposure to chemical agents may occur through different routes. The inhalation route is often the most relevant, particularly where dusts, gases, vapours or fumes are inhaled. The finer the particles, the greater their potential to reach deep regions of the respiratory system. The dermal route involves direct contact with the skin and is particularly important when handling solvents, acids, fuels, oils or irritant products. Eye contact may result from splashes or projections. The ingestion route is less common, but may occur through poor hygiene practices, such as eating, drinking or smoking in contaminated areas.

The effects of chemical agents may be acute or chronic. Acute effects arise after short-term exposures and may include irritation, burns, poisoning, dizziness, nausea, breathing difficulties or eye injuries. Chronic effects result from repeated or prolonged exposures and may include respiratory diseases, neurological changes, liver or kidney damage, dermatitis, sensitisation, reproductive effects or cancer, depending on the agent involved.

Prevention of chemical risk begins with correctly identifying the substances present. Appropriate labelling, consultation of safety data sheets, a chemical inventory, identification of the tasks in which products are used and assessment of the actual exposure conditions are therefore essential. Chemical classification and labelling make it possible to recognise quickly the main hazards associated with each substance or mixture. From the label and safety data sheet, workers can identify whether the product is flammable, corrosive, toxic, irritant, sensitising, carcinogenic or hazardous to the environment. This information does not replace risk assessment, but it helps determine how the product should be stored, handled, transported, used and disposed of safely. Unlabelled products, improvised containers, incompatible mixtures, disorganised storage or lack of ventilation are indicators of increased risk.

For chemical agents, the priority is to prevent or reduce exposure at source. Where elimination or substitution is not feasible, ventilation, containment, labelling, storage according to chemical compatibility, clear procedures, training, monitoring and appropriate PPE should be applied as complementary measures. The application of this approach to tasks involving mineral dusts, silica and other chemical agents is shown in Figure 2.3.

2.1.3.2 Mineral dusts and respirable crystalline silica

Mineral dusts require particular attention because they are present at several stages of the extractive industry: drilling, blasting, loading, haulage, crushing, screening, cleaning, maintenance and storage. Fine particles can reach deep regions of the respiratory system. Where the material contains silica, the potential for exposure to RCS must be considered.

This combination is particularly evident at the primary crusher, where high mechanical energy may simultaneously generate dust, intense noise, vibration, falling material and interaction with moving parts and mobile equipment. Dust exposure should therefore be assessed together with visibility, noise, traffic and maintenance requirements.

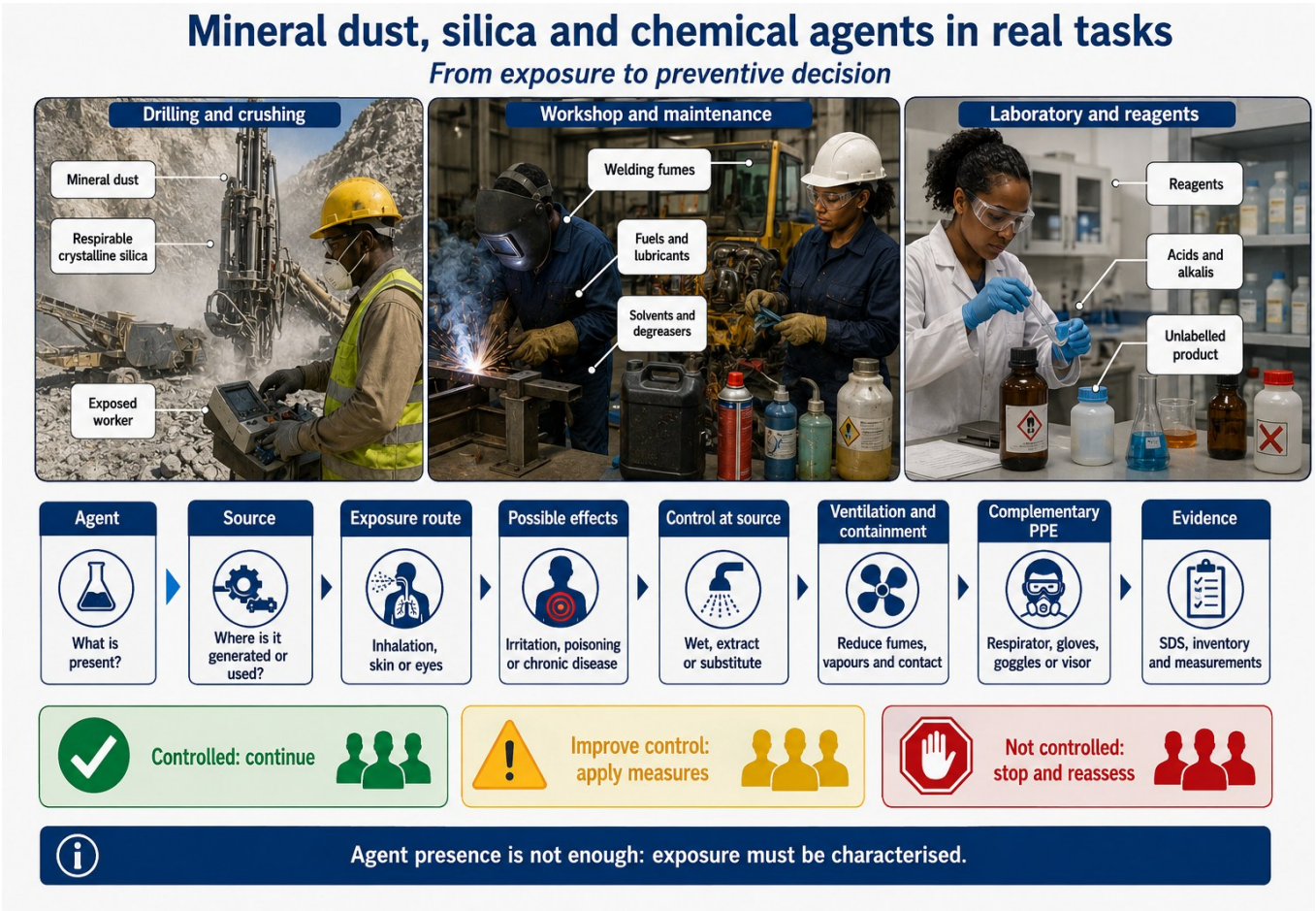


Figure 2.3 — Mineral dusts, silica and chemical agents in real tasks

2.1.3.3 Critical situations and priority measures

Table 2.2 presents examples of critical situations that commonly require intervention.

Table 2.2 — Critical situations involving exposure to mineral dusts and chemical agents, and priority measures

Observable situation	Agent or source	Health and safety risk	Priority measure
Crushing dry material with the wet suppression system not operational	Airborne mineral dust	Respiratory irritation, chronic exposure and reduced visibility	Control dust at source: wet suppression, local exhaust ventilation (LEV), water misting, partial enclosure and appropriate cleaning.
Unlabelled product in the laboratory	Unknown chemical substance	Dermal contact, inhalation or misuse, with unpredictable effects	Isolate, identify and label the product, and consult the safety data sheet before use.
Welding or maintenance generating fumes or vapours	Metal fumes or chemical vapours	Inhalation of fumes or vapours and respiratory irritation	LEV, general ventilation, task organisation and suitable respiratory protective equipment (RPE).
Fuels, oils and lubricants	Flammable or irritant liquids and vapours	Dermal contact, fire, spills and contamination	Safe storage, containment, ventilation, labelling and spill response.
Traffic on dry roads	Dust raised by traffic	Respiratory exposure and reduced visibility	Controlled watering, road maintenance, speed control and monitoring.

Problem for reflection — Mineral dusts in crushing

At a crushing plant, a high concentration of airborne dust is observed. The wet suppression system is not operational and cleaning is carried out using dry methods. Some workers use RPE, but others remove it during part of the shift because of discomfort.

Questions:

- Which contaminant is present?
- What is the main route of exposure?
- Which collective protective measures should be considered before PPE?
- What evidence should be collected?

Activity 2.2 — Practical application

Choose a task involving chemical agents, such as crushing, drilling, refuelling, welding, cleaning, laboratory work, maintenance or storage. Record: chemical agent, physical form, source, exposed workers, route of exposure, acute effects, chronic effects, measure for elimination or substitution, engineering control, organisational control, complementary PPE and evidence to be collected.

2.1.4 Noise and vibration

2.1.4.1 Physical agents

Physical agents are factors present in the workplace which, because of their intensity, duration or form of exposure, may affect workers' health, safety and well-being. In the extractive industry, noise and vibration are particularly important and are associated with mobile equipment, drilling rigs, crushers, pneumatic tools, heavy vehicles, compressors, generators and other mechanical sources.

Occupational noise is unwanted or harmful sound present in the workplace. It may hinder communication, reduce the ability to perceive warning signals, increase fatigue and contribute to accidents. Where exposure is high or prolonged, it may cause auditory fatigue, tinnitus, temporary hearing loss and, in situations of repeated or intense exposure, permanent hearing loss. In the mining context, noise is common during drilling, crushing, haulage and mobile equipment traffic, ventilation, operation of mining haul trucks and wheel loaders, mechanical maintenance, workshop activities and use of impact tools.

Noise assessment should consider the noise level, duration of exposure, distance from the source, number of exposed workers, condition of the equipment and the presence of impulsive noise events. Warning signs such

as difficulty communicating at close range, a constant need to raise the voice, tinnitus or discomfort after the shift should be taken seriously and may indicate excessive exposure.

For noise, priority should be given to control at source and along the transmission path: selecting quieter equipment, maintaining machinery, enclosing sources, installing barriers, moving workstations farther from the source and organising exposure times. Hearing protection should complement these measures rather than replace technical controls.

Occupational vibration consists of oscillatory movements transmitted to the human body through tools, machines, vehicles or vibrating surfaces. It may be classified as hand-arm vibration (HAV) or whole-body vibration (WBV). HAV occurs when pneumatic hammers, angle grinders, hand-held drills and other vibrating tools are used. Prolonged exposure may cause tingling, loss of sensation, pain, vascular changes and musculoskeletal disorders.

WBV occurs when a worker is seated on or supported by a vibrating surface, as is the case for operators of mining haul trucks, wheel loaders, excavators, trucks, tractors or forklifts. This risk may be aggravated by deteriorated roads, uneven surfaces, prolonged driving, unsuitable seats, poor maintenance and excessive speed. Consequences may include fatigue, discomfort, lower-back pain and aggravation of musculoskeletal disorders.

Vibration control should include selecting equipment with lower vibration emissions, regular maintenance, improving traffic routes, suspension seats, low-vibration tools, limiting exposure time, task rotation, operator training and health surveillance.

In summary, noise and vibration are common physical agents in the extractive industry. Their management requires identification of sources, exposure assessment, collective and organisational measures, PPE where necessary, and continuous monitoring of actual working conditions. The relationship between sources, forms of exposure, warning signs, control measures and operational decision-making is summarised in Figure 2.4.



Figure 2.4 — Noise and vibration in extractive operations

2.1.4.2 Mining examples of exposure

Table 2.3 presents examples of mining tasks involving exposure to noise or vibration, identifying the factors that increase exposure and the main applicable preventive measures.

Table 2.3 — Examples of exposure to noise and vibration in mining tasks

Example	Physical agent	Factors that increase exposure	Main measures
Crushing where communication is difficult	Noise	Crusher, falling material, continuous operation and absence of barriers	Measurement, maintenance, enclosure, barriers, increased distance, exposure limitation and hearing protection.
Mining haul truck operator on a deteriorated road	Whole-body vibration	Potholes, ruts, worn seat, prolonged driving and inappropriate speed	Road maintenance, suspension seat, equipment inspection, speed control and breaks.
Use of a pneumatic hammer	Noise and hand-arm vibration	Percussive action, prolonged grip, awkward posture and a worn tool	Suitable tool, maintenance, breaks, task rotation, dust control and hearing protection.
Fans and compressors	Noise and structure-borne vibration	High power, poor maintenance and remaining close to the source	Acoustic attenuators, enclosure, maintenance, increased distance and area signage.

Problem for reflection — High noise levels in crushing

At a crushing plant, workers have difficulty communicating at close range and need to raise their voices for much of the shift. The company provides hearing protectors, but there have been no recent noise measurements, and there are no acoustic barriers, crusher enclosure or plan to limit exposure time.

Questions:

- Which signs indicate possible excessive exposure?
- What effects may this have on health and operational safety?
- Why is providing hearing protectors without assessing exposure insufficient?

Problem for reflection — Mining haul truck operator on deteriorated roads

A mining haul truck operator works for several hours each day on uneven internal mine roads with potholes and deteriorated surfaces. The equipment seat is worn, and the operator reports frequent fatigue and lower-back pain at the end of the shift.

Questions:

- What type of vibration is present?
- Which factors increase exposure?
- What roles do road maintenance and seat maintenance play?

Activity 2.3 — Practical application

Choose a task involving noise, vibration or both, such as crushing, drilling, driving a mining haul truck, using a pneumatic hammer, mechanical maintenance or operating a wheel loader. Identify the source, exposed workers, likely duration, health effects, effects on operational safety, a control measure at source, a collective protective measure, an organisational control, complementary PPE and evidence to be collected.

2.1.5 Biological agents

Biological agents are microorganisms, cell cultures, parasites or materials of biological origin that may cause infections, allergies, poisoning or other adverse health effects in workers. They include bacteria, viruses, fungi, parasites and toxins produced by living organisms. Although they are often associated with hospitals, laboratories or agricultural activities, they may also be present in extractive-industry settings, particularly where there is contaminated water, damp soil, organic waste, inadequate sanitary facilities, contact with animals, vectors, or tropical environments conducive to the proliferation of microorganisms.

As an introduction, biological agents may be classified into four hazard groups. Hazard Group 1 includes agents that are unlikely to cause disease in workers. Hazard Group 2 includes agents that may cause disease and present a hazard to workers, but are unlikely to spread to the community and for which effective prevention or treatment is generally available. Hazard Group 3 includes agents that may cause severe disease, present a serious risk to workers and may spread to the community, although effective preventive or treatment measures may be available. Hazard Group 4 includes agents that may cause severe disease, present a high risk and may spread readily, with no effective preventive or treatment measures generally available.

Classification by hazard group provides a general technical framework. The assessment of each situation should consider the agent actually present, the route and intensity of exposure, workers' vulnerability, and the applicable legal and public-health requirements in each country.

In mining activities, exposure to biological agents may occur in various situations: work in areas with standing water, contaminated drainage, contact with mud or potentially contaminated soil, cleaning sanitary facilities, handling waste, staying in temporary accommodation, using canteens or eating areas without adequate hygiene conditions, laboratory activities involving contaminated samples, or work in areas where rodents, insects or other animals are present. In tropical regions, consideration should also be given to the risk associated with vectors, such as mosquitoes, which may transmit diseases relevant to workers' health.

Assessment should take account of local climatic, sanitary and logistical conditions, integrating environmental controls with health surveillance and plans for preventing vector-borne diseases.

Exposure may occur through different routes. The dermal route is important where there is contact with water, soil, waste or contaminated materials, particularly where cuts, wounds or skin irritation are present. Exposure through inhalation may occur through contaminated aerosols, biological dusts or droplets. The ingestion route may result from poor hygiene practices, such as eating, drinking or smoking in contaminated areas. Exposure may also occur through insect bites or contact with animals or their waste.

Health effects may vary considerably. Some agents cause mild infections; others may result in severe disease, prolonged absence from work or a high risk for more vulnerable workers. Risk depends on the agent present, the dose or intensity of exposure, the route of entry into the body, hygiene conditions, the worker's health status, vaccination status, age, fatigue, and the preventive measures in place.

Prevention should begin by identifying potential sources of contamination and the tasks in which workers may be exposed. Adequate hygiene and sanitation, a supply of potable water, clean sanitary facilities, proper waste management, control of standing water, regular cleaning of work areas and vector control should be ensured. Where necessary, procedures should be established for handling contaminated materials, cleaning, decontamination and incident response.

Collective protective and organisational measures should be prioritised. These include adequate drainage, elimination of standing water, ventilation, physical barriers, suitable waste containers, worker information, health surveillance and vaccination where applicable. PPE such as gloves, boots, masks, safety glasses and protective clothing should be used as a complementary measure where contact with contaminated materials may occur.

The main sources and situations involving exposure to biological agents in mining contexts are shown in **Figure 2.5**.

Biological agents in mining contexts

From biological source to preventive decision

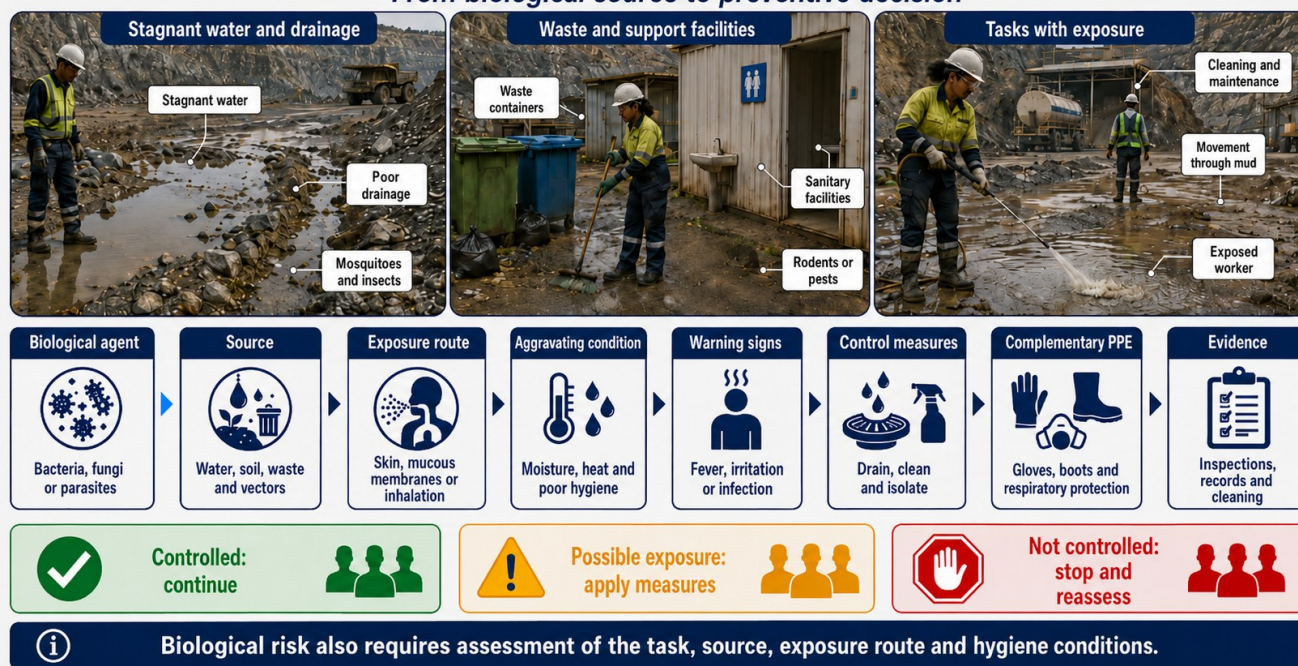


Figure 2.5 — Biological agents in mining contexts

Situations to observe in mining contexts

Table 2.4 presents examples of situations in which biological agents may be present in mining contexts, linking potential sources, routes of exposure and priority preventive measures.

Table 2.4 — Examples of situations to observe in mining contexts

Situation	Possible source	Route of exposure	Preventive measures
Standing water after rainfall	Microorganisms and vectors, such as mosquitoes	Dermal contact, bites, aerosols or accidental ingestion	Drainage, elimination of standing water, vector control, suitable boots, and reporting and recording.
Sanitary facilities without adequate cleaning	Biological contamination and waste	Dermal contact or contact with contaminated surfaces, and accidental ingestion	Potable water, hand hygiene, regular cleaning, waste management and suitable eating areas.
Organic waste or presence of rodents	Bacteria, viruses, parasites or allergens	Contact, inhalation or inoculation	Waste collection, pest control, cleaning and PPE for contaminated tasks.
Laboratory handling contaminated samples	Environmental or biological samples	Contact, inhalation, inoculation or accidental ingestion	Procedures, containment, decontamination, training and health surveillance.

Problem for reflection — Standing water near the work area

After several days of rainfall, areas of standing water form near a working area and along access routes used by workers. Some workers cross these areas wearing worn boots and report frequent insect bites.

Questions:

- Which biological agents or vectors may be associated with this situation?
- Which workers are exposed?
- Which collective protective measures should be applied?

Problem for reflection — Sanitary facilities without adequate hygiene conditions

At a remote mining operation, the sanitary facilities are poorly cleaned, there is no regular supply of water for handwashing, and waste is not removed frequently. Some workers eat near the work area without adequate hygiene conditions.

Questions:

- Which biological hazards are present?
- Why is hand hygiene essential?
- What minimum conditions should be provided to protect workers' health?

2.1.6 Atmospheres in underground mines: ventilation, monitoring and control

In underground operations, ventilation is an essential collective control measure for supplying breathable air, removing contaminants and preventing hazardous atmospheres. The basic operation of this system, the main atmospheric hazards, and the monitoring and control measures are presented in [Figure 2.6](#). The figure shows the parameters to be monitored and the response logic for an unsafe atmosphere. Applicable limit values should be confirmed against the legislation, technical standards and procedures in force in each country and operation.

2.1.6.1 Ventilation as a collective control measure

Mine ventilation systems comprise equipment, infrastructure, ducting, airways, control devices and operating procedures intended to ensure the renewal and distribution of air and the control of air quality in mining workplaces. They are particularly critical in underground mines, tunnels, roadways, development headings, chambers, shafts, underground workshops, loading areas, blasting areas, areas containing diesel equipment, storage locations, technical installations and spaces with little natural air renewal.

The main function of mine ventilation is to supply sufficient breathable air, remove contaminants, dilute hazardous gases, control dust, reduce diesel exhaust gases and particulate matter, remove blasting fumes, control temperature and humidity, prevent hazardous atmospheres and support safe evacuation in an emergency. In underground settings, ventilation is not merely a comfort measure: it is essential for survival and risk control.

From an OSH perspective, mine ventilation should be analysed as a critical prevention system. The absence, insufficiency or poor distribution of air may result in oxygen-deficient atmospheres, accumulation of toxic gases, presence of explosive gases, exposure to respirable dusts, blasting fumes, diesel exhaust gases and particulate matter, heat stress, loss of visibility, fatigue, poisoning, asphyxiation, fire, explosion and inability to evacuate.

Ventilation systems may be primary, auxiliary or local. Primary ventilation provides the mine's overall airflow circuit, normally through main fans, intake airways, return airways, shafts, ramps, raises and main roadways. Auxiliary ventilation directs air to specific areas, such as development headings, blind headings, chambers under development or locations distant from the primary circuit. Local ventilation is applied to specific contaminant sources, such as workshops, loading points, welding areas, diesel equipment, underground crushing or locations with localised emissions of dust and gases.

Mine ventilation should be understood as a dynamic system. The development of new roadways, advances in mining operations, changes at working faces, installation or removal of doors, falls of material, fires, breakdowns, obstructions, electrical failures, changes in diesel equipment, weather changes, or operating errors may alter the airflow circuit. Ventilation, therefore, requires continuous planning, measurement, monitoring, maintenance, recording, reporting and review.

Mine Ventilation and Atmospheric Hazards

Ventilation as a collective barrier and the importance of controlling the occupational atmosphere



Figure 2.6 — Mine ventilation and atmospheric hazards

2.1.6.2 Atmospheric hazards and ventilation-dependent areas

The main atmospheric hazards include oxygen deficiency, toxic or flammable gases, blasting fumes, diesel exhaust gases and particulate matter, respirable dusts, heat, humidity and recirculation of contaminated air. These hazards may be aggravated by fan or sensor failures, damaged ducting, obstructions, airflow reversal and unauthorised changes to the airflow circuit.

Monitoring should be intensified at development headings, blind headings, post-blast areas, areas containing diesel equipment, return airways, underground workshops, shafts, raises, abandoned or sealed areas, and locations without adequate atmospheric monitoring.

2.1.6.3 Essential control measures

- Prepare and keep the ventilation plan up to date, including airflow circuits, flow directions, air quantities, measuring points, fans, doors, regulators, working faces and return airways.
- Design ventilation capacity for the activity, taking account of the number of workers, diesel equipment, explosives, dusts, heat, humidity, depth, roadway length and expected contaminants.
- Ensure sufficient air quantity at working faces, particularly in blind headings, development headings, chambers and areas distant from the primary circuit.
- Install auxiliary ventilation where necessary, ensuring that the ducting reaches sufficiently close to the face and that there are no significant leaks.
- Prevent recirculation of contaminated air by correctly positioning fans, ducting, return airways and discharge points.
- Keep doors, regulators, curtains and ventilation stoppings in good condition, preventing air short-circuiting and unauthorised changes.
- Measure air quantity and velocity regularly and compare the results with the requirements defined in the ventilation plan.
- Monitor hazardous gases using fixed sensors and portable gas monitors, with defined alarm levels and a clear operational response.
- Carry out atmospheric testing before entry into critical areas, such as poorly ventilated roadways, post-blast areas, confined spaces, shafts, raises or abandoned areas.

- Establish post-blast re-entry times based on effective ventilation, atmospheric testing and supervisory authorisation.
- Control diesel exhaust gases and particulate matter at source through maintenance, limiting the number of items of equipment operating simultaneously, suitable filters, appropriate fuels and sufficient ventilation.
- Control dust at source by using wet drilling, water misting, local exhaust ventilation, appropriate cleaning and maintenance of extraction systems.
- Keep fans in good condition, with inspections of blades, bearings, guards, motors, cables, mountings, vibration, noise and performance.
- Guard moving parts of fans to prevent contact with blades, belts, pulleys, couplings or motors.
- Ensure a reliable electrical supply, including fault protection, protected electrical panels, cables in good condition and, where necessary, a backup power supply.
- Define the response to ventilation failure, including stopping work, evacuation, reporting, access restriction and atmospheric testing before re-entry.
- Mark prohibited or authorisation-dependent areas, indicating atmospheric risk, lack of ventilation or the need for prior testing.
- Control temperature and humidity, particularly in deep or hot areas or where physically demanding work is performed.
- Integrate ventilation into the emergency plan, taking account of fire, explosion, fumes, evacuation, refuge arrangements, communication and mine rescue team access.
- Train workers and supervisors in ventilation principles, atmospheric hazards, alarms, gases, dusts, evacuation routes, prohibited areas, and reporting and recording anomalies.
- Prohibit unauthorised changes to the ventilation circuit, including opening or closing doors, cutting ducting, removing curtains or adjusting regulators.
- Keep inspection and measurement records to support traceability, trend analysis and continuous improvement.
- Use PPE as a complementary measure, including RPE only where specified by risk assessment and procedure and where it is compatible with the type of contaminant.
- Reassess ventilation whenever the mine changes, including the development of new working faces, equipment changes, blasting, fires, obstructions, breakdowns or changes in the working method.

2.1.6.4 Operational summary

In summary, mine ventilation is a critical collective control measure. Safe operation requires an up-to-date plan, adequate air quantities, fans and ducting in good condition, regular atmospheric testing, defined responses to alarms and failures, access control, training and integration with the emergency plan. Whenever ventilation or air quality cannot be demonstrated to be adequate, work should be stopped and the area reassessed.

2.1.7 Ergonomic and psychosocial factors

In addition to chemical, physical and biological agents, an integrated assessment of working conditions within OSH should consider ergonomic and psychosocial factors that may affect workers' health, safety and performance. These factors are not always immediately visible, but they influence how work is carried out, fatigue, concentration, the likelihood of error and the risk of injury or occupational disease. The relationship between the tasks observed, ergonomic and psychosocial factors, possible effects and preventive measures is summarised in [Figure 2.7](#).

Ergonomic and psychosocial factors in mining tasks

From task organisation to preventive decision-making



Figure 2.7 — Ergonomic and psychosocial factors in mining tasks

Ergonomic factors relate to adapting work to human capabilities and limitations. They include manual handling of loads, awkward postures, repetitive movements, high physical demands, prolonged standing or sitting, use of unsuitable tools, poorly positioned controls, uncomfortable cabs, worn seats, and tasks carried out in confined or difficult-to-access spaces. Where these factors are not controlled, they may contribute to lower-back pain, musculoskeletal disorders, fatigue, loss of efficiency and a greater likelihood of accidents.

In the extractive industry, ergonomic risks may arise in various tasks. During maintenance, they may result from lifting heavy components, working in awkward positions or prolonged use of hand tools. In laboratories and storage areas, they may be associated with handling samples, reagents or materials. When driving mining haul trucks, wheel loaders, excavators or trucks, they may result from prolonged postures, vibration, unsuitable seats and difficult access to the cab. Significant physical demands and repetitive tasks may also be present in crushing areas, workshops and working faces.

Psychosocial factors relate to how work is organised, managed and experienced by workers. They include excessive workload, production pressure, long shifts, insufficient breaks, fatigue, isolation, poor communication, conflict, role ambiguity, low worker participation, inadequate leadership and a perceived lack of support. These factors may contribute to stress, demotivation, difficulty concentrating, decision-making errors, at-risk behaviour, and physical and mental health problems.

In mining settings, psychosocial factors are particularly relevant because many operations take place in demanding, remote and noisy environments involving heavy equipment, variable weather conditions and pressure to meet production targets. Where the organisation values speed of execution above safety, workers may feel pressured to disregard procedures, take shortcuts, or fail to report and record hazardous situations. Safety leadership, clear communication and the ability to stop unsafe work strengthen safety culture and reduce the costs of accidents.

Prevention of ergonomic and psychosocial factors should follow the same control approach applied to other risks. Wherever possible, work should be redesigned to reduce physical effort, repetition, awkward postures

and prolonged exposure. Mechanical lifting aids, suitable tools, adjustable seats, improved access, task rotation, planned breaks, equipment maintenance and appropriate organisation of workspaces may be used. In the psychosocial domain, realistic planning, effective communication, worker participation, training, close supervision, fatigue management, and appropriate handling of reports and records are essential.

Ergonomic and psychosocial factors show that prevention does not depend solely on the presence of substances, noise, vibration or biological agents. It also depends on how work is designed, allocated, carried out and supervised. Integrating these factors into risk assessment helps protect workers' health, reduce errors, improve performance and reinforce a stronger safety culture in the extractive industry.

Typical situations

Table 2.5 presents typical situations in which ergonomic or psychosocial factors may affect workers' health, attention and performance, together with appropriate preventive measures.

Table 2.5 — Typical situations associated with ergonomic and psychosocial factors

Situation	Main factor	Possible effect	Preventive measure
Manual handling of samples and materials	Physical effort, awkward postures and unsuitable storage	Lower-back pain, upper-limb disorders and fatigue	Reorganise storage, use mechanical aids, reduce weight and provide training in safe handling techniques.
Prolonged use of hand tools	Repetition, vibration, grip force and posture	Musculoskeletal disorders and fatigue	Suitable tools, task rotation, breaks, maintenance and ergonomic task design.
Prolonged driving on deteriorated roads	Whole-body vibration and prolonged sitting	Lower-back pain, fatigue and loss of attention	Road maintenance, suitable seat, breaks and exposure limits.
Production pressure and unsafe shortcuts	Workload, pressure, supervision and culture	Normalisation of deviance and increased accidents	Realistic planning, communication, the right and duty to stop work, and safety leadership.

Problem for reflection — Manual handling of samples and materials

In a laboratory supporting a mining operation, workers manually handle boxes of samples, reagents and small items of equipment. Some boxes are heavy, are stored on shelves that are too low or too high, and require trunk flexion, body twisting or lifting above shoulder height.

Questions:

- Which ergonomic factors are present?
- Which mechanical aids could be used?
- Why is training insufficient if the workstation remains poorly organised?

Problem for reflection — Production pressure and unsafe shortcuts

At a quarry, the team is behind the production schedule. Management insists that the task must be completed quickly. Some workers begin to reduce checks, shorten procedures and accept situations that would normally be reported and recorded.

Questions:

- Which psychosocial factors are present?
- How does production pressure influence preventive behaviour?
- What role does the right and duty to stop unsafe work play?

2.1.8 Practical preventive measures in mining contexts

Across occupational hygiene, the hierarchy of controls presented in Chapter 1 — Work Safety and Safety Culture can be expressed as a simple rule: first, control the agent at source; then provide collective protection; next, organise time, the working method and exposure; and finally use PPE as a supplementary barrier (Table 2.6).

Table 2.6 — Application of the hierarchy of controls to the agents and factors addressed in the chapter

Category of measure	Examples applicable to this chapter
Elimination or substitution	Eliminate a hazardous substance; replace a product, process or tool with a less harmful alternative; reduce dust generation at source.
Engineering controls / collective protective measures	Ventilation, local exhaust ventilation, enclosure, wet suppression, acoustic barriers, suspension seats, drainage, containment and road maintenance.
Work organisation	Task rotation, exposure limits, shift planning, breaks, signage, permits-to-work, training, reporting and recording.
Monitoring and verification	Measurements of dust, noise, vibration, gases and air quantity; inspections; records; safety data sheets; and health surveillance.
Supplementary PPE	Respiratory protection, hearing protection, gloves, safety glasses, face shield, boots, protective clothing, self-rescuer or escape equipment, where applicable.

When to stop or reassess

- Where dust is uncontrolled, visibility is insufficient, or workers report persistent respiratory symptoms.
- Where noise prevents safe communication or there are no adequate measurements or controls for high exposure.
- Where there is abnormal vibration, deteriorated roads, a damaged seat or evident operator fatigue.
- Where a chemical product is unlabelled, the safety data sheet is unavailable, or a spill is uncontrolled.
- Where a hazardous atmosphere, ventilation failure, alarm, gas, fume or oxygen deficiency is suspected.
- Where standing water, waste, pests or sanitary facilities without minimum acceptable conditions are present.
- Where the task requires excessive physical effort, an unsafe posture, or production pressure that encourages shortcuts.

2.2 Apply — integrative activity

Activity 2.4 — Short exposure assessment worksheet

Complete **Table 2.7** to record the assessment of the observed exposure and justify the decision to continue, continue with additional controls, or stop the task.

Table 2.7 — Short exposure assessment worksheet

Field	Learner's response
Task or situation assessed	
Agent or factor identified	
Source of the agent	
Workers exposed	
Route or form of exposure	
Likely duration/frequency	
Possible health effects	
Possible effects on operational safety	
Control measure at source	
Collective protective or engineering control	
Organisational control	
PPE required as a supplementary measure	
Monitoring/verification required	
Decision: continue / continue with additional controls / stop	
Evidence to be recorded in the portfolio	

For a more complete assessment, use the worksheet in [A.2 — Occupational exposure analysis](#). The matrices, examples, integrative activity and self-assessment remain within the chapter.

2.3 Quick self-assessment

- What distinguishes occupational safety from occupational hygiene?
- What are the four fundamental stages of occupational hygiene?
- Why does the absence of immediate effects not mean that there is no risk?
- Which collective protective measures can reduce exposure to mineral dusts?
- Why is it insufficient to rely solely on hearing protectors in a noisy environment?
- What is the difference between hand-arm vibration and whole-body vibration?
- Which mining situations may involve biological agents?
- Why is ventilation a critical collective control measure in underground mines?
- How can production pressure aggravate psychosocial risks and unsafe behaviour?
- What evidence should be recorded when a relevant exposure is identified?

2.4 Practical summary

Occupational hygiene makes visible exposures that often cause no immediate harm but may lead to occupational disease or loss of capacity over time.

Assessment should begin with the task: source, agent, route of exposure, exposed workers, likely effects and existing controls.

Mineral dusts, noise, vibration, chemical and biological agents, ergonomic factors and psychosocial factors should be considered together with the actual operating conditions.

Ventilation, local exhaust ventilation, wet suppression, enclosure, maintenance, drainage and work organisation are essential preventive barriers.

PPE is important, but it should complement technical, collective protective and organisational measures.

Whenever there is uncertainty about exposure, the effectiveness of controls, ventilation, communication or workers' health status, the situation should be reported, recorded and reassessed; where safe conditions cannot be demonstrated, the task should be stopped.

CHAPTER 3

Particularities of the mining industry



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Chapter 3 — Particularities of the Mining Industry

1.1.6 Chapter 1 Chapter 2 4.1.5 Chapter 5 5.1.2 Chapter 6

Chapter overview

Learn | Observe | Decide | Apply | Reflect

Section	Pedagogical function
Before you begin	Guide the learner, clarify the objectives and define the expected output.
Learning pathway	Explain the Learn–Observe–Decide–Apply–Reflect pathway and the evidence to be collected.
Core technical content	Understand the mine as a dynamic system and relate operations, critical areas, equipment, the evolution of risks, and interaction with the environment and communities.
Apply — integrative activity	Use the checklist and complete the risk-mapping worksheet.
Quick self-assessment	Complete the self-assessment at the end of the chapter and review the answers using the criteria provided.
Practical summary	Consolidate the operational decision and the messages that must never be forgotten.

Before you begin

The mining industry differs from many other sectors because the workplace changes continuously. The working face advances, benches are modified, access routes are opened or closed, equipment moves between work areas, and ground conditions may change during the shift.

This chapter helps the learner understand the mine as a dynamic operational system. Its purpose is not to repeat general Occupational Safety and Health concepts or revisit occupational hygiene topics. The focus is on understanding how safety depends on the relationship between the production process, equipment, ground conditions, environmental conditions, work organisation and the people exposed. To review general safety concepts, see [Chapter 1 — Work Safety and Safety Culture](#); for a more detailed examination of occupational exposures, see [Chapter 2 — Fundamentals of Occupational Hygiene](#).

Question to be answered

How can critical areas be recognised in a mining operation, which equipment is involved, how does risk change throughout the production process, and when may a task continue, continue with additional controls, or must it be stopped for reassessment?

Learning objectives

- Describe the mining operations cycle, from the working face to mineral processing.
- Recognise critical areas at working faces, benches, roads, loading areas, crushing plants and product dispatch areas.
- Relate equipment categories to operational functions, exclusion zones and rules governing presence in these areas.
- Interpret the interaction between people, machinery and the natural environment in mining contexts.
- Identify predominant risks at each stage of the production process.
- Understand how risks evolve throughout the operational life of a mining operation.
- Relate technical, environmental and community factors to preventive decisions.

Expected output

By the end of the chapter, the learner should produce a short operational analysis worksheet containing:

- stage of the mining process observed;
- equipment or installation involved;
- critical area;
- relevant operating condition;
- predominant risk;
- people exposed;
- priority preventive measure;
- final decision: continue; continue with additional controls; stop and reassess;
- evidence to be recorded in the digital portfolio.

Learning pathway

Stage	What to do	Output or evidence
Learn	Read the essential texts on the mining operations cycle, working face, bench, equipment and critical areas.	Reading notes or personal summary.
Observe	Analyse images of a mining operation.	List of critical areas and equipment observed.
Decide	Identify predominant risks and the criteria for continuing, continuing with additional controls, or stopping and reassessing.	Responses to the decision questions.
Apply	Complete the risk-mapping worksheet for each stage of the production process.	Individual or group worksheet.
Reflect	Relate the assessment to a familiar mining context in the country of origin or another setting.	Entry in the digital portfolio.

Supporting materials for Chapter 3

For a more detailed assessment of mining operations, use the checklists and portfolio worksheet in **ANNEX B — OPERATIONAL CHECKLISTS**.

3.1 The mine as a dynamic operational system

A mine or quarry should not be analysed as a set of isolated tasks. The operation functions as a system: drilling prepares blasting; blasting determines loading; loading influences haulage; haulage feeds the crushing stage; and crushing and screening determine stockpiling, dispatch and the management of stockpiles.

Each stage creates the conditions for the next. A poorly positioned drillhole may affect blast quality. An irregular blast may generate oversize material. Oversize material may hinder loading, cause crusher blockages or require maintenance interventions. A deteriorated mine road may turn haulage into a critical operation. A poorly organised crushing area may create conflicts involving mobile equipment, pedestrians, dust, noise, moving parts and maintenance activities.

Therefore, in a mining context, safety depends on the ability to observe the system as a whole. The central question is not simply “what hazard is present?”, but rather: at what stage of the operation are we, which area is critical, what equipment is involved, what condition may change the risk, who may be exposed and what preventive decision should be taken?

3.1.1 Mining operations cycle: from the working face to mineral processing

The typical sequence of operations, from drilling and blasting to stockpiling or dispatch, is shown in Figure 3.1.



Figure 3.1 — Mining operations cycle: from the working face to mineral processing

In a mine or quarry, the operational cycle may vary according to the type of mineral deposit, the mining method, the scale of the operation and the intended use of the material. Nevertheless, a typical sequence can be identified in many open-pit operations:

drilling → blasting → loading → haulage → crushing → screening → stockpiling and/or dispatch

Drilling creates drillholes in the rock mass. Blasting fragments the material. Loading removes the blasted material. Haulage transports the material to the crushing plant, stockyard, waste dump or dispatch area. Crushing reduces the size of the blocks. Screening separates the material by particle size. Stockpiling and dispatch organise the output of the product or the placement of waste material.

Each stage has its own critical areas and rules. The working face requires control of stability, scaling and a safe stand-off distance. The loading area requires communication between operators and pedestrian segregation. Haul roads require maintenance, controlled speed, suitable safety berms and sufficient visibility. Crushing requires access control, guards, emergency stops, energy isolation during interventions and organised traffic (Table 3.1).

Table 3.1 — Mining operations cycle and main preventive focus

Stage	Operational function	Main preventive focus
Drilling	Prepare drillholes in the rock mass for blasting, drainage, geotechnical control or other technical operations.	Confirm bench stability, machine position, distance from the berm, the exclusion zone and communication arrangements.
Blasting	Fragment the rock mass using explosives or another authorised method.	Ensure that the blast plan, evacuation, safety perimeter, re-entry control and post-blast inspection are in place.
Loading	Remove blasted material using an excavator, wheel loader or other equipment.	Control falling blocks, blind spots, interaction with mining haul trucks and the presence of pedestrians.
Haulage	Move material to the crushing plant, stockyard, waste dump or dispatch area.	Confirm the condition of haul roads, safety berms, ramps, visibility, speed and right-of-way rules.
Crushing	Reduce blocks to sizes compatible with haulage, screening or processing.	Control moving parts, falling material, dust, noise, blockages and safe maintenance.
Screening	Separate material by size.	Control vibration, dust, moving parts, access to platforms and safe cleaning.
Stockpiling and dispatch	Organise stockpiling, loading and dispatch of material.	Control stockpile stability, truck traffic, dust, safe loading and interaction with third parties.

3.1.2 Working face and bench: critical areas and rules for safe presence and positioning

The working face is the area where the rock mass is worked to extract material. It may be associated with drilling, blasting, excavation, scaling, loading or inspection. A bench is a working platform created in an open-pit operation and associated with elements such as the face, toe of the slope, crest, berm and haul roads.

These areas require special attention because they combine unstable ground, heavy equipment, loose material, dust, vibration, noise, traffic routes and rapidly changing working conditions. Safety depends not only on the machine being used, but also on how the area is organised. The main elements of a bench, the critical areas and examples of acceptable and unacceptable positioning are shown in Figure 3.2.

Critical areas to identify

The main elements of working faces, benches and haul roads that should be checked before entering or remaining in a critical area are identified in Table 3.2.

Table 3.2 — Critical areas to identify

Element	What to observe
Working face	Loose blocks, cracks, recently blasted areas, falling material and insufficient scaling.
Bench crest	Proximity of equipment, traffic close to the edge, cracks and absence of signage or protection.
Toe of the slope	Accumulation of material, falling blocks and the inappropriate presence of people or equipment.

Element	What to observe
Safety berm	Continuity, height, deterioration and ability to prevent dangerous approach to the edge.
Bench platform	Width, levelness, mud, ruts, standing water, loose blocks and stability for equipment.
Haul road	Traffic directions, intersections, visibility, dust, speed, ramps, bends and interaction with pedestrians.
Exclusion zone	Demarcation, signage, communication, entry authorisation and access control.

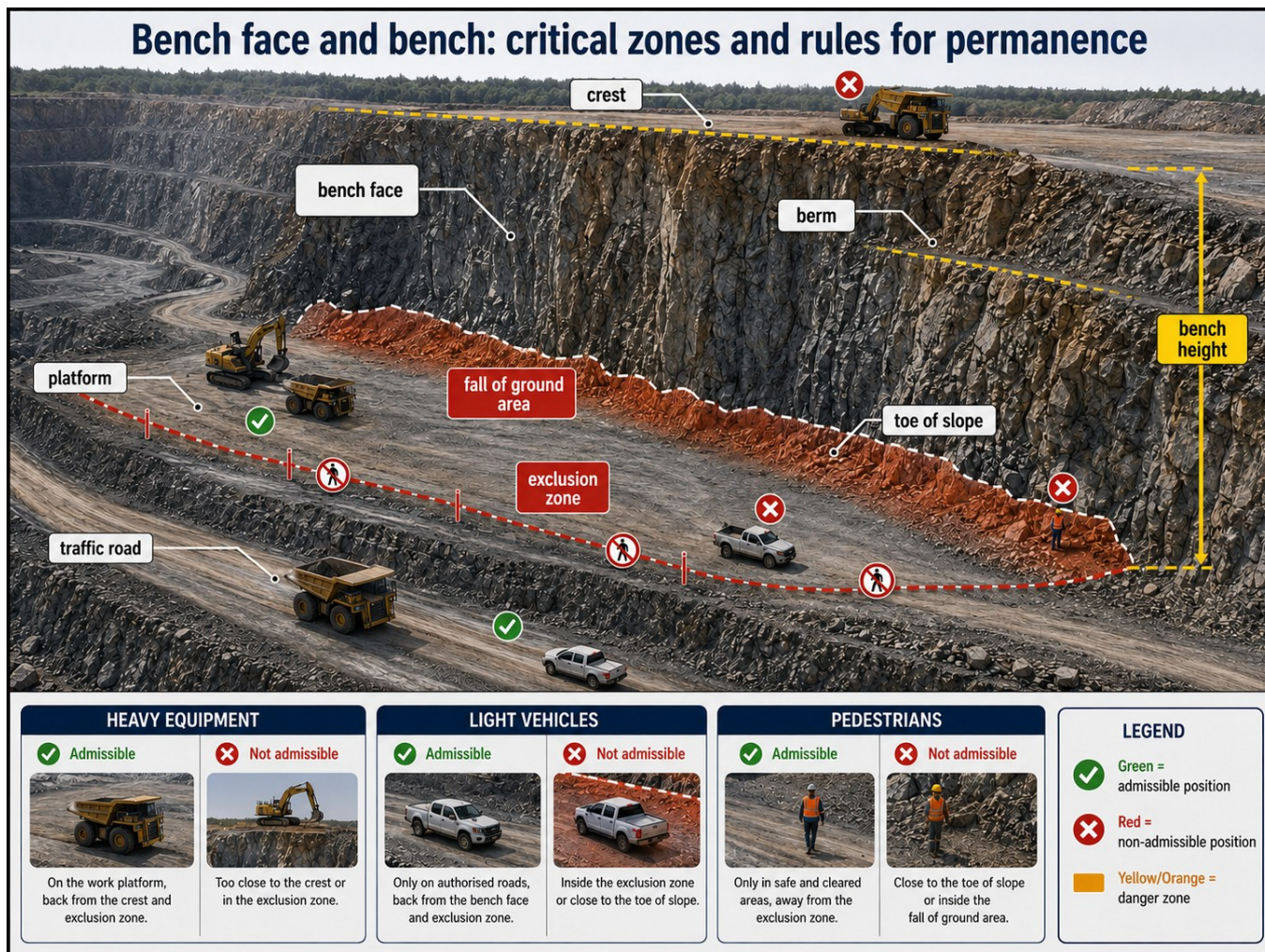


Figure 3.2 — Working face and bench: critical areas and rules for safe presence and positioning

Practical rules for safe presence

Presence at the working face, on a bench or in a loading area should be limited to what is strictly necessary. Pedestrians, visitors, support workers and light vehicles should not remain in heavy-equipment operating areas, within the operating radius of excavators, close to bench edges, at the toe of unstable slopes or in areas where there is no clear communication with the operator.

Before entering a critical area, the following should be confirmed:

- authorisation to enter;
- communication with the operator or supervisor;
- demarcation of the area;
- sufficient visibility;
- absence of signs of instability;
- suitable road or platform conditions;
- availability of a safe exit route;
- a clear criterion for stopping the task.

3.1.3 Main equipment and exclusion zones

Mining equipment should be analysed according to the function it performs in the production process and the hazard zone it creates around it.

Safety distances and exclusion zones should be defined according to the equipment, internal procedure, mine plan, ground conditions and the site rules. The relationship between the main types of mining equipment, their critical areas and their exclusion zones is summarised in Figure 3.3.



Figure 3.3 — Main equipment and exclusion zones

The figure is complemented by Table 3.3, which relates the main equipment categories to their function in the mining process and to the critical areas associated with their operation.

Table 3.3 — Equipment categories and critical areas

Equipment category	Examples	Function in the mining process	Main critical area
Drilling	Drill rig, face drill rig (jumbo), pneumatic hammer	Prepare drillholes for blasting and, using suitable equipment, carry out localised scaling.	Bench, working face, area near the mast, drilling point and equipment traffic area.
Loading	Excavator, wheel loader, load-haul-dump machine (LHD)	Remove and load blasted material.	Operating radius of the boom and bucket, swing area, blind spots and interaction with mining haul trucks.
Haulage	Mining haul truck, truck, tractor, underground haul truck	Transport material to the crushing plant, stockyard, waste dump or dispatch area.	Haul roads, ramps, intersections, bends, loading/unloading areas and safety berms.
Processing	Crusher, screen, conveyor belt	Reduce, classify and move material.	Hoppers, feed openings, conveyor belts, transfer points, platforms and maintenance areas.
Operational support	Compressor, generator, pump, overhead crane, forklift	Provide power, compressed air, pumping, materials handling and maintenance support.	Energy and pressure points, suspended loads, access to components and maintenance areas.
Specialised underground equipment	Ventilation and ground-support equipment, face drill rig, LHD and underground articulated haul truck	Support drilling, loading, haulage, ground support and ventilation in mine roadways.	Underground faces, roof and sidewalls, roadways, intersections, ventilation circuits and evacuation routes.

An exclusion zone should be understood as an area where the presence of unauthorised people may result in a person being struck by a vehicle, a collision, crushing, projection of material, falling blocks, exposure to moving parts or interference with the task. The safety distance depends on the equipment, ground conditions, the task, visibility and site rules.

The organisation of traffic directions, intersections, right-of-way rules and segregation between heavy equipment, light vehicles and pedestrians is illustrated in Figure 3.4.



Figure 3.4 — Internal traffic and segregation between heavy equipment, light vehicles and pedestrians

3.1.4 Interaction between people, machinery and the natural environment

A central feature of the mining industry is the continuous interaction between people, machinery and the natural environment.

The worker observes, communicates, decides and carries out the task; when deviations or occurrences arise, the worker reports and records them. Machinery increases production capacity, but introduces mechanical, hydraulic, pneumatic or electrical energy, blind spots, maintenance requirements and exclusion zones. The natural environment includes geology, topography, water, dust, wind, rain, temperature, rock mass instability and changes in ground conditions.

This interaction is dynamic. A road may be acceptable at the beginning of a shift and become unsafe after rain, heavy traffic or the accumulation of mud. A working face may appear stable before blasting and require a new inspection after the blast. A crushing area may change from normal operation to a critical situation when a blockage occurs, material accumulates or there is pressure to resume production quickly. The interaction between human factors, equipment and natural conditions, together with the resulting dynamic change in risk, is illustrated in Figure 3.5.

Operational signs of changes in risk

The learner should learn to observe simple signs, such as:

- new cracks in the ground, slope or bench;
- loose blocks or recently displaced material;
- a deteriorated berm or absence of edge protection;
- mud, accumulated water or deep ruts on roads;
- dust that reduces visibility;

- simultaneous movement of pedestrians and mobile equipment;
- poor communication between operators;
- heavy traffic at intersections or loading areas;
- unusual noise, vibration or equipment behaviour;
- pressure to continue the task despite a changed operating condition.

Simple practical rule

If actual conditions no longer correspond to the planned procedure or operating plan, the task must be reassessed before work continues.

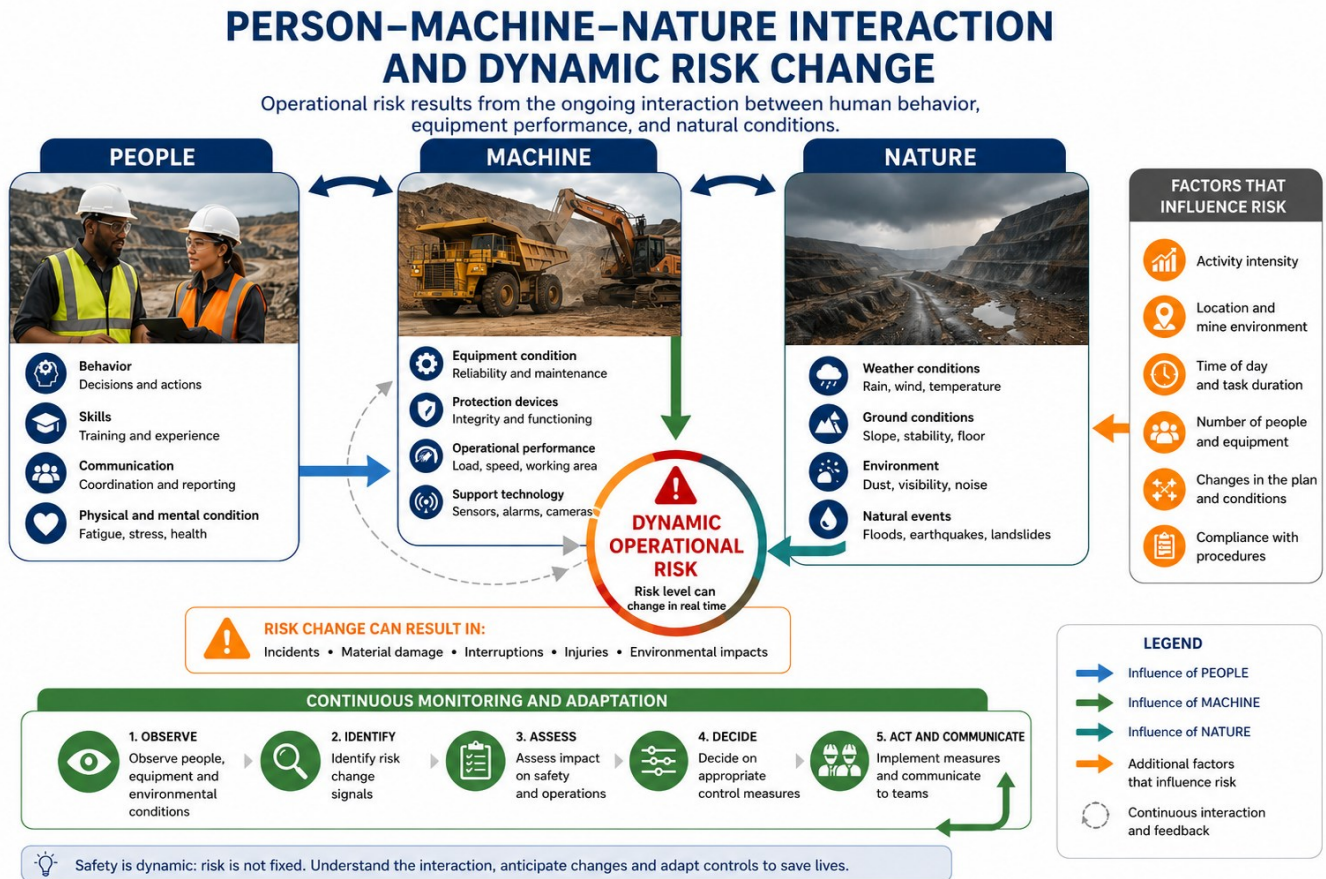


Figure 3.5 — Interaction between people, machinery and the natural environment and dynamic change in risk

3.1.5 Risks by stage of the production process

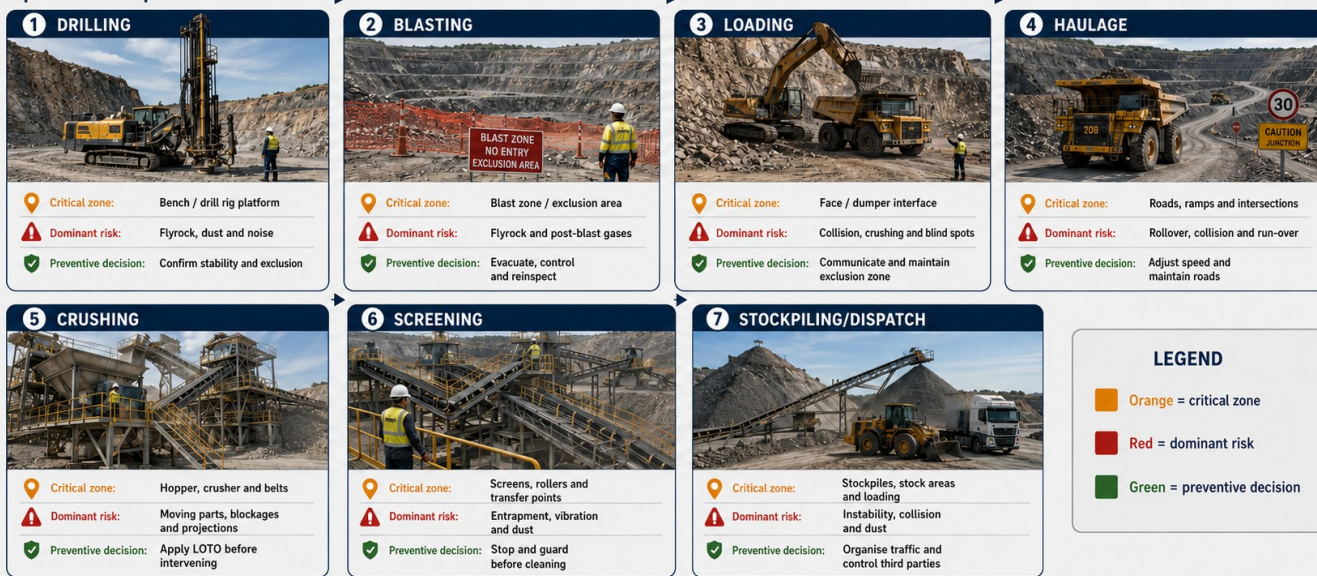
Table 3.4 provides a summary. For additional examples organised by stage of the process, use **ANNEX A — CROSS-CUTTING APPLICATION FORMS**.

Figure 3.6 provides an overview of the predominant risks at each stage of the production process, while Table 3.4 sets out the corresponding critical area and typical preventive measures.

DOMINANT RISKS BY PRODUCTION PROCESS STAGE

Identify the stage, critical zone, dominant risk and preventive decision.

Operational sequence



Before proceeding: check, communicate and record the decision.



Figure 3.6 — Predominant risks by stage of the production process

Table 3.4 — Stage, critical area, predominant risk and preventive decision

Stage	Critical area	Predominant risk	Typical preventive decision
Drilling	Bench, working face and drill pad	Falling blocks, rollover, flyrock, dust, noise and contact with moving parts.	Confirm bench stability, distance from the berm, the exclusion zone, dust control and communication.
Blasting	Blasting area and exclusion zone	Flyrock, misfire, post-blast fumes and premature re-entry.	Confirm evacuation, the safety perimeter, re-entry authorisation, post-blast inspection and recording of anomalies.
Loading	Working face, excavator/wheel-loader area and interaction with the mining haul truck	Falling material, collision, crushing, blind spots and pedestrians approaching the area.	Ensure an exclusion zone, radio communication, a defined loading sequence and the absence of people from the equipment operating area.
Haulage	Roads, ramps, bends, intersections and berms	Rollover, collision, a person being struck by a vehicle, loss of traction and falling material.	Adjust speed, maintain roads, inspect berms, segregate pedestrians and equipment, and signal changed conditions.
Crushing	Hopper, feed opening, platforms and conveyors	Entanglement, falling or projected material, blockages and maintenance while hazardous energy remains present.	Maintain guards, control access, apply lockout/tagout before intervention and organise cleaning.
Screening and conveyors	Screens, conveyor idlers, conveyor pulleys and transfer points	Entanglement, vibration, falling material, dust and unsafe maintenance.	Ensure guards, planned cleaning, safe access and shutdown before intervention.
Stockpiling and dispatch	Stockpiles, stockyards, weighbridge and truck-loading areas	Stockpile instability, collision, a person being struck by a vehicle, falling material and dust.	Organise traffic directions, waiting areas, controlled loading and control of third parties.

3.1.6 Life cycle of the mining operation and evolution of risks

A mining operation has a limited operational life because it depends on finite mineral resources and a defined mine plan. In broad terms, its life cycle comprises prospecting, mine opening and development, production, transition, closure and rehabilitation. Each phase changes the type of work, the equipment used, the accessible areas, traffic intensity and the predominant risks. The evolution of operations and risks throughout the different phases of the mining operation is summarised in Figure 3.7.

LIFE OF MINE AND RISK EVOLUTION

Safety follows each phase: observe, update controls and protect people.

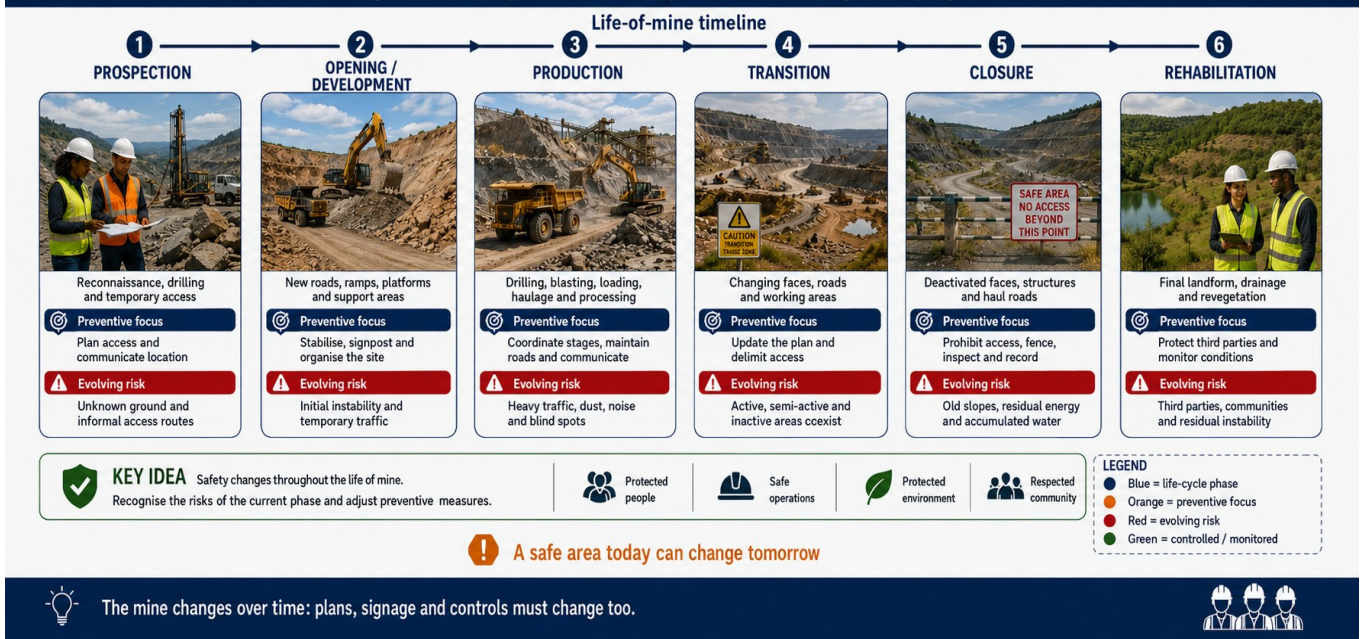


Figure 3.7 — Life cycle of the mining operation and evolution of risks

During prospecting, fieldwork, drilling and temporary access routes predominate. During mine opening and development, new access routes, benches, ramps, platforms, roadways, facilities and support areas are created. During production, drilling, blasting, loading, haulage and processing operations predominate. During transition phases, active, partially active and inactive areas may coexist. During closure and rehabilitation, attention shifts to old slopes, accumulated water, decommissioned structures, waste, deteriorated access routes and the protection of third parties.

Table 3.5 sets out the particular features of the main phases in the life cycle of a mining operation and the preventive focus required in each phase.

Table 3.5 — Life-cycle phases and preventive focus

Phase	Particular features	Preventive focus
Prospecting	Initial investigation and characterisation of the mineral deposit, including fieldwork, drilling and temporary access routes.	Work planning, access control, ground stability, travel in remote areas and environmental protection.
Mine opening and development	Creation of access routes, preparation of working faces, development of benches or roadways, and installation of infrastructure.	Initial stability, temporary traffic arrangements, signage, entry authorisation and worksite organisation.
Production	Regular operation involving heavy equipment and several simultaneous stages.	Coordination between drilling, loading, haulage, crushing, maintenance and dispatch.
Transition	Changes to working faces, roads, equipment and work areas.	Update the plan, communicate changes, review access arrangements and control partially inactive areas.
Closure	Progressive decommissioning of working faces, facilities and traffic areas.	Restrict access to hazardous areas, control residual energy, ensure slope stability and manage water.
Rehabilitation	Final landform shaping, drainage, revegetation or a new land use.	Protect workers, third parties and communities, control access and carry out monitoring.

Safety must evolve with these changes. An area that was safe during production may become hazardous if it is no longer maintained, loses its signage, accumulates water or is accessed by unauthorised people.

3.1.7 Technical, environmental and community interface

Mining operations may affect workers, the environment and communities at the same time. Dust, noise, vibration, heavy vehicle traffic, surface runoff, mud on roads, blasting, waste, lighting and external traffic are

examples of factors that link occupational safety to environmental management and relations with third parties. The relationship between mining operations, worker exposure, environmental impacts and effects on communities is shown in Figure 3.8.

This chapter does not replace a chapter on the environment or sustainability. The focus is operational: recognising when a technical factor may also create occupational exposure, an environmental impact or community conflict.

Situations to observe

Table 3.6 presents operational situations that may simultaneously affect workers, the environment, communities and other third parties, thereby requiring integrated analysis and appropriate recording.

Table 3.6 — Relevant situations to analyse

Situation	Why it is relevant
Dust on roads, at crushing plants or in stockyards	Reduces visibility, hinders communication and may affect workers and nearby communities.
Vibration from blasting or equipment	May indicate a need to review the blast plan, communication arrangements and controls on operating times.
Heavy vehicle traffic near external access points	Increases road risk and requires separation between internal and external traffic.
Mud, stones or material carried onto public roads	Creates a risk to third parties and indicates inadequate cleaning or operational control.
Accumulated water or surface runoff	May deteriorate roads, slopes, drainage systems and traffic areas.
Community complaints	May reveal control failures that are also relevant to workers.

Engagement with communities requires organisation, signage, fencing, communication and recording. When a complaint, alert or external observation indicates an uncontrolled condition, the situation should be analysed as a possible sign of operational failure.

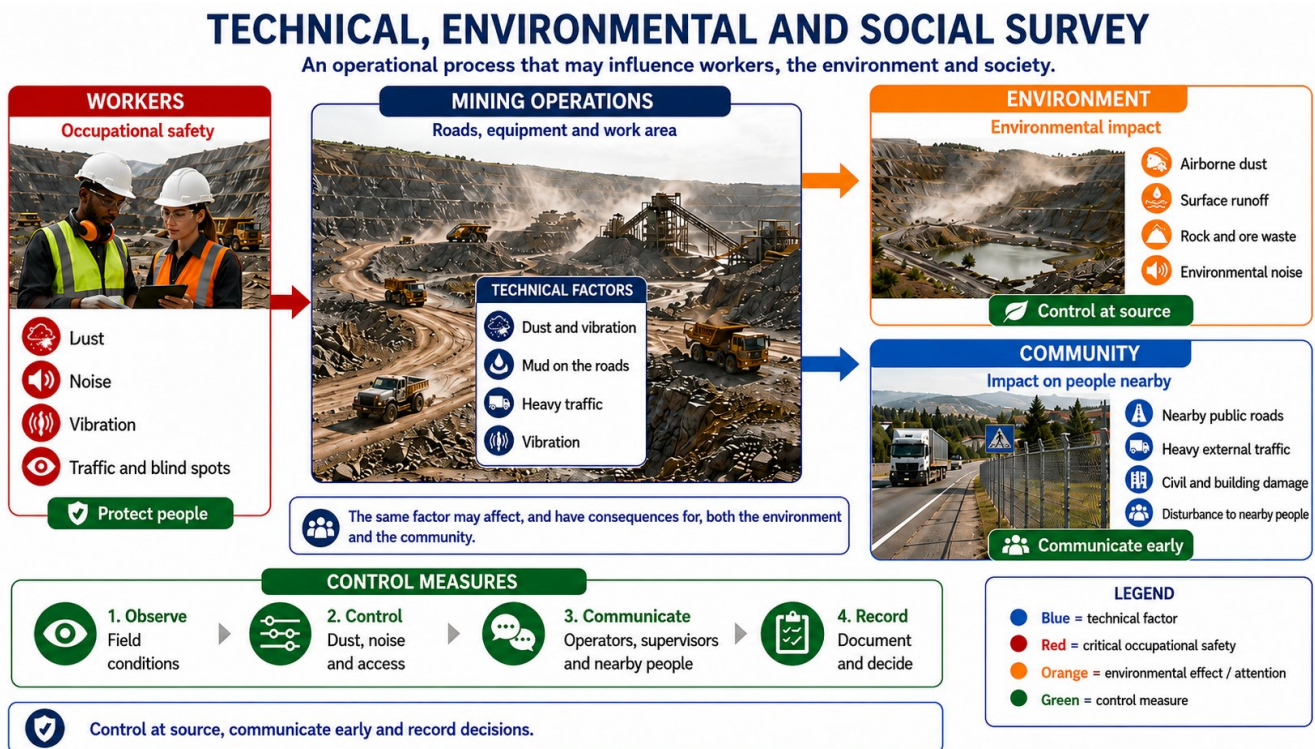


Figure 3.8 — Technical, environmental and community interface

3.2 Apply — integrative activity

Minimum checklist

Table 3.7 presents the minimum checklist for Chapter 3. To use fillable checklists by area or stage — working face and bench, roads, loading and haulage, crushing, underground operations and legacy areas — see ANNEX B — OPERATIONAL CHECKLISTS.

Table 3.7 — Minimum checklist for Chapter 3

Question	Yes / No / Comments
Has the process stage been identified?	
Has the critical area been recognised and demarcated?	
Have the main equipment and its exclusion zone been identified?	
Do the actual conditions correspond to the plan?	
Have there been any changes in the ground conditions, visibility, roads, berms or communication?	
Have the exposed pedestrians, operators, maintenance workers, supervisors and third parties been considered?	
Is there a clear criterion for continuing, continuing with additional controls, or stopping and reassessing?	
Has the required evidence been recorded in the digital portfolio?	

Activity 3.1 — Mapping risks in the operational flow of an extractive operation

The following activity presents the short version of the integrative task. To record the situation, analysis, decision, evidence and final reflection in full, use ANNEX D — PORTFOLIO AND LEARNING EVIDENCE and ANNEX B — OPERATIONAL CHECKLISTS.

Choose an image, video, technical visit or case description from a mining operation and complete the worksheet presented in Table 3.8.

Table 3.8 — Risk-mapping worksheet for the operational flow of an extractive operation

Field	Response
Stage of the process observed	
Location or critical area	
Equipment or installation involved	
Relevant operating condition	
Predominant risk	
People exposed	
Priority preventive measure	
Final decision: continue / continue with additional controls / stop and reassess	
Evidence to be recorded	
Main learning point	

3.3 Quick self-assessment

After completing the reading and the integrative activity, complete the quick self-assessment presented in this section. Record in **ANNEX D — PORTFOLIO AND LEARNING EVIDENCE** only the difficulties, decisions and learning points that are relevant to the portfolio.

3.4 Practical summary

The mining industry should be analysed as a dynamic system. Risk is not located solely in a machine, a worker or an isolated hazard: it results from the interaction between the production process, ground conditions, equipment, roads, the environment, work organisation and the people exposed. The analytical sequence leading to the decision to continue, continue with additional controls, or stop and reassess the task is summarised in **Figure 3.9**.

What must never be forgotten

A mine changes throughout the shift, the week and the operational life of the mining operation.

The working face, bench, roads, loading area and crushing plant are critical areas.

Heavy equipment requires exclusion zones, effective communication and traffic rules.

Rain, mud, dust, water, vibration, traffic and visibility can change the level of risk rapidly.

Complete equipment forms should be consulted when a specific machine or task needs to be examined in greater detail.

When actual conditions do not correspond to what was planned, the task must be reassessed before continuing.

Evidence must be recorded: an authorised photograph, checklist, analysis form, communication record or group summary.

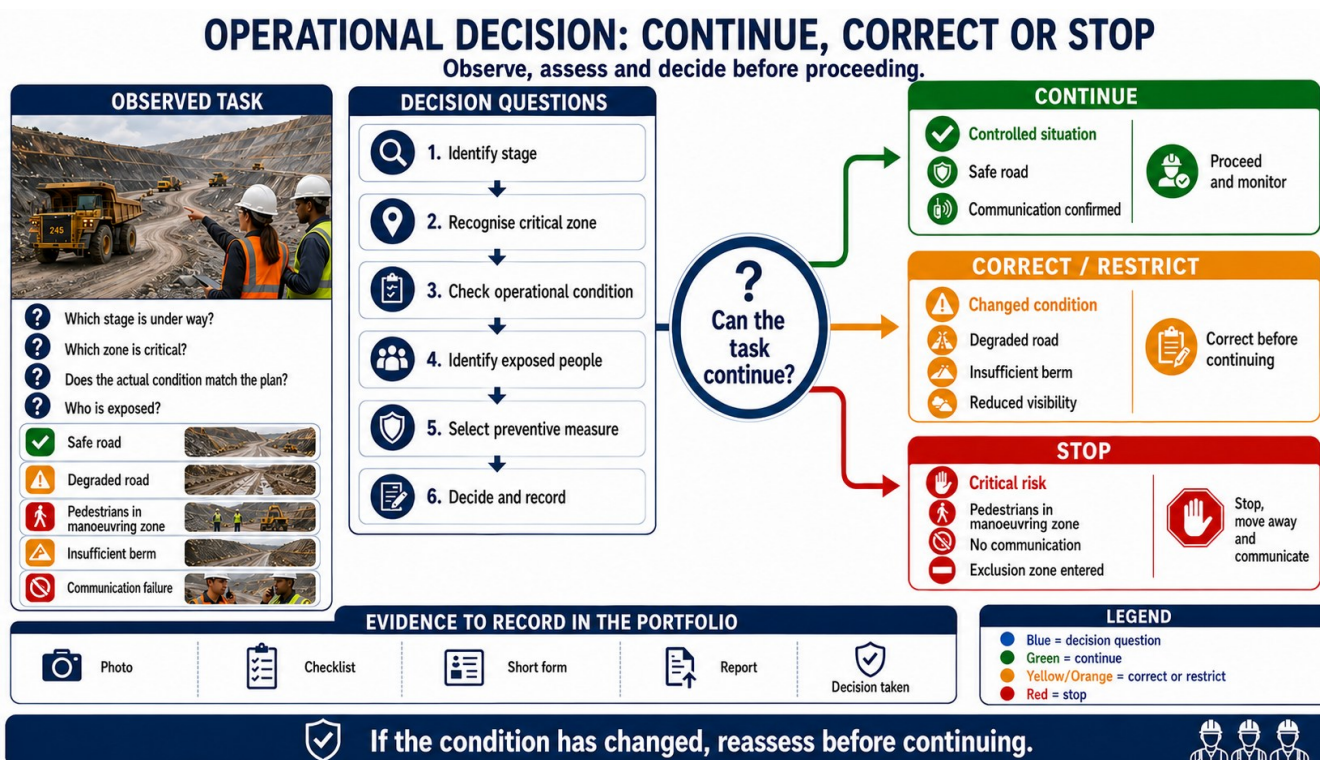


Figure 3.9 — Operational decision: continue, continue with additional controls, or stop and reassess

CHAPTER 4

Operational technical safety and maintenance



SAFETY TRAINING WITH
REAL IMMERSIVITY FOR MINING



Co-funded by
the European Union

Chapter 4 — Operational Technical Safety and Maintenance

4.2 Chapter 5 Chapter 6 6.1.2 8.1.5

Chapter overview

Learn | Observe | Decide | Apply | Reflect

Section	Pedagogical function
Before you begin	Guide the learner and clarify the guiding question, learning objectives and competences to be developed.
Learning pathway	Explain the Learn–Observe–Decide–Apply–Reflect sequence and the expected learning outputs.
Technical core of the chapter	Apply prevention to specific technical tasks: work area, tool, energy, access, worker and PPE.
Apply — integrative activity	Prepare a technical task and record the decision, controls and evidence.
Quick self-assessment	Check the ability to identify critical conditions and make preventive decisions.
Practical summary	Consolidate the decision-making chain and the expected final output of the chapter.

Before you begin

Question to be answered

How can it be ensured that a technical task — maintenance, housekeeping, storage, use of tools, work at height or an intervention involving residual energy — begins only when the work area, equipment, energy, access, worker and PPE are under control?

Purpose of the chapter

This chapter helps the learner recognise common technical situations in the extractive industry that can lead to serious accidents when they are not controlled before the task is carried out.

The focus is not on repeating definitions of hazard, risk, exposure, consequence, the hierarchy of controls or occupational hygiene agents. The focus is on applying these concepts to practical operating and maintenance situations: facilities, tools, storage, work at height, compressed air, pressurised water, residual energy, ergonomics, fitness for work and PPE selection.

The chapter's operational question is simple: is the technical task ready to start safely? The answer should lead to an explicit decision: proceed; rectify before proceeding; or stop and reassess.

Key message

A safe technical task begins before it is carried out. It begins with preparing the work area, identifying energy sources, checking the tool, controlling access, confirming the worker's fitness and selecting the correct PPE.

Learning objectives

- verify minimum conditions of orderliness, cleanliness, access and housekeeping before starting a task;
- recognise risks associated with stacking, storage, falling materials, incompatibilities and obstructed access;
- identify unsafe conditions in the use of hand tools, portable power tools and pneumatic tools;
- apply a simple lockout/tagout (LOTO) sequence before maintenance interventions;
- recognise risks in work at height, ladders, scaffolds, platforms and work near slopes or benches;

- identify situations involving compressed air, pressurised water, hydraulic, pneumatic, electrical, mechanical, gravitational or residual energy;
- relate ergonomics, fatigue and fitness for work to the likelihood of error, loss of control and an accident;
- select PPE according to the task, recognising its limitations;
- decide whether a technical task may proceed, requires prior rectification, or must stop and be reassessed.

Competences to be developed

Competence	Expected evidence
Inspect a technical area before the task	Completed simple checklist.
Identify energy sources before maintenance	Simplified LOTO record card.
Check a ladder, scaffold or platform	Quick inspection form.
Select PPE by task	Task–risk–PPE grid.
Recognise signs of fatigue or unfitness for work	Decision to stop, replace the worker or reassess the task.
Record evidence in the portfolio	Photograph, form, checklist, LOTO record card or decision summary.

Learning pathway

The chapter follows the E-book’s cross-cutting pedagogical logic: learn, observe, decide, apply and reflect. This sequence should help the learner move from reading the principles to making a decision about a specific technical task.

Stage	What the learner does	Output or evidence
Learn	Reads essential technical safety rules for common tasks.	Personal summary of the critical points.
Observe	Analyses images or videos involving maintenance, tools, work at height, storage or residual energy.	List of unsafe conditions.
Decide	Determines whether the task may proceed, requires rectification before proceeding, or must stop and be reassessed.	Justified decision.
Apply	Completes a lockout/tagout record card, ladder/scaffold checklist and PPE selection form.	Practical forms.
Reflect	Records what was learned and how it would be applied to another mining task.	Entry in the digital portfolio.

Common decision criterion for the chapter

For each task analysed, the learner should determine whether it may proceed, whether rectification is required before proceeding, or whether the task must stop for reassessment. The decision should be supported by evidence: a checklist, a photograph obtained without exposing the worker to risk, a form, a lockout/tagout record card, an inspection record or a group summary.

4.1 Technical safety in operation and maintenance tasks

The following sections apply the chapter's cross-cutting criterion to eight groups of technical situations. In each case, the learner should verify actual conditions, select the controls required before work begins and justify the decision to proceed, rectify before proceeding, or stop and reassess.

4.1.1 Facilities, maintenance and safe housekeeping

Before starting an operation or maintenance task, the first control is to check whether the work area is ready. Many occurrences begin with simple conditions: materials out of place, obstructed walkways, slippery floors, loose cables, improvised tools, inadequate lighting, removed guards or incomplete maintenance. These signs should be treated as operational warning signs, not as minor details. Orderliness, cleanliness and housekeeping act as preventive barriers. They allow people to move safely, access equipment, evacuate in an emergency, find suitable tools and reduce falls, trips, crushing, fires and contact with hazardous parts.

This check should cover workshops, crushing areas, warehouses, stockyards, maintenance areas, traffic routes, access points, emergency exits and the specific area where the task will be carried out. The objective is to answer objectively: is the work area ready for the technical task?

Key message

If the work area is not ready, the task is not ready either. The task should begin only when access, the floor, lighting, materials, tools, guards, energy, communication and authorisation are under control.

What to check before starting

- access routes, traffic routes and emergency exits are clear and signposted;
- the floor is stable and clean, with no spills, mud, loose objects or cables crossing the area, and no slippery surfaces;
- materials, parts, waste and tools are stored away from walkways;
- tools are available, suitable for the task and free from visible damage;
- guards, protective devices, guardrails and signage are in place;
- lighting is sufficient to see the task, access routes and hazard points;
- energy is controlled when the task involves equipment, pressure, movement, moving parts or maintenance;
- communication, supervision and authorisation have been confirmed before work begins.

Conditions requiring work to stop

The task must be stopped or must not begin when a condition prevents minimum control of the work area. Critical examples include a slippery floor, an uncontrolled spill, a removed guard, a blocked access route or exit, a damaged tool, insufficient lighting, uncontrolled energy, lack of communication, lack of authorisation or uncertainty about who may intervene.

This preparation is particularly important in maintenance tasks. The area should be clean, demarcated and signposted; the equipment should be in a safe condition; the people involved should be informed; and energy should be controlled where applicable. Lockout/tagout will be addressed in detail in [4.1.4 Lockout/tagout \(LOTO\) during maintenance](#), but no intervention should begin with guards removed, the energy state undefined or authorisation unclear.

The contrast between a work area ready for the task and one with critical conditions is shown in [Figure 4.1](#). [Table 4.1](#) provides a systematic means of checking whether the area meets the minimum conditions required to begin a technical task.

Table 4.1 — Checklist: work area ready for the technical task

Field	Practical verification criterion	Compliant / Non-compliant / Comments
Clear access	The access route, work area and exit are unobstructed.	
Stable, clean floor	There are no spills, mud, loose objects, cables crossing the area or slippery surfaces.	
Sufficient lighting	The task, access routes, tools and hazard points are visible.	
Materials properly stored	Parts, waste, pallets, tools and consumables are kept away from walkways.	
Suitable tools available	The correct tool is available, intact and shows no signs of damage or improvisation.	
Guards in place	Guards, guardrails, covers, barriers and signage are in place.	
Energy controlled where applicable	There is no uncontrolled electrical, mechanical, hydraulic, pneumatic, gravitational or residual energy.	
Communication and authorisation confirmed	The team knows who will intervene, who authorises the work, who supervises it and when the task may begin.	
Stop-work criterion defined	It is clear when to proceed, rectify before proceeding, or stop and reassess.	

Prepared vs critical technical work area

PREPARED AREA



- ✓ Clear access
- ✓ Clean, stable floor
- ✓ Tools stored and suitable
- ✓ Guards in place
- ✓ Adequate lighting
- ✓ Energy controlled
- ✓ Authorisation and communication confirmed

✓ **TASK MAY START**

CRITICAL AREA



- ✗ Blocked access
- ✗ Slippery floor
- ✗ Cables and hoses on the floor
- ✗ Loose materials and parts
- ✗ Guard removed
- ✗ Poor lighting
- ✗ Damaged tool
- ✗ Uncontrolled energy

✗ **STOP AND CORRECT**

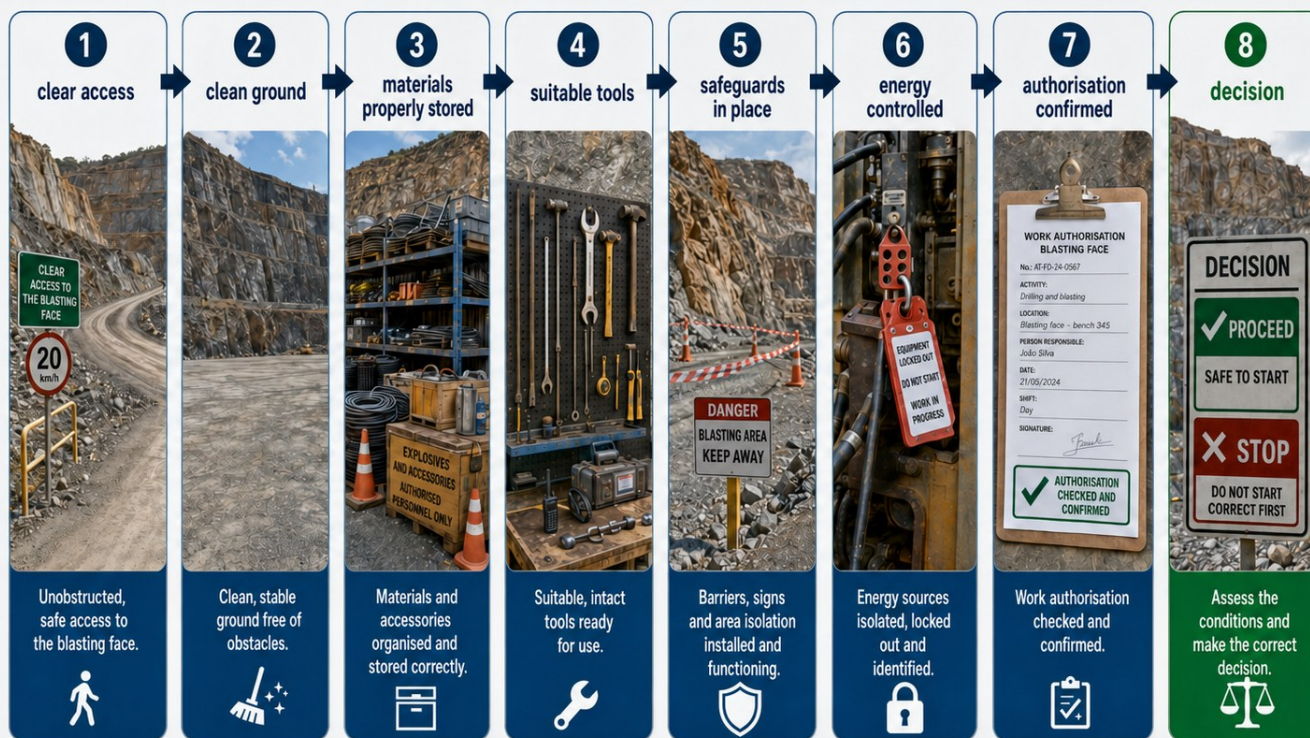
Figure 4.1 — Prepared technical work area and critical technical work area

Practical decision rule

If any critical item is marked “Non-compliant”, the condition must be rectified before work begins. If rectification cannot be completed immediately, or if there is uncertainty regarding energy, access, guards, authorisation or the condition of the area, the safe decision is to stop and reassess. The safety-readiness sequence applied to a working face is summarised in Figure 4.2.

SAFETY READINESS SEQUENCE AT THE BLASTING FACE

Check each stage before starting the task. No stage should be skipped.



SAFETY IS A CONSCIOUS DECISION. Each stage helps prevent incidents and ensures safe operation at the blasting face.

Figure 4.2 — Safety-readiness sequence at the working face

4.1.2 Stacking and storage

Storage should be treated as a technical safety condition. An unstable stack, a drum without secondary containment, an improperly supported pallet, a hose crossing a walkway or material placed beside an exit can cause falling objects, crushing, fire, a spill, obstruction of routes or unnecessary physical effort.

Before starting a task, check whether materials, parts, pallets, samples, pipes, drums, bags, tools and components are stored in a stable, identified and accessible manner. The objective is not merely to tidy the area; it is to prevent storage from creating new risks for people moving through the area, retrieving material, operating equipment or carrying out maintenance.

Stability depends on the base, height, alignment, containment and the way in which the material will be removed. A stack that appears stable may become critical when it is too high, poorly supported, lacks separators, is close to a traffic route, is subject to vibration, stands on an uneven floor or requires a worker to pull material with excessive force or from above shoulder height.

Key message

Safe storage keeps material stable, identified, compatible, contained and accessible, without blocking walkways, exits, fire extinguishers, electrical panels or traffic areas.

What to check before accepting the storage arrangement

- materials are stacked on a stable, level and load-bearing base;
- the height is compatible with the type and weight of the material, access requirements and the method of retrieval;
- stacks are aligned, contained and set back from edges, roads, traffic areas and mobile equipment;

- parts, pipes, bags, samples, pallets and components cannot roll, fall or move;
- fuels, lubricants, chemicals and waste are stored in a designated, labelled and ventilated area, with secondary containment where applicable;
- incompatible products are segregated and are not mixed with tools, personal protective equipment (PPE), general waste or maintenance materials;
- tools, hoses, cables, ladders, PPE and components are stored away from walkways and protected against damage;
- emergency exits, fire extinguishers, electrical panels, access routes, walkways and work areas are clear.

When to rectify or cordon off the area

Storage must be rectified before the task when there is instability, leaning material, an excessively high stack, lack of containment, a spill, an unlabelled container, an evident incompatibility, blocked access or a need to retrieve material with excessive effort. Work must stop and the area must be cordoned off when there is an immediate risk of falling objects, crushing, fire, an uncontrolled spill, contact with energy, obstruction of emergency facilities, or exposure of workers and pedestrians to a traffic area. Figure 4.3 shows examples of safe and critical conditions in mineral storage and dispatch. Other materials and products should be assessed using the same criteria of stability, identification, compatibility, containment and accessibility.

Table 4.2 provides a short assessment form for evaluating the stability, location, compatibility and accessibility of stored materials and supporting the decision to proceed, rectify before proceeding, or stop and cordon off the area.

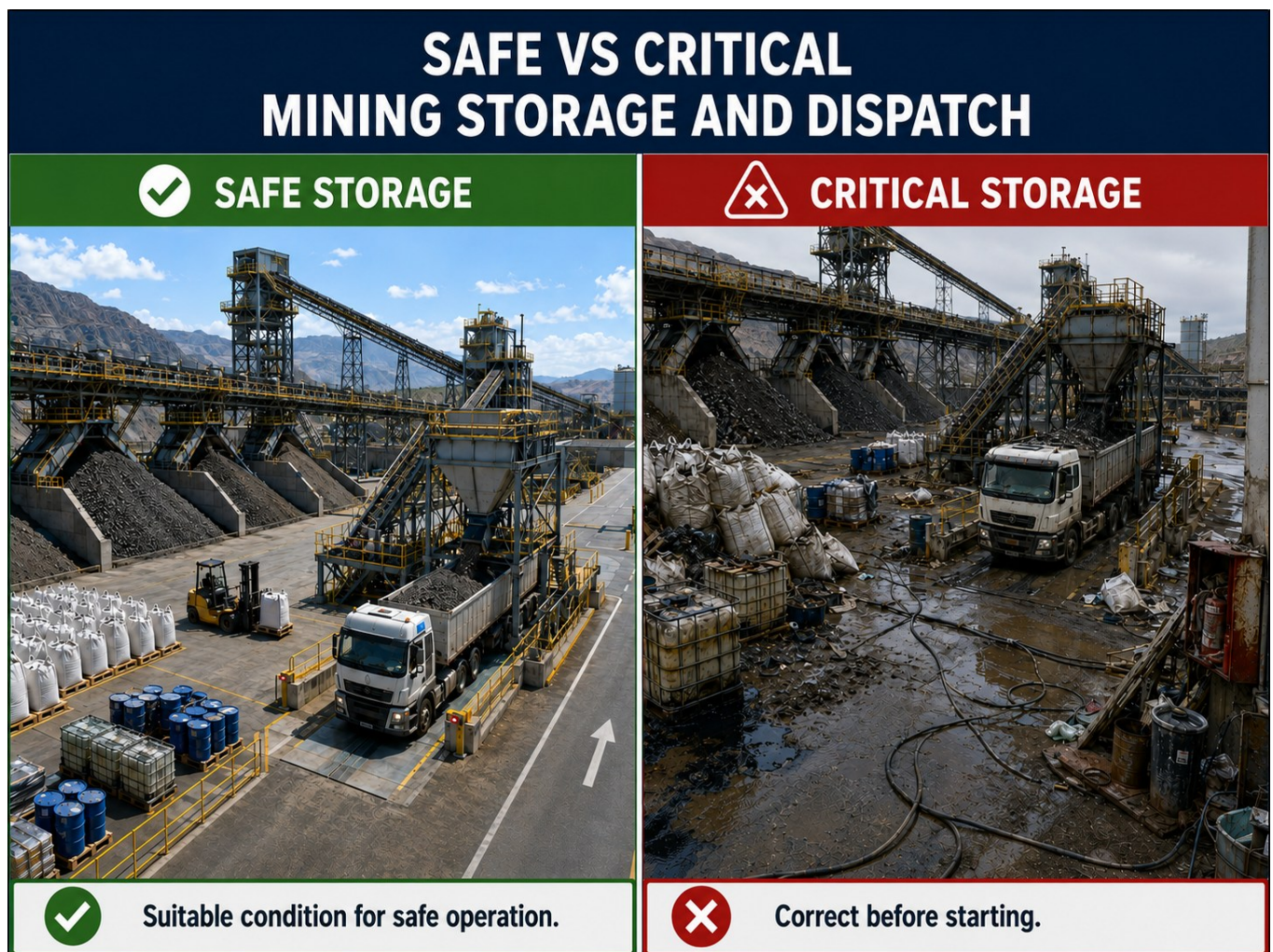


Figure 4.3 — Mineral storage and dispatch: safe and critical conditions

Table 4.2 — Short assessment form: safe or critical storage

Field	Practical observation criterion	Response / decision
Stored material	Identify the material, part, pallet, sample, pipe, drum, bag, tool, cable, ladder, PPE or component.	
Location	Confirm that the location is suitable and does not interfere with a walkway, exit, fire extinguisher, electrical panel, road or work area.	
Stability	Check the base, support, alignment, containment and risk of falling, rolling or movement.	
Height	Confirm that the height allows safe retrieval and does not compromise stability, visibility or access.	
Compatibility	Check segregation between fuels, lubricants, chemicals, waste, tools and PPE.	
Containment	Confirm the presence of a secondary containment bund, closed container, labelling and spill control where applicable.	
Access	Confirm that retrieving the material does not require an awkward posture, excessive reaching or entry into a traffic area.	
People exposed	Identify workers, maintenance personnel, operators, pedestrians, visitors or other third parties who may pass through the area or retrieve material.	
Decision	Proceed / rectify before proceeding / stop and reassess; where applicable, cordon off the area.	

4.1.3 Hand tools, portable power tools and pneumatic tools

Hand tools, portable power tools and pneumatic tools may appear simple, but they involve serious risks: cuts, flying particles, electric shock, noise, vibration, dust, fire, loss of control and musculoskeletal disorders. Before using any tool, confirm that it is suitable for the task and is in a safe condition.

Key message

A small tool does not mean a small risk. If the tool is unsuitable, damaged, unguarded, poorly connected, or produces unusual noise or vibration, the task must stop.

The check should cover hand tools, such as hammers, spanners, pliers, saws, files and chisels; portable power tools, such as angle grinders, drills, power screwdrivers, saws and extension leads; and pneumatic tools, such as pneumatic hammers, hoses, couplings and pressurised systems. [Figure 4.4](#) illustrates the main points to inspect on a portable pneumatic tool before use.

The operating rule is simple: use the correct tool, in the correct condition, with the correct accessory and in the correct working position. Improvised or damaged tools, tools with a removed guard, a defective cable or plug, a leaking hose, an irregular trigger, a worn disc, a damaged tool bit or an unsafe connection must not be used.

Noise, vibration, dust and flying particles should be treated as signs to consider during the task. In this chapter, they support the decision to use, rectify or withdraw the tool from service. The assessment of exposure to noise and vibration is developed in [Chapter 2 — Fundamentals of Occupational Hygiene](#).

What to check before use

- the tool is suitable for the task, material and workplace;
- the general condition shows no cracks, looseness, deformation, overheating or visible wear;
- the cable, plug, extension lead, connection or hose is intact, with no improvised joints, leaks or crushing;
- the guard, protective device, auxiliary handle, trigger and controls are in place and functional;
- the disc, blade, drill bit, tool bit, chisel or accessory is compatible, securely fitted and free from visible damage;
- the air pressure is suitable and pneumatic couplings are secure, where applicable;
- the work area is clear of people not involved, loose materials and ignition sources where sparks or flying particles may occur;

- PPE is selected according to the cutting, flying-particle, dust, noise, vibration, posture and exertion hazards.

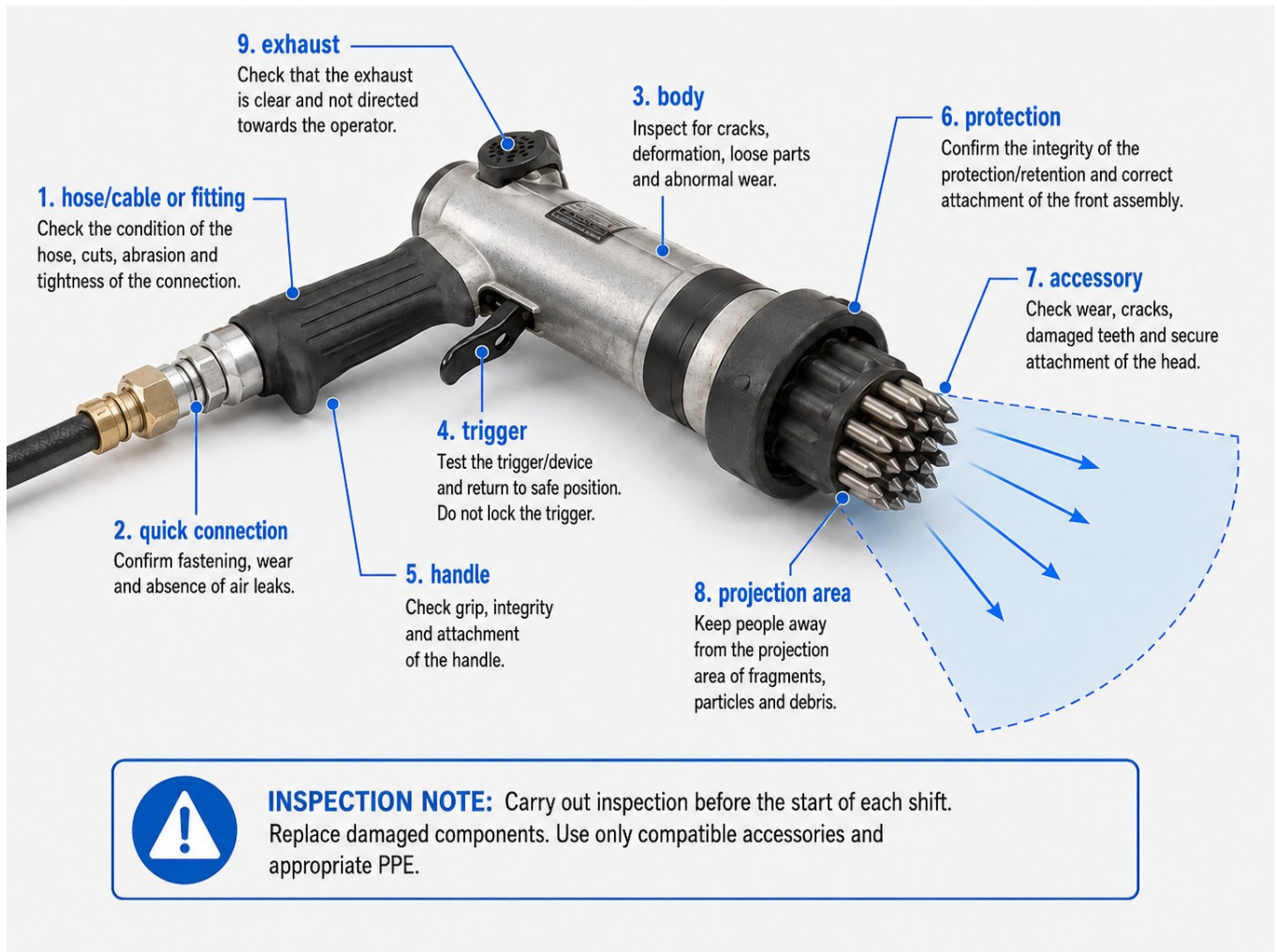


Figure 4.4 — Inspection points on a pneumatic bush hammer

Criteria for withdrawal from service

The tool must be withdrawn from service if the cable or plug is damaged, an improvised extension lead is used, a hose is leaking, the trigger is defective, a guard has been removed, or a disc, blade or tool bit is unsuitable, cracked or worn. It must also be withdrawn if there is unusual noise or vibration, overheating, a burning smell, an air or oil leak, or any uncertainty about its safety. A withdrawn tool should be tagged, isolated and reported for repair or replacement.

Table 4.3 brings together the main points to check before using a portable tool and supports the decision to use it, rectify the condition or withdraw it from service.

Table 4.3 — Portable tool inspection form

Field	Practical verification criterion	Use / Rectify / Withdraw
Tool	Identify the tool and confirm that it is suitable for the intended task.	
Task	Describe the work to be carried out and the material on which the tool will be used.	
General condition	Check for cracks, looseness, deformation, wear, overheating or dirt that could impair control.	
Guard / protective device	Confirm that the guard, protective device, auxiliary handle, control and safety device are in place and functional.	

Field	Practical verification criterion	Use / Rectify / Withdraw
Cable / plug / hose	Check integrity and absence of cuts, improvised joints, crushing, leaks or loose connections.	
Accessory / disc / tool bit	Confirm compatibility, secure fitting, condition and suitability for the material and operating speed or pressure.	
Unusual noise / vibration	Stop if there is unusual noise, vibration, overheating, a burning smell or irregular behaviour.	
Dust / flying particles	Confirm control of the work area, separation of people not involved and protection against particles.	
Required PPE	Select PPE suitable for the task: eye and face, hearing and respiratory protection, footwear and clothing and, where compatible with the task and where there is no entanglement risk, gloves.	
Decision	Use only if all critical items are controlled. Rectify or withdraw from service if there is any uncertainty.	

Practical decision rule

The task may proceed only when the tool is suitable, intact, guarded and controllable. If the abnormal condition can be rectified before work begins, the task may proceed only after rectification. If there is damage, a missing guard, an unsafe connection, an unsuitable accessory or uncertainty, the task must stop and the tool must be withdrawn from service. The criteria are summarised in Figure 4.5.

Portable tools: use, correct or remove from service		
USE	CORRECT BEFORE USE	REMOVE FROM SERVICE
✓ Overall condition: good ✓ Guard: fitted and functional ✓ Cable/hose: intact ✓ Accessory: correct and undamaged ✓ Projection zone: clear ✓ PPE: suitable	! Overall condition: acceptable ! Guard: fitted and functional ! Cable/hose: intact ! Accessory: replace ! Projection zone: organise ! PPE: face shield missing	✗ Overall condition: damaged ✗ Guard: removed ✗ Cable/hose: damaged or leaking ✗ Accessory: cracked or worn ✗ Noise/vibration: abnormal ✗ Projection zone: uncontrolled ✗ PPE: does not compensate for the defect
MAY BE USED	CORRECT AND REINSPECT	ISOLATE AND REPORT

Figure 4.5 — Safe tool, tool requiring rectification, and tool to be withdrawn from service

4.1.4 Lockout/tagout (LOTO) during maintenance

4.1.1 4.1.6

The lockout/tagout procedure, commonly referred to by the acronym LOTO, is intended to prevent unexpected start-up or the release of any form of energy during an intervention. Before work begins, all energy sources must be identified and isolated; the energy isolation points must be locked out and tagged; residual energy must be discharged; and the zero-energy state must be verified.

This procedure is a critical technical and organisational measure before maintenance, cleaning, unblocking, adjustment, component replacement or intervention on conveyor belts, crushers, pumps, electrical switchboards, and hydraulic, pneumatic or mechanical systems.

Key message

A stopped machine is not a safe machine. The task should begin only after the energy has been isolated, locked out, tagged and discharged, and the zero-energy state has been verified.

When to apply LOTO

Apply the lockout/tagout procedure whenever an intervention may expose a worker to unexpected start-up, movement of moving parts, falling loads, stored pressure, electricity, hydraulic fluid, compressed air, heat, chemicals or any other uncontrolled energy.

Energy sources to identify

- electrical: switchboards, cables, sockets, motors, batteries and controls;
- hydraulic: pumps, hoses, cylinders, accumulators and pressurised fluid;
- pneumatic: compressors, air lines, hoses, couplings and pneumatic tools;
- mechanical: belts, gears, shafts, transmissions, rollers, blades and moving parts;
- gravitational: suspended loads, raised vehicle or equipment bodies, supported components, buckets and accumulated material;
- thermal: hot surfaces, steam, motors, welding, friction and heated materials;
- chemical: fuels, lubricants, reagents, gases, vapours or stored products;
- stored pressure and residual energy: springs, accumulators, pressurised circuits, trapped fluid, compressed air, pressurised water or components under stored tension.

Simple LOTO sequence

1. Prepare the intervention: identify the task, equipment, people involved and energy sources.
2. Communicate the intervention to the team, supervision and affected workers.
3. Shut down or stop the equipment using the prescribed procedure.
4. Isolate all identified energy sources.
5. Apply a physical lockout at the energy isolation points.
6. Tag the lockout with the identification, date, time and reason for the intervention.
7. Discharge residual energy: pressure, suspended load, heat, fluid, air, water or stored movement.
8. Verify the zero-energy state by carrying out a controlled start attempt or equivalent check and confirming that the equipment does not move, start or release energy.
9. Carry out the task only after confirmation.
10. Remove tools, loose components and people from the intervention area.
11. Each personal lockout must be removed by the worker who applied it. Any exceptional removal by another person must follow a formal procedure, authorisation, verification that the worker is absent, and a documented record.
12. Restore energy, test operation and communicate the return to service.

Critical situations

LOTO is particularly important for a blocked crusher, conveyor belt, pump, compressor, pressurised hose, raised vehicle or equipment body, suspended load, pneumatic tool, or any equipment with moving parts, pressure, load, fluid or residual energy.

Actions that must never be taken

- intervene simply because the machine has stopped;
- rely solely on the switch, stop button or remote control;
- use another person's lockout;
- remove another worker's lockout outside the formal exceptional-removal procedure;
- begin the task without discharging residual energy;
- begin the intervention without verifying the zero-energy state;

- restore energy without confirming that tools and people have been removed from the work area.

Table 4.4 provides a simplified lockout/tagout record card for recording the energy sources, energy isolation points, lockouts applied, verification of the zero-energy state and authorisation to return to service.

Practical decision rule

If it has not been possible to identify, isolate, lock out, tag, discharge and verify all energy sources, the intervention must stop. The task may begin only after the zero-energy state has been confirmed. The complete sequence is shown in Figure 4.6.

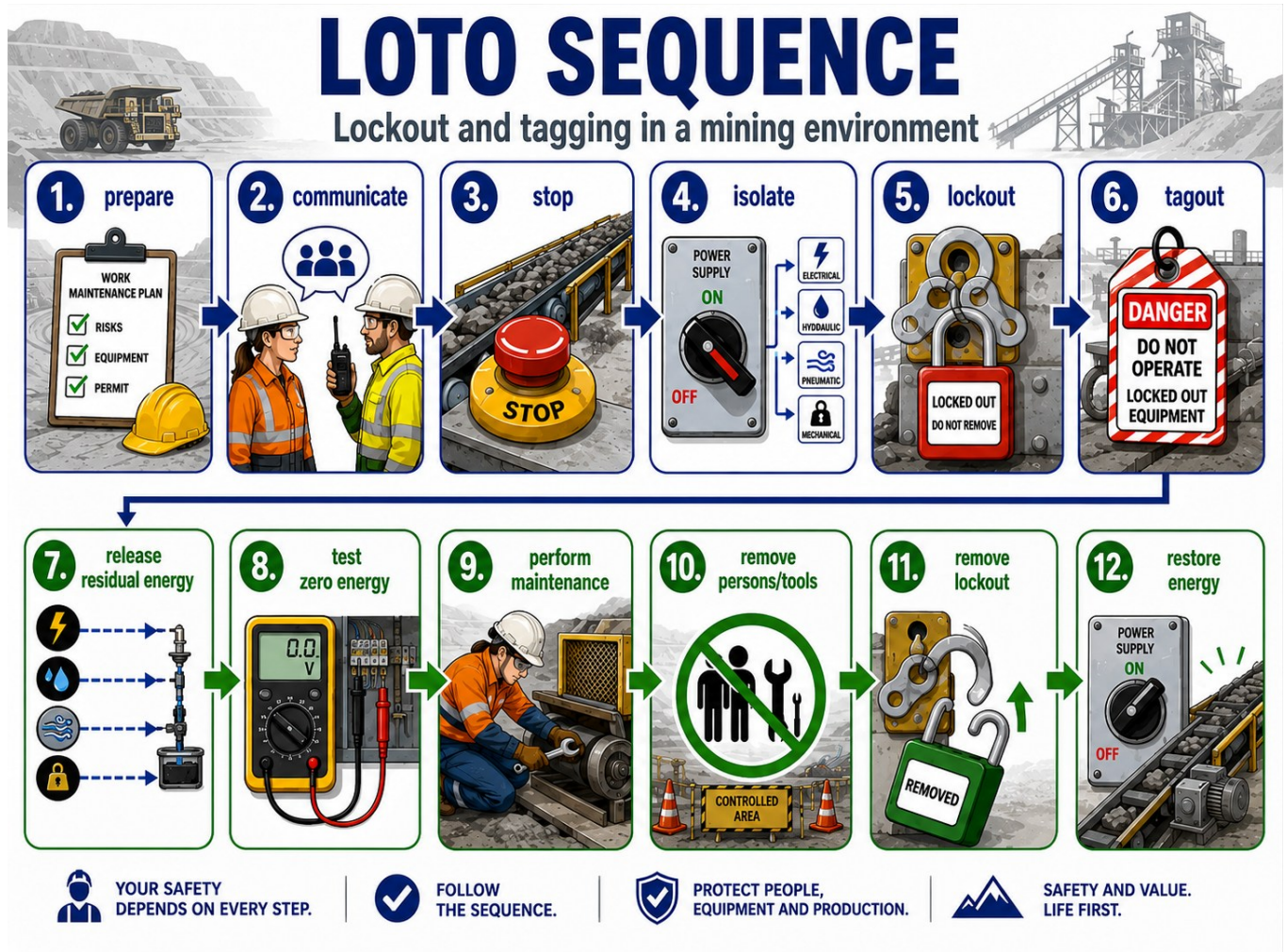


Figure 4.6 — LOTO sequence

Table 4.4 — Simplified lockout/tagout record card

Field	Completion / evidence
Equipment	Identify the machine, installation, tool or system to be worked on.
Location	Specify the area, workshop, working face, crushing plant, warehouse, pump, conveyor, switchboard or other location.
Task	Describe the maintenance, cleaning, unblocking, adjustment, component replacement or intervention.
Energy sources identified	Electrical, hydraulic, pneumatic, mechanical, gravitational, thermal, chemical, stored pressure or residual energy.
Energy isolation points	Specify circuit breakers, valves, isolators, lockout points, bleed or drain points, or isolated controls.
Lockouts applied	Record the padlock, lockout device, physical lockout or other means used.
Tag completed by	Name, role and contact details of the authorised worker, where applicable.

Field	Completion / evidence
Date/time	Record the start of the lockout and, where applicable, the time of return to service.
Residual energy discharged	Confirm discharge of pressure, fluid, air, water, heat, suspended load or stored movement.
Zero-energy state verified	Confirm a controlled start attempt or equivalent verification before the intervention.
Authorisation to return to service	Confirm that people and tools have been removed, lockouts have been removed in a controlled manner, and the return to operation has been communicated.

4.1.5 Work at height: ladders, scaffolds, platforms and slopes

In a mining context, work at height means any task where there is a risk of falling to a lower level, including work on ladders, scaffolds, platforms, crushing structures, silos, tanks or equipment, or near edges, bench crests, slopes and other changes in level. The task should begin only when access, stability, fall protection, surrounding conditions and authorisation have been confirmed.

Ladders, scaffolds and platforms should not be used as improvised solutions for reaching the work area. Before use, the condition of the structure, support, angle or level, securing, safe working load, guardrails where applicable, and safe access must be confirmed.

When working near slopes, crests, benches or changes in level, the knowledge from **Chapter 3 — Particularities of the Mining Industry** should be used to determine whether the ground, berm, traffic and exclusion zone allow the task to be carried out. If there is any uncertainty about stability, falling material or proximity to an edge, the task must stop.

Key message

Work at height is acceptable only when access is safe, the surface is stable, fall protection is in place and the surroundings do not introduce an additional hazard.

What to check before starting

- the portable ladder is intact, has stable support, is set at a suitable angle, is secured where necessary and is used only temporarily;
- the worker can maintain three points of contact and is not carrying loads that compromise balance;
- the scaffold has been erected by an authorised person, inspected, and fitted with guardrails, toe boards, an intact platform and safe access;
- the fixed or mobile platform has guardrails, a non-slip surface, safe access, and confirmed safe working load and stability;
- the area below is controlled to prevent pedestrians, workers or equipment from being exposed to falling objects;
- collective protective measures are considered before the use of a harness, whenever technically possible;
- the harness, lifeline and anchorage point are used only when they are suitable, compatible, inspected and authorised;
- the surrounding conditions have been checked: surface, wind, rain, mud, lighting, slope, berm, traffic and loose materials.

Conditions requiring work to stop

The task must stop, or must not begin, in strong winds, rain or mud, or where there is an unstable surface, degraded berm, absence of guardrails, a damaged ladder, an uninspected scaffold, an unstable platform, a questionable anchorage point, traffic in the area below or a risk of falling objects. Any uncertainty about the stability of the access or ground should be treated as a stop-work criterion.

Table 4.5 structures the pre-use inspection of ladders, scaffolds and platforms around five essential points, enabling conditions that must be rectified before work begins to be identified.

Practical decision rule

If any of the five points is not controlled, the task should not begin. Where the correction is simple and immediate, the task may proceed only after correction. Where there is uncertainty about stability, fall protection, anchorage, the berm, the slope, traffic or falling objects, the safe decision is to stop and reassess. The five essential points are shown in Figure 4.7.

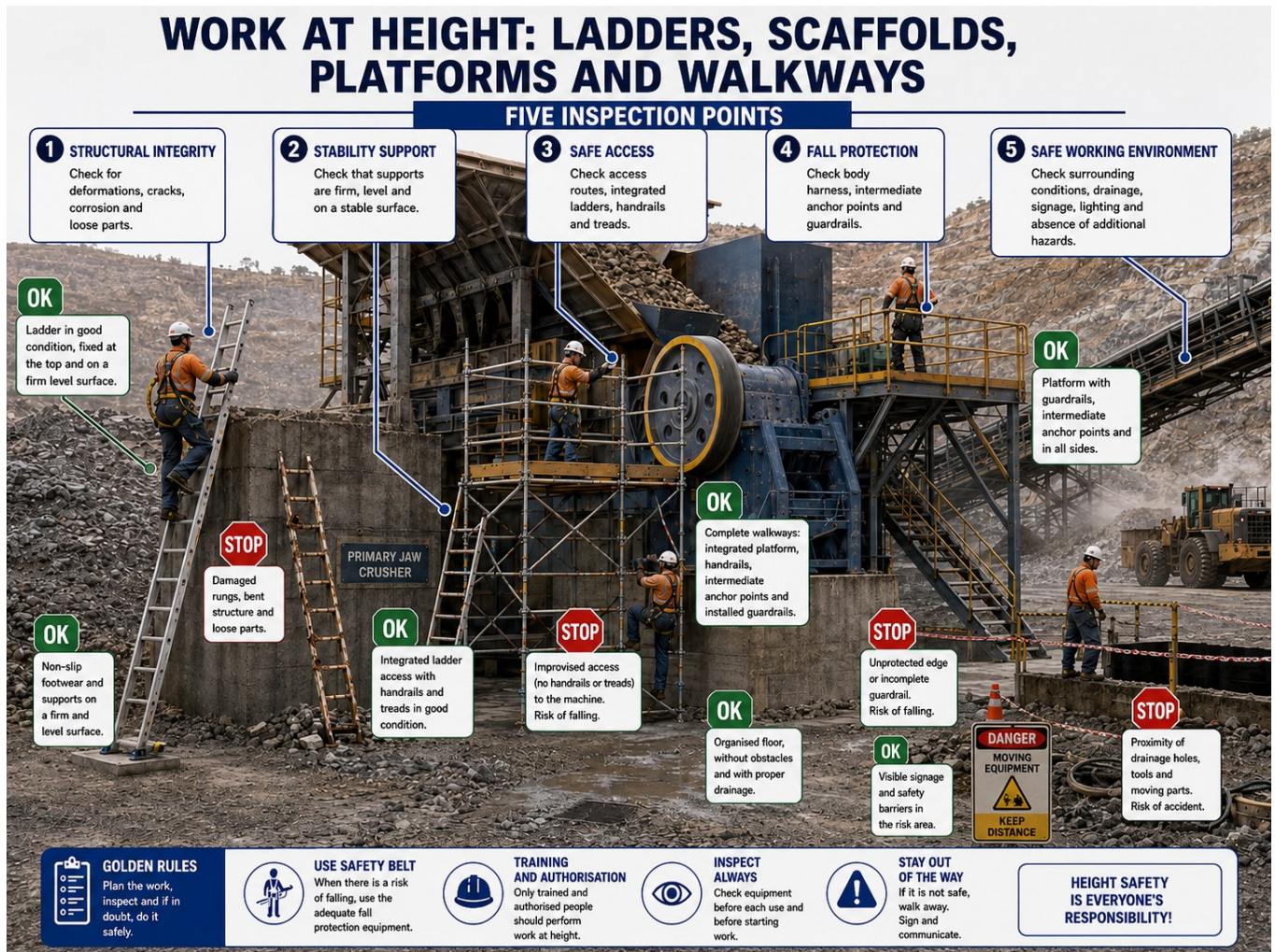


Figure 4.7 — Work at height

Table 4.5 — Five-point rapid inspection of a ladder, scaffold or platform

Point	What to confirm	Compliant / Non-compliant / Comments
1. Intact structure	Ladder, scaffold, platform, guardrails, toe boards, rungs, bracing, wheels and accessories are free from damage, deformation, critical corrosion or missing components.	
2. Stable support	Firm, level and non-slip base; clear of edges, mud, traffic and loose materials; ladder set at a suitable angle and secured.	
3. Safe access	Entry, exit and route are clear; three points of contact can be maintained; no manual carrying of loads that compromises balance.	
4. Fall protection	Collective protection is installed where applicable; a harness, lifeline and anchorage are used only when suitable, compatible and authorised.	
5. Safe surrounding conditions	Surface, wind, rain, mud, lighting, slope, berm, traffic and falling-object hazards are controlled before the task begins.	

4.1.6 Compressed air, pressurised water and residual energy

Compressed air, pressurised water and residual energy should be treated as energy sources. Even when they appear only to support the operation, they can cause hose whip, flying particles, hazardous jets, slipping, unexpected movement, pressure release or loss of control of the task.

Before using or working on compressors, pumps, hoses, pneumatic tools, hydraulic systems, washing systems, drainage systems or wet-suppression systems, the pressure, connections, condition of accessories, means of depressurisation and presence of residual energy must be confirmed.

Key message

An installation or tool is safe for intervention only when the energy has been identified, isolated, discharged and verified. A stopped machine, a disconnected hose or a closed valve is not sufficient if pressure, load, heat, movement or stored energy remains.

What to check before starting

- compressors, pumps, hoses, couplings, valves, pressure gauges and accessories are in good condition;
- the pressure is compatible with the tool, hose, tool bit, nozzle, jet or system being used;
- there are no leaks, cuts, kinks, crushed sections, improvised connections or couplings without safety restraints;
- hoses are positioned to prevent trips, hose whip, crushing by vehicles or contact with sharp edges;
- depressurisation has been confirmed before hoses, tool bits, nozzles, discs, accessories or components are changed;
- compressed air is not used to clean the body, clothing or skin;
- pressurised water is controlled during washing, drainage, pumping and wet-suppression operations;
- mud, accumulated water, jets, spills and slipping hazards are controlled before the task;
- the effect of water on roads, slopes, platforms, stockpiles and storage areas has been considered;
- residual energy has been identified: pressure, gravity, a raised vehicle or equipment body, suspended load, springs, accumulators, hydraulic fluid, heat or moving parts.

Integration with LOTO

For maintenance, cleaning, unblocking, adjustment or component-replacement tasks, the lockout/tagout sequence described in [4.1.4 Lockout/tagout \(LOTO\) during maintenance](#), should be applied, including identification and isolation of the sources, discharge of residual energy and verification of the zero-energy state.

Conditions requiring work to stop

The task must stop where there is uncontrolled pressure, a leak, damaged hose, unsafe coupling, possible hose whip, absence of a functioning pressure gauge or valve, uncertainty about depressurisation, a suspended load, an unsupported raised component, pressurised hydraulic fluid, water compromising stability, a slippery surface, an uncontrolled jet, or an inability to verify the zero-energy state.

Table 4.6 guides the identification, isolation, discharge and verification of the different forms of residual energy before any intervention.

Table 4.6 — Short assessment form: presence of residual energy

Field	Response / verification	Compliant / Non-compliant / Comments
Equipment/system		
Type of energy	Electrical / hydraulic / pneumatic / mechanical / gravitational / thermal / chemical / stored pressure / other	
Source		
How to isolate		
How to discharge		

Field	Response / verification	Compliant / Non-compliant / Comments
How to verify		
Who authorises		
Evidence recorded		

Practical decision rule

If residual energy cannot be identified, discharged and verified as safe for the intervention, the task must stop. The intervention may proceed only after confirming the absence of pressure, movement, load, heat or stored energy capable of causing harm. The identification, isolation, discharge and verification steps applicable to compressed air, pressurised water and residual energy are summarised in Figure 4.8.



Figure 4.8 — Compressed air, pressurised water and residual energy

4.1.7 Ergonomics, fatigue and fitness for work

Ergonomics, fatigue and fitness for work should be checked before the task is carried out. Even when the work area, tool and procedure appear suitable, the task may become unsafe if it requires excessive force, an unstable posture, repetitive movements or prolonged attention, or if the worker is not physically or mentally fit to carry it out at that time.

Detailed ergonomic and psychosocial assessment is addressed in Chapter 2 — Fundamentals of Occupational Hygiene. At this point, the question is operational: is the worker fit, and is the task suitably adjusted to be carried out safely now?

Key message

A task should not proceed simply because a procedure exists. It should proceed only when the load, posture, tool, duration, attention, communication and worker fitness allow the work to be carried out under control.

What to check before starting

- manual handling of loads: weight, volume, grip, distance, lifting height and need for a mechanical handling aid;
- awkward postures during maintenance, in warehouses or laboratories, on platforms or when accessing equipment;
- repetitive movements, prolonged exertion or a need to maintain the same position for a long time;
- prolonged use of hand tools, portable power tools or pneumatic tools, considering exertion, control, grip, vibration or abnormal noise;
- conditions that increase the likelihood of error: fatigue, drowsiness, heat, long shifts, production pressure, distraction or reduced concentration;
- visibility, communication, understanding of instructions and the ability to use PPE correctly.

Warning signs

The task should be reassessed if the worker shows pain, tremor, loss of strength, drowsiness, reduced concentration, dizziness, changes in alertness, coordination or behaviour, high stress, difficulty understanding instructions, or an inability to use PPE correctly.

Practical decision

When the task is not adjusted to the worker or the actual conditions, the response should not be to improvise. The decision should be to modify the task before proceeding—for example, use a mechanical handling aid, rotate workers, introduce breaks, temporarily remove the worker from the task or assign it to another worker who meets the necessary conditions, or request assistance—or stop until safe conditions exist. The relationship between task demands, worker fitness, actual conditions and the operational decision is shown in Figure 4.9.



Figure 4.9 — Fitness-for-work assessment: task, worker, actual conditions and decision

Table 4.7 guides the identification of ergonomic issues that may arise throughout the production cycle.

Table 4.7 — Pre-task assessment: ergonomics and fitness for work

Field	Practical verification criterion	Proceed / Rectify before proceeding / Stop and reassess
Load / weight	Can the load be moved without excessive exertion? Are a suitable grip, space, route and mechanical handling aid available where needed?	
Posture	Does the task avoid twisting, excessive reaching, work above shoulder height, prolonged kneeling or unstable balance?	
Repetition	Does the task require repetitive movements or sustained force for a prolonged period?	
Tool	Does the tool allow control, a stable grip and use without excessive exertion or abnormal vibration/noise?	
Duration	Is the expected duration compatible with breaks, worker rotation or alternation of tasks?	
Fatigue	Are there signs of drowsiness, reduced concentration, pain, tremor, loss of strength, dizziness, changes in alertness, coordination or behaviour, or high stress?	
Visibility / communication	Can the worker see the work area, understand the instructions and communicate with the team?	
Need for assistance	Is support from another worker, supervision, a mechanical handling aid or a change in method required?	
Final decision	Proceed, rectify before proceeding, or stop and reassess.	

Practical decision rule

If the task requires exertion that the worker cannot control, if the posture compromises balance or attention, or if there are signs of fatigue or unfitness for work, the task must be adapted or interrupted.

4.1.8 Selection and use of PPE

PPE should be selected on the basis of the specific task, the main risk and the actual conditions in which the task will be carried out. It should not be chosen solely out of habit or from a generic list. The practical question is: what protection is required for this task, at this location, with this tool, this material and these people exposed?

A safety helmet, safety footwear, gloves, safety glasses, a face shield, hearing protection, respiratory protection, high-visibility clothing, a harness, cut-resistant protection, chemical protection or protection against biological agents may be required. Selection should also consider compatibility, fit, condition, cleaning, maintenance, storage and replacement.

Compatibility is essential. Safety glasses, a respirator, a safety helmet and hearing protection must be capable of being worn together without compromising the seal, visibility or communication. The harness must be compatible with the vest, lifeline and anchorage point. Gloves must protect the worker without compromising grip, control of the tool or the sensitivity required for the task.

PPE has limitations. It does not eliminate uncontrolled energy and does not replace LOTO, guards, guardrails, ventilation, containment, work-area organisation or a permit-to-work. For tasks involving hazardous biological agents, protection should include, where applicable, gloves, boots, eye or face protection, respiratory protection, hygiene, cleaning and decontamination.

Key message

The correct PPE is the PPE that protects against the risk arising from the task, is compatible with the other equipment, is in good condition, fits the worker and does not create new risks.

What to check before starting

- PPE has been specified on the basis of the task, the main risk and the people exposed;
- a safety helmet, safety footwear, gloves, safety glasses, a face shield, hearing protection, respiratory protection, high-visibility clothing, a harness or specific protection has been selected where applicable;
- compatibility has been checked between safety glasses, respirator, safety helmet, hearing protection, harness, vest and gloves;

- the general condition has been confirmed: there are no cracks, wear, contamination, deformation, excessive dirt, or equipment past its expiry date or service life;
- fit to the worker has been confirmed before the task, including the respirator seal, field of vision, mobility and communication;
- gloves are suitable for the risk: cuts, abrasion, heat, chemicals, biological agents or operation of a tool;
- a harness is used only with a lifeline, a valid anchorage point and authorisation for the task;
- PPE is clean, stored correctly and replaced when it no longer provides protection;
- the limitations are recognised: PPE does not replace lockout, guards, guardrails, ventilation, containment or organisation of the task.

When to rectify or stop

The task must be rectified or stopped when mandatory PPE is absent, damaged, contaminated, poorly fitted, incompatible with another item of PPE or unsuitable for the main risk. It must also stop when the harness has no valid anchorage, a glove compromises control of the tool, respiratory protection does not seal correctly, or eye/face protection does not cover the area exposed to flying particles.

Table 4.8 provides examples of task-based PPE selection according to the main risk, including verification of compatibility, limitations and the evidence required.

Practical decision rule

If the PPE does not protect against the main risk, is incompatible with the other equipment or causes loss of control of the task, the activity must be adapted before it begins. If no safe alternative is available, it must stop. The relationship between the task, main risk, recommended PPE and equipment compatibility is illustrated in Figure 4.10.

Table 4.8 — Task-based PPE selection grid

Task	Main risk	PPE required	Compatibility	Limitation	Evidence
Unblocking a crusher after LOTO	Flying particles / dust / cuts	Safety glasses, gloves, safety helmet and respiratory protection where applicable	Check compatibility with hearing protection and face shield	Does not replace lockout	LOTO form + record
Working on a ladder	Fall / falling objects	Safety helmet with chinstrap and non-slip safety footwear; personal fall protection system only where technically specified	Confirm the access system and, where applicable, compatibility between the harness, lanyard and anchorage point	A harness does not compensate for an unstable ladder or support and must not be used without a suitable anchorage system	Ladder checklist
Grinding	Flying particles / noise / cuts	Face shield, safety glasses, suitable gloves and hearing protection	Confirm that the tool guard is fitted	Do not use a damaged disc	Tool inspection form
Pneumatic tool	Flying particles / noise / vibration / hose whip	Safety glasses or face shield, suitable gloves, hearing protection and safety footwear	Check the hose, coupling and mobility while wearing gloves	Does not replace pressure control and a secure connection	Tool inspection form
Chemical storage	Spill / contact / splash	Compatible gloves, safety glasses or face shield, boots and suitable clothing	Check chemical compatibility and mobility	Does not replace labelling, containment and ventilation	Storage assessment form
Handling water and waste	Biological contact / splash / slipping	Gloves, boots, eye/face protection and respiratory protection where applicable	Confirm decontamination and hygiene	Does not replace cleaning, drainage and segregation	Task record

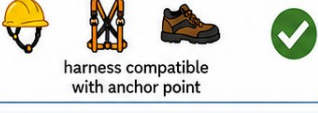
 MATRIX: TASK → RISK → PPE 			
Select PPE according to the task and risk.			
TASK	MAIN RISK	RECOMMENDED PPE	COMPATIBILITY
1  Drilling / blasting	 dust, noise, projections	 helmet goggles hearing protection respirator gloves boots	 use together
2  Cutting and grinding	 sparks, particles, noise	 face shield or goggles hearing protection gloves boots	 protect eyes + ears + hands
3  Handling chemical products	 splashes, vapours, skin contact	 sealed goggles respirator chemical gloves apron boots	 check compatible material
4  Load handling	 falling objects, crushing	 helmet gloves toe-capped boots high-visibility vest	 PPE without limiting mobility
5  Work at height	 fall, impact, instability	 helmet with chin strap safety harness slip-resistant footwear gloves	 harness compatible with anchor point
 Head protection  Eye protection  Hearing protection  Respiratory protection  Hand protection  Foot protection  Body protection  Fall protection			
 PPE must be suitable for the task, the risk and compatibility with other equipment.			

Figure 4.10 — Task–risk–PPE matrix

4.2 Apply — integrative activity

This activity integrates the main controls covered in **Chapter 4 — Operational Technical Safety and Maintenance**. Before the task is carried out, the learner must prepare a technical task by confirming the work area, equipment, critical condition, people exposed, prior controls and final decision.

Key message

The task should proceed only when the learner can justify, with evidence, that the work area is ready, energy is controlled where applicable, access is safe, the PPE is suitable and the final decision is consistent.

Proposed integrative activity — Prepare a safe technical task before it is carried out

The learner chooses one of the following situations:

- crusher maintenance;
- conveyor cleaning;
- use of a portable tool;
- work on a ladder;
- stacking material;
- an intervention involving a pressurised hose;
- manual handling of components;
- PPE selection for a specific task.

To prepare and record the task before it is carried out, use **A.3 — Safe preparation of a technical task**. Additional training cases may be made available by the trainer on the STRIM platform.

How to carry out the activity

- describe the selected technical task and the location where it takes place;
- identify the equipment, tool or installation involved;
- observe the critical condition that may prevent the task from starting safely;
- confirm whether energy, pressure, work at height, poor housekeeping, an unsuitable tool, fatigue or incompatible PPE is present;
- decide whether the task may proceed, requires rectification before proceeding, or must stop and be reassessed;
- retain the completed form as evidence in the portfolio.

Complete the safety preparation form provided in Table 4.9.

Table 4.9 — Technical task safety preparation form

Field	Response
Selected technical task	
Location	
Equipment/tool/installation	
Critical condition observed	
Energy source or technical hazard	
People exposed	
Required prior control	
Existing controls and observed effectiveness	
Is LOTO required? Yes/No. Justify.	
Is work at height involved? Yes/No. Justify.	
PPE required	
Signs of fatigue/unfitness to consider	
Final decision: proceed / rectify before proceeding / stop and reassess	
Evidence to be retained in the portfolio	

Practical decision rule

If the critical condition is not controlled, if lockout/tagout is required and has not been applied, if access is unsafe or if the worker is not fit for the task, the decision must be to rectify the situation before proceeding or to stop and reassess.

4.3 Quick self-assessment

This self-assessment confirms whether the learner can apply the Chapter 4 controls to rapid decisions before a technical task. The answers should be short, practical and linked to the decision: proceed, rectify before proceeding, or stop and reassess.

Key message

The self-assessment does not seek long answers. It checks whether the learner identifies the critical condition, selects the correct prior control and justifies the decision to proceed, rectify before proceeding, or stop and reassess.

Short questions

1. What minimum conditions should be checked before starting a maintenance task?
2. Why is a machine that has stopped not necessarily a safe machine?
3. What energy sources should be identified before applying LOTO?
4. What information should be included on a simplified LOTO record card?
5. What signs indicate that a ladder should not be used?

6. Why is it dangerous to use compressed air to clean clothing or the body?
7. What is the relationship between fatigue and operational error?
8. Why should PPE be selected for the specific task?
9. What criteria justify withdrawing a tool from service?
10. What evidence should be retained in the portfolio after a technical task?

Decision cases

For each case in Table 4.10, state the decision, provide a short justification and identify the evidence.

Table 4.10 — Decision cases for self-assessment

Case	Learner's decision	Short justification	Evidence to retain
Blocked crusher without LOTO			
Ladder with unstable support			
Leaking compressed-air hose			
Fatigued worker before using a cutting tool			
Unstable stack of materials next to a traffic route			
Work at height next to a bench without collective protection			

Self-assessment criterion

The answer is adequate when it identifies the critical condition, recognises who may be exposed, selects the required prior control and presents a safe decision. Where there is doubt about energy, access, stability, the tool, PPE or fitness for work, the decision must be to stop and reassess.

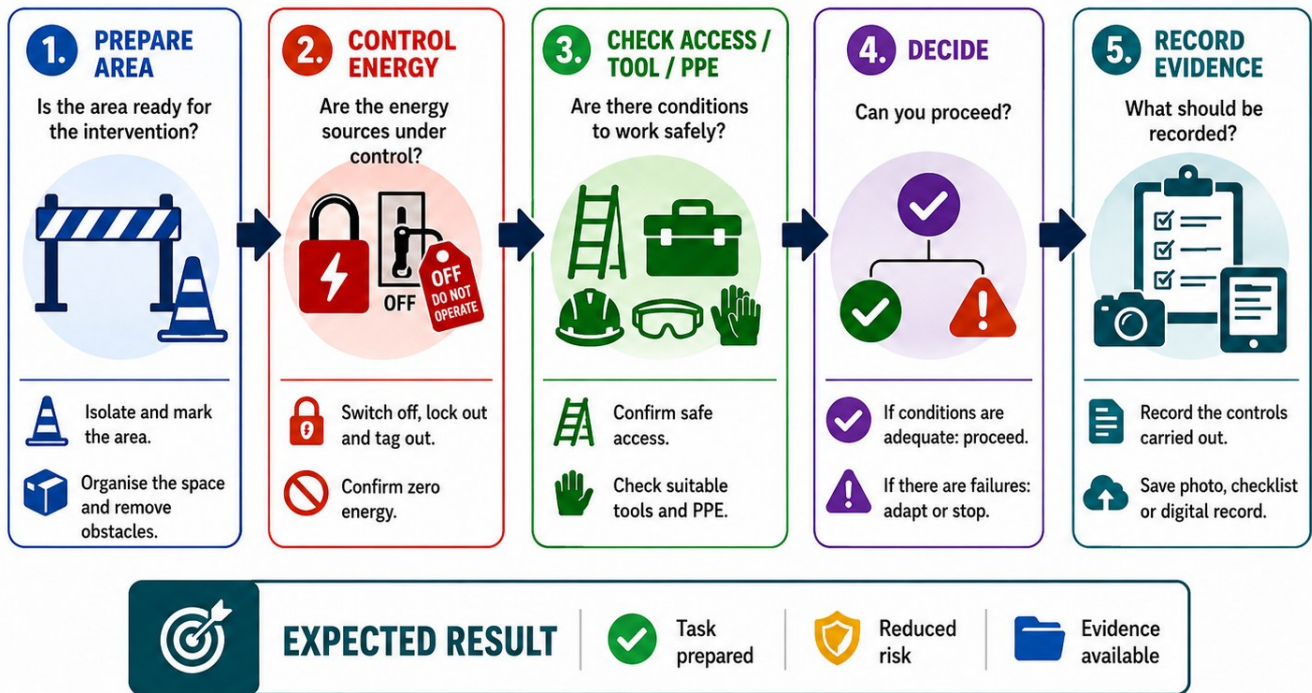
4.4 Practical summary

This summary brings together the essential points of Chapter 4 to support the immediate decision before starting a technical task. The aim is to ensure that the work area, energy, tool, access, worker and PPE are controlled before the task is carried out. The integrated chain covering work-area preparation, energy control, access and equipment checks, decision-making and recording of evidence is shown in Figure 4.11.



DECISION CHAIN AND TASK PREPARATION

Verification sequence before carrying out the intervention



RULE: If it is not safe, do not proceed.



Figure 4.11 — Task preparation and decision chain

What must never be forgotten

A technical task begins before it is carried out: it begins with preparation of the work area, energy, tool, access, worker and PPE.

Poor housekeeping, unstable stacking and blocked access are signs of operational risk.

Damaged or improvised tools, or tools without guards, must be withdrawn from service.

During maintenance, stopping the machine is not sufficient: residual energy must be isolated, locked out, tagged and discharged, and the zero-energy state must be verified.

Work at height requires safe access, stability, collective protection and a clear stop criterion.

Compressed air, pressurised water and residual energy can cause serious accidents.

Fatigue, awkward posture and lack of fitness for work increase the likelihood of error.

PPE is essential, but it does not replace organisation, collective protection, lockout/tagout, safe access and technical controls.

The presence of a control is not sufficient: it must be confirmed that the control is present, suitable and effective under the actual task conditions.

The preventive decision must be recorded in the portfolio: a form, checklist, lockout/tagout record card, photograph taken without creating additional exposure to risk, or summary.

Expected final product of Chapter 4

A technical task safety preparation form integrating the work area, task, equipment/tool/installation, energy source, access, work at height, ergonomics, fitness for work, PPE, final decision and evidence for the portfolio. The visual structure of the final form and the elements to be checked before the task is carried out are shown in Figure 4.12.

Final safe technical task preparation sheet

CHECK BEFORE STARTING

1. WORK AREA Access, floor, lighting and housekeeping 	2. TASK Objective, sequence and authorisation 	3. EQUIPMENT / TOOL / INSTALLATION Condition, safeguards and suitability 	4. ENERGY SOURCE Isolation, LOTO and residual energy 	5. ACCESS Circulation, demarcation and authorisation 
6. WORK AT HEIGHT Platform, safeguards and anchorage 	7. ERGONOMICS / FITNESS FOR WORK Posture, exertion, fatigue and fitness 	8. PPE Selection, compatibility and condition 		
9. FINAL DECISION Can the task proceed? ✓ CONTINUE ! CONTINUE WITH ADDITIONAL MEASURES ✗ STOP			10. EVIDENCE What record must be retained? CHECKLIST LOTO CARD PHOTOGRAPH DIGITAL PORTFOLIO	

ALL CONTROLS MUST BE CONFIRMED BEFORE THE TASK STARTS

Figure 4.12 — Final technical task safety preparation form

CHAPTER 5

Fundamentals of risk assessment



SAFETY TRAINING WITH
REAL IMMERSIVITY FOR MINING



Co-funded by
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Chapter 5 — Fundamentals of Risk Assessment

Chapter 6 6.1.6 Chapter 9 9.1.8

Chapter overview

Section	Pedagogical function
Before you begin	Guide the learner, clarify the guiding question, the objectives, the competences and the expected output.
Learning pathway	Explain the Learn–Observe–Decide–Apply–Reflect sequence and the expected outputs.
Core technical content	Transform an observed situation into a simple, substantiated and recordable assessment.
Apply — integrative activity	Assess the current risk of an observed situation and record the control, decision and evidence.
Quick self-assessment	Check the ability to distinguish concepts, classify risk and justify the decision.
Practical summary	Consolidate the foundations, decision rules and final product of the chapter.

Before you begin

Question to be answered

How can the risk level of an observed situation in a mine, quarry, workshop, warehouse, laboratory or crushing area be assessed simply and consistently?

Purpose of the chapter

This chapter helps the learner move from observing a hazardous situation to carrying out an initial risk assessment. The aim is to link the hazard, triggering event, exposure, vulnerability, likelihood, consequence and initial control measure in a simple and verifiable form.

Before classifying the risk, the minimum context of the assessment must be defined: location, task or process, people or equipment exposed, existing controls, and the criterion used to decide whether the situation may continue, continue with additional controls, or must stop and be reassessed.

In this chapter, the current risk level is assessed for the actual conditions observed, taking account of the existing controls and their effectiveness. The expression “initial control measure” means the first additional measure to be applied when the current risk is not acceptable or when the existing controls are insufficient.

The chapter does not replace advanced methods or the organisation’s internal procedures. Its purpose is to create a common basis for classifying risks qualitatively, justifying decisions and preparing the following chapters on identification, prioritisation, control and operational communication.

Key message

Assessing risk is not simply about identifying hazards. It means understanding what may happen, who or what is exposed, what consequence is plausible, how likely it is, what risk level results and what initial control measure should be proposed.

Learning objectives

- Distinguish between hazard and risk in real situations in the extractive industry.
- Identify the triggering event, exposure and vulnerability in an observed situation.
- Distinguish between occupational, environmental and technological risks.
- Differentiate between qualitative, semi-quantitative and quantitative assessment.
- Apply a simple 5 × 5 risk matrix using likelihood and consequence.

- Justify the scores assigned to likelihood and consequence.
- Propose the first additional measure required when the current risk level is not acceptable.
- Record the assessment on a minimum form, with evidence for the digital portfolio.

Competences to be developed

Competence	Expected evidence
Identify hazard and risk in a specific situation	Completed short hazard–risk form.
Recognise the triggering event, exposure and vulnerability	Hazard → triggering event → exposure/vulnerability → risk chain.
Classify occupational, environmental and technological risk	Classification table by type of harm.
Apply a simple 5 × 5 risk matrix	Completed matrix with likelihood, consequence and risk level.
Justify the assessment carried out	Short justification of likelihood and consequence.
Propose an initial control measure	Initial measure consistent with the risk identified.
Record evidence in the portfolio	Form, matrix, safe photograph, record or decision summary.

Expected output

The main output of Chapter 5 is an initial risk assessment form. The form should record: (1) the situation and context; (2) the hazard, triggering event, exposure and vulnerability; (3) the risk and possible consequence; (4) the likelihood and severity of the consequence, with justification; (5) the current risk level and initial control measure; and (6) the decision and evidence for the digital portfolio.

Learning pathway

The chapter follows the cross-cutting pedagogical logic of the e-book: learn, observe, decide, apply and reflect. This sequence helps the learner move from the essential concepts to a simple risk assessment, with a record and a justified decision.

Stage	What the learner does	Output or evidence
Learn	Review the minimum elements of risk assessment.	Short summary of the concepts.
Observe	Analyse a photograph or case.	List of hazards and of people or equipment exposed.
Decide	Assign likelihood and consequence, justifying the score.	Justified risk level.
Apply	Complete the minimum initial risk assessment form.	Hazard → risk → initial control measure record.
Reflect	Compare the decision taken with the initial control measure proposed.	Digital portfolio entry.

Common decision criterion for the chapter

For each situation analysed, the learner must conclude whether the operation may continue, may continue with additional controls, or must stop and be reassessed. The decision must be accompanied by evidence: a 5 × 5 risk matrix, form, photograph taken without exposing the worker to risk, observation record or group summary.

Links to previous chapters

This chapter revisits the concepts of hazard, risk and preventive decision-making from **Chapter 1 — Work Safety and Safety Culture**; uses occupational hygiene agents from **Chapter 2 — Fundamentals of Occupational Hygiene** as assessment examples; applies the operational understanding of the mine developed in **Chapter 3 — Particularities of the Mining Industry**; and uses the technical tasks from **Chapter 4 — Operational Technical Safety and Maintenance** as situations for analysis. Whenever these topics need to be examined in greater depth, the corresponding chapter should be consulted.

5.1 Fundamentals of risk assessment

The following subsections organise the elements required to turn an observation into a reasoned classification and a recorded preventive decision.

5.1.1 Difference between hazard and risk

Risk assessment begins by distinguishing hazard from risk. A hazard is a source, condition or situation with the potential to cause harm. Risk represents the combination of the likelihood of a hazardous event or exposure occurring and the severity of the potential consequence, taking account of the actual context and the effectiveness of existing controls.

This distinction must be applied to the specific situation. The mechanical energy of a conveyor belt, the instability of a slope, the presence of respirable dust or the disc of an angle grinder are hazards. The corresponding risks are, respectively, entanglement, falling blocks, inhalation exposure, or cuts and flying particles, with consequences of varying severity.

Key message

A hazard is something that can cause harm. Risk results from the combination of that hazard, the existing exposure, the likelihood of occurrence and the potential consequence.

The same hazard can generate different risk levels. An unguarded conveyor belt represents a very high risk if it is moving, accessible and close to workers. The risk may be lower if it is isolated, locked out, signposted and no one is exposed. Risk assessment must therefore always consider the actual context, the existing controls and who may be affected.

Short examples

- Unstable slope — hazard: rock mass instability; triggering event: rain, vibration or rock detachment; risk: falling blocks or engulfment; consequence: serious or fatal injury and damage to equipment.
- Unguarded conveyor belt — hazard: accessible moving parts and mechanical energy; triggering event: contact or unexpected start-up; risk: entanglement or crushing; consequence: serious or fatal injury.
- Dust at the crushing plant — hazard: respirable dust; triggering event: intense release or insufficient control at source; risk: inhalation exposure and reduced visibility; consequence: respiratory effects, collision or interruption of the task.
- Angle grinder without a guard — hazard: rotating disc and accessible projectile hazard area; triggering event: disc failure or loss of control; risk: cuts or flying particles; consequence: injury to the eyes, face or limbs.
- Pedestrians near mobile equipment — hazard: the energy and movement of the equipment; exposure: pedestrians in the equipment operating area; triggering event: unexpected movement or communication failure; risk: being struck by the equipment or crushed; consequence: serious or fatal injury.

Table 5.1 provides simple examples that distinguish the hazardous source or condition from the risk that may result from exposure to that situation.

Table 5.1 — Short exercise: distinguishing hazard from risk

Situation	Hazard	Risk
Moving unguarded conveyor belt	Accessible moving part	Entanglement / crushing
Muddy road used by a mining haul truck	Deteriorated or slippery road surface, or low traction	Loss of control / collision / overturning / pedestrian struck by vehicle
Angle grinder without a guard	Unguarded disc and projectile hazard area	Cuts / flying particles / loss of control
Pedestrians near manoeuvring mobile equipment	Interaction between people and machinery, and blind spots	Pedestrian struck by equipment / collision / crushing

Practical decision rule

Before classifying the risk, first confirm that the hazard has been described correctly. Then identify who is exposed, what may trigger the occurrence and what the most severe plausible consequence may be. The distinction between hazard, exposure and risk, together with the influence of existing controls, is summarised in

Figure 5.1.



Figure 5.1 — Hazard and risk

5.1.2 Triggering event, vulnerability and exposure

Risk does not depend solely on the existence of a hazard. To assess a situation, it is necessary to understand what may initiate the occurrence, who or what is exposed, and which vulnerabilities may increase the likelihood or severity of harm.

In the extractive industry, this analysis must be rapid and practical. The same condition may represent a low, moderate or high risk depending on the exposure, the control applied, the condition of the ground, the proximity of people, the energy present and the vulnerability of workers or equipment.

Key message

Risk assessment must answer three questions: what may trigger the occurrence, who or what is exposed, and which vulnerabilities make harm more likely or more severe?

Elements to consider in the assessment

- Triggering event: an event, failure or change that may turn the hazard into an accident, exposure or harm.
- Exposure: people, equipment, the environment or the community within the area of influence of the hazard.
- Vulnerability: a weakness that increases the likelihood of occurrence or aggravates the consequence, such as insufficient training, fatigue, inadequate protection, deteriorated equipment or unstable ground.

Applied examples

- Deteriorated road — triggering event: heavy rain and water accumulation; exposure: the driver, mining haul truck and other road users; risk: loss of control; consequence: collision or overturning.
- Unstable slope — triggering event: vibration, rain or a change in the rock mass; exposure: workers and equipment at the toe of the slope; risk: falling blocks or localised collapse.
- Equipment with energy that has not been isolated — triggering event: unexpected start-up; exposure: the maintenance team; risk: entanglement, crushing or flying particles.
- Insufficient ventilation — triggering condition: failure or reduction in air quantity; exposure: workers in the affected area; risk: exposure to dust, gases, fumes or oxygen deficiency.
- Pedestrians in the equipment operating area — exposure: people within the area of influence of the equipment; triggering event: unexpected movement, reversing or communication failure; risk: being struck by the equipment or crushed.

- A new or fatigued worker, or a worker without specific training — vulnerability: reduced ability to recognise warning signs, understand instructions or respond in time.

In this chapter, the working face, bench, slope, traffic routes and exclusion zone should be used only as the context for the assessment. The operational explanation of these elements is provided in [Chapter 3 — Particularities of the Mining Industry](#).

Table 5.2 organises the main assessment elements into a chain linking the hazard to the triggering event, exposure, vulnerability, risk and consequence.

Practical decision rule

If the triggering event, who or what is exposed, or the existing vulnerability is unclear, the risk assessment is incomplete. These three elements must be identified before likelihood and consequence are assigned. The relationship between hazard, triggering event, exposure, vulnerability, risk and consequence is shown in [Figure 5.2](#).

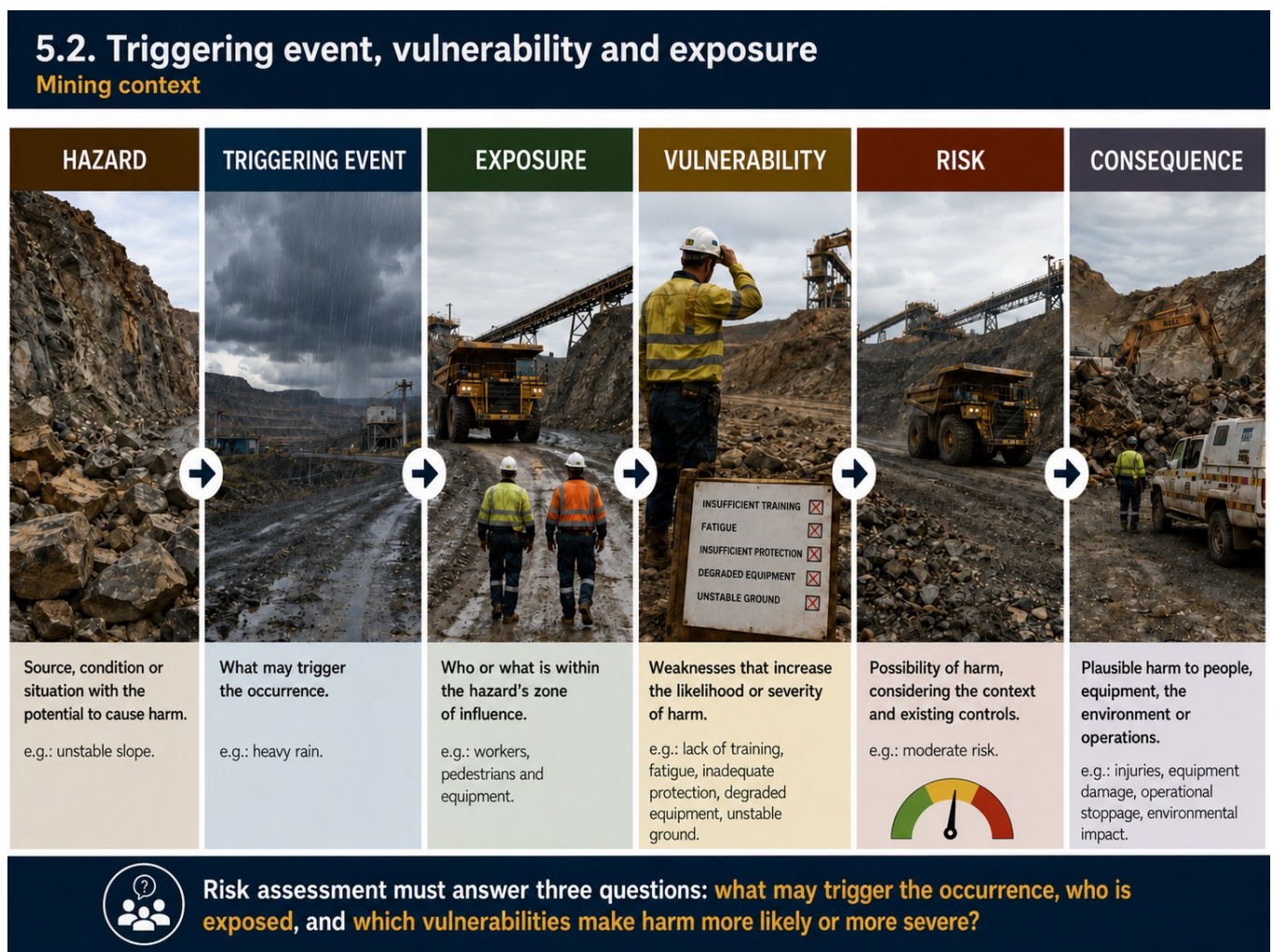


Figure 5.2 — Triggering event, vulnerability and exposure

Table 5.2 — Short assessment chain

Hazard	Triggering event	Exposure	Vulnerability	Risk	Consequence
Source, condition or situation with the potential to cause harm.	What may initiate the occurrence.	Who or what is within the area of influence.	A weakness that increases likelihood or severity.	Possibility of harm, taking account of the context and controls.	Plausible harm to people, equipment, the environment or operations.

5.1.3 Occupational, environmental and technological risk

Risk assessment should not be limited to immediate injury to a worker. The same situation may affect people, the environment, equipment, continuity of production and critical infrastructure. Before likelihood and consequence are assigned, it is therefore necessary to understand what type of harm is involved.

In the extractive industry, this analysis should be simple and applied. The aim is to recognise whether the risk is occupational, environmental or technological, or whether it combines several of these dimensions in the same situation.

Key message

The same situation may generate different types of risk. Sound assessment means asking: who may be harmed, what environmental impact may occur, and what technological failure may result?

Types of risk to consider

- Occupational risk: the possibility of harm to workers, operators, maintenance staff, laboratory staff, visitors, pedestrians or other third parties within the area of influence of the hazard.
- Environmental risk: the possibility of a spill, dust emissions, contaminated water, instability affecting areas outside the working area, soil or water contamination, or degradation of the surrounding environment.
- Technological risk: the possibility of harm resulting from a failure of equipment, a process, an energy source, a control system or technical infrastructure, including fire, explosion, rupture, loss of control, damage to installations or significant operational disruption.

Combined dimensions in the same situation

- A fuel spill may cause worker contact, a fall or a fire; it may contaminate the soil; and it may require equipment to be stopped.
- A conveyor belt failure may cause entanglement or crushing and, at the same time, interrupt production or damage components.
- An unstable slope may strike workers or equipment, carry material beyond the working area and interrupt operations at the working face.

Table 5.3 illustrates how the same situation may simultaneously present occupational, environmental and technological dimensions.

Table 5.3 — Risk dimensions

Situation	Occupational	Environmental	Technological
Fuel spill	Contact, fall, fire	Soil contamination	Equipment shutdown
Unstable slope	Engulfment / falling blocks	Material run-off	Interruption of operations at the working face
Conveyor belt failure	Entanglement / crushing	Normally limited, unless there is a spill, dust emission or material run-off	Production stoppage / damage to components
Intense dust at the crushing plant	Inhalation / reduced visibility	Dust emissions to the surrounding environment	Loss of efficiency / shutdown to implement controls
Unlabelled product in a laboratory or warehouse	Contact, splashing, inhalation or incorrect use	Spill or incorrect disposal	Interruption of the task / segregation required

Practical decision rule

When a situation involves more than one risk dimension, the consequence should reflect the most severe plausible harm, and the initial control measure should protect people, the environment and operational continuity wherever applicable. The possible coexistence of occupational, environmental and technological dimensions in the same situation is illustrated in Figure 5.3.

5.3. OCCUPATIONAL, ENVIRONMENTAL AND TECHNOLOGICAL RISK

In a mining context, the same situation can involve more than one risk dimension.



Figure 5.3 — Occupational, environmental and technological risk

5.1.4 Qualitative, semi-quantitative and quantitative assessment

Assessment may be qualitative, semi-quantitative or quantitative. Qualitative assessment uses descriptive categories and informed judgement. Semi-quantitative assessment converts categories into simple numerical scales, such as the 5 × 5 risk matrix, while still requiring interpretation and justification. Quantitative assessment uses measurements, frequencies, rates, concentrations or numerical models.

In this chapter, the 5 × 5 risk matrix is used as a semi-quantitative tool for reasoned classification. A quantitative assessment should be requested when the decision depends on measurements, reference values, actual frequencies or more detailed technical analysis.

Key message

Qualitative assessment supports decisions based on justified categories. Quantitative assessment provides greater depth when sufficient measurements, data or historical information are available.

What to distinguish before carrying out the assessment

- Qualitative assessment is suitable for screening and an initial decision based on descriptive categories.
- Semi-quantitative assessment uses numerical scales linked to categories and requires justification of the assigned values.
- Quantitative assessment is appropriate when measurements, reliable historical data or evidence of exposure, frequency or trends are required.
- When measured data are unavailable, numbers should not be invented: the classification should be justified and the need for measurement recorded where applicable.
- When measured values or a history of occurrences are available, these data should support the assessment but do not replace observation of the actual conditions.

Table 5.4 compares qualitative, semi-quantitative and quantitative approaches and indicates the intended use of each within this chapter.

Table 5.4 — Risk assessment approaches

Type of assessment	Main basis	Application
Qualitative	Descriptive categories, observation and experience	Screening and initial decision without numerical calculation
Semi-quantitative	Numerical scales linked to categories	5 × 5 risk matrix used in this chapter
Quantitative	Measurements, frequencies, rates, concentrations and models	More detailed assessment when the decision depends on measured data

Practical decision rule

Use qualitative assessment for descriptive screening; apply the 5 × 5 risk matrix as a semi-quantitative assessment; and request a quantitative assessment when the decision depends on measurements, limits, actual frequency, cumulative exposure or technical historical data. The three approaches are summarised in Figure 5.4.



Figure 5.4 — Qualitative, semi-quantitative and quantitative assessment

5.1.5 5 × 5 risk matrix: likelihood × consequence

The 5 × 5 risk matrix is a simple semi-quantitative tool that supports classification of the current risk level. It uses numerical likelihood and consequence scales, but the result must be interpreted qualitatively and always justified. The matrix does not replace observation in the field, technical experience, verification of existing controls or internal procedures; it helps organise the decision.

The classification is obtained by multiplying likelihood by consequence. Each scale ranges from 1 to 5. The higher the score, the higher the control priority and the stronger the justification required for the decision.

Key message

The 5 × 5 risk matrix is useful only when the selected values are justified. Assigning numbers is not enough; it is necessary to explain why likelihood and consequence were classified in that way.

How to use the matrix

- Identify the observed situation, the hazard and the likely triggering event.
- Confirm who or what is exposed and whether relevant vulnerabilities exist.
- Assign a likelihood value from 1 to 5, considering frequency, exposure, actual conditions and existing controls.
- Assign a consequence value from 1 to 5, considering the most severe plausible harm.
- Calculate: risk = likelihood × consequence.
- Classify the result as low, moderate, significant, high or critical.
- Define the decision: continue, continue with additional controls, or stop and reassess.

The likelihood and consequence scales are presented in Table 5.5. The relationship between score, risk level and decision guidance is provided in Table 5.6. The matrix used to calculate the current risk level is presented in Table 5.7.

Table 5.5 — Likelihood and consequence scales

Value	Likelihood	Consequence
1	Rare or very unlikely under the current conditions.	Minor harm or limited impact.
2	Unlikely, but possible.	Minor, reversible or readily controllable harm.
3	Possible under some working conditions.	Moderate harm, injury involving limited absence from work, or relevant operational damage.
4	Likely if the condition persists.	Severe harm, serious injury, significant environmental impact or major operational stoppage.
5	Very likely or imminent.	Death, permanent disability, severe environmental damage, explosion, collapse or critical loss of control.

Table 5.6 — Risk level classification and decision guidance

Score	Classification	Decision guidance
1–4	Low	Continue; maintain and verify the existing controls.
5–9	Moderate	Continue with additional controls; rectify weaknesses and verify the measures.
10–14	Significant	Continue with additional controls; implement and verify the measures before proceeding.
15–19	High	Stop and reassess; reduce the risk before proceeding.
20–25	Critical	Stop and reassess; apply an immediate control measure and verify its effectiveness before resuming.

Table 5.7 — Simplified 5 × 5 risk matrix

L × C	C1	C2	C3	C4	C5
L1	1 L	2 L	3 L	4 L	5 M
L2	2 L	4 L	6 M	8 M	10 S
L3	3 L	6 M	9 M	12 S	15 H
L4	4 L	8 M	12 S	16 H	20 C
L5	5 M	10 S	15 H	20 C	25 C

Legend: L = low; M = moderate; S = significant; H = high; C = critical.

Short application examples

- Unstable ladder: likelihood increases when the support is uneven, mud is present or the ladder is not secured.
- Blocked crusher without lockout/tagout (LOTO): the consequence may be very severe if there is an unexpected start-up or release of energy.
- Intense dust at the crushing plant: likelihood and consequence depend on intensity, duration, ventilation, visibility and the protection in place.
- Pedestrians near a mining haul truck: direct exposure and blind spots may increase the risk level.
- Unstable storage of materials: height, base, containment and proximity to traffic routes influence the classification.

Table 5.8 provides three examples of applying the 5 × 5 risk matrix, linking the assigned score to the risk level and corresponding preventive decision.

Table 5.8 — Completed example of applying the 5 × 5 risk matrix

Situation	Likelihood	Consequence	Level	Decision
Blocked crusher without LOTO	4	5	20 — critical	Stop and reassess; apply the lockout/tagout procedure.
Ladder with unstable support	3	4	12 — significant	Continue with additional controls; rectify the support before starting.
Use of an angle grinder with the guard fitted and suitable personal protective equipment (PPE)	1	3	3 — low	Continue; maintain and verify the existing controls.

Practical decision rule

The matrix must support the decision, not replace it. If the plausible consequence is severe and there is uncertainty about exposure, energy, stability, protection or control, the decision should be conservative: rectify the condition before continuing, or stop and reassess. Application of the 5 × 5 risk matrix to an observed situation, from the selection of likelihood and consequence through to the preventive decision, is illustrated in Figure 5.5.

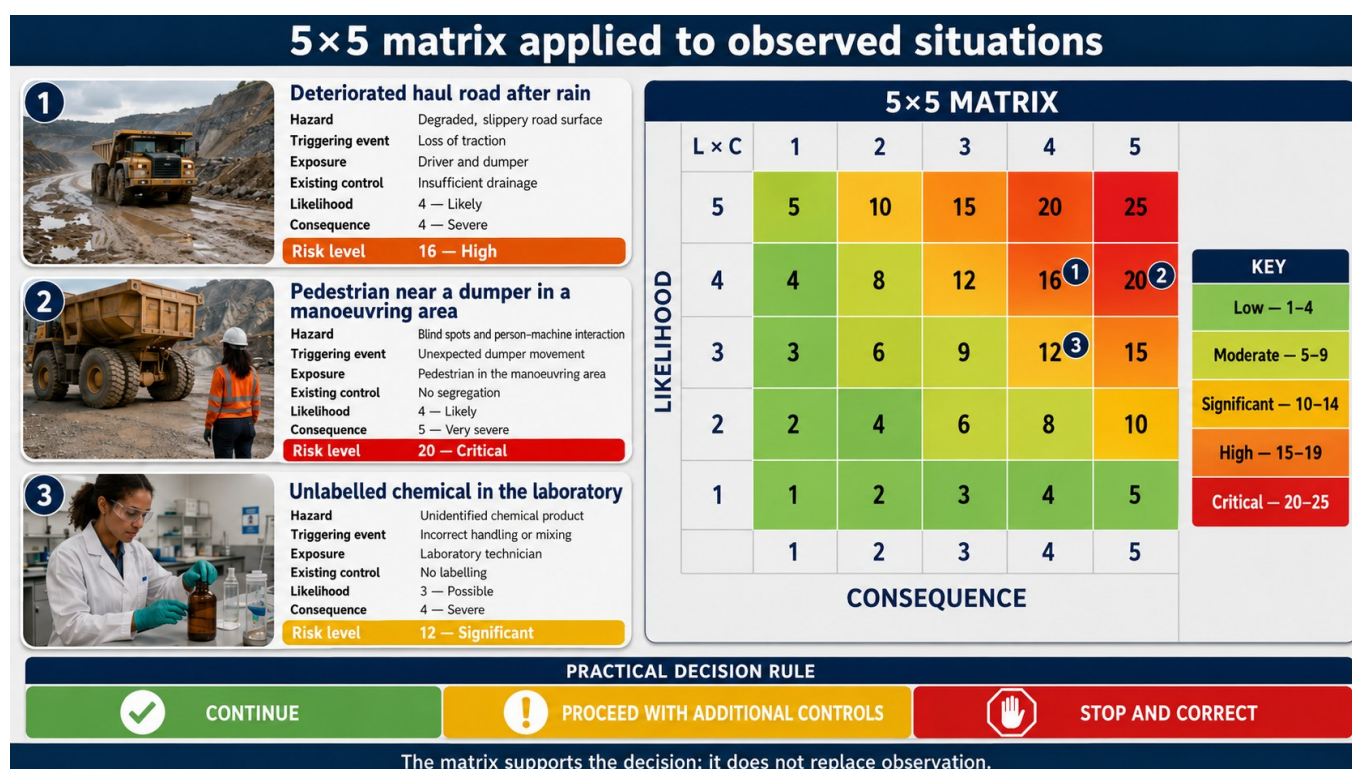


Figure 5.5 — 5 × 5 risk matrix applied to an observed situation

5.1.6 Minimum record: from the observed situation to the initial control measure

The minimum record is the point of transition between observation and decision. It should provide a concise account of the observed situation, the hazard, the event that may trigger harm, who or what is exposed, the relevant vulnerabilities, the risk and potential consequence, the resulting current risk level, and the initial control measure to be applied.

A long report is not required. The record should be sufficient to justify the classification, support an immediate decision and retain evidence in the portfolio. More comprehensive identification methods, checklists, group brainstorming, the 5 Whys technique, audits, and corrective actions with specific, measurable, achievable, relevant and time-bound (SMART) objectives will be addressed in Chapter 6 — Hazard Identification and Risk Prioritisation.

Key message

A risk assessment is complete only when it leaves a verifiable record: observed situation, hazard, triggering event, exposure, vulnerability, risk level, initial control measure and decision.

What the record should contain

- Observed situation: what was seen, where it was seen, and during which task or process.
- Hazard: a source, condition or situation with the potential to cause harm.
- Triggering event: the event that may initiate the occurrence.
- Exposure: people, equipment, the environment or the community within the area of influence.
- Vulnerability: a weakness that may increase likelihood or severity.
- Risk: the possibility of the hazardous event or exposure occurring; potential consequence: the plausible resulting harm.
- Likelihood and consequence: the values assigned in the 5 × 5 risk matrix, with justification.
- Risk level: the qualitative result of the classification.
- Initial control measure: the first additional measure required when the current risk is unacceptable or the existing controls are insufficient.
- Evidence and decision: a record, photograph taken without exposing the worker to risk, form, matrix or summary that justifies continuing, continuing with additional controls, or stopping and reassessing.

Table 5.9 brings together the minimum fields required to document an initial risk assessment in a concise, coherent and verifiable manner.

Table 5.9 — Minimum initial risk assessment form

Field	Completion guidance	Learner's response
Observed situation	Briefly describe the situation, task, location or process analysed.	
Context and decision criterion	State the location, task/process, operating condition and criterion used to decide whether to continue, continue with additional controls, or stop and reassess.	
Hazard	Identify the source, condition or situation with the potential to cause harm.	
Triggering event	State the event, failure or change that may initiate the occurrence.	
Exposure	State who or what is within the area of influence of the hazard.	
Vulnerability	Record relevant vulnerabilities: training, fatigue, protection, stability, access, equipment or the environment.	
Risk	Formulate the risk objectively: fall, entanglement, collision, exposure, spill, fire or another outcome.	
Potential consequence	State the most relevant plausible harm: injury, disease, environmental damage, technological failure or operational stoppage.	
Likelihood	Assign a value from 1 to 5 and justify it using exposure, frequency, actual conditions and existing controls.	
Consequence	Assign a value from 1 to 5, considering the most severe plausible harm.	
Current risk level	Calculate likelihood × consequence and classify the result as low, moderate, significant, high or critical.	
Existing controls	State which measures are already in place and whether they appear suitable, insufficient or unverified.	
Initial control measure	Define the first additional measure required before proceeding: isolate, signpost, lock out, rectify, protect, clean, move people away or stop.	
Evidence	State the form, photograph taken without exposing the worker to risk, matrix, checklist, record, lockout/tagout card or decision summary.	
Uncertainties or limitations	State what could not be confirmed: actual exposure, duration, measurement, control effectiveness, technical information or validation by a competent person.	
Decision	Continue / continue with additional controls / stop and reassess.	

Practical decision rule

If the hazard, triggering event, exposure, vulnerability, likelihood, consequence and initial control measure cannot be completed, the assessment is incomplete. The task or situation must be reassessed before an operational decision is made. The minimum recording sequence, from observation of the situation through risk classification, the initial control measure and the decision, is shown in Figure 5.6.

Minimum record for initial risk assessment

From observation to initial control

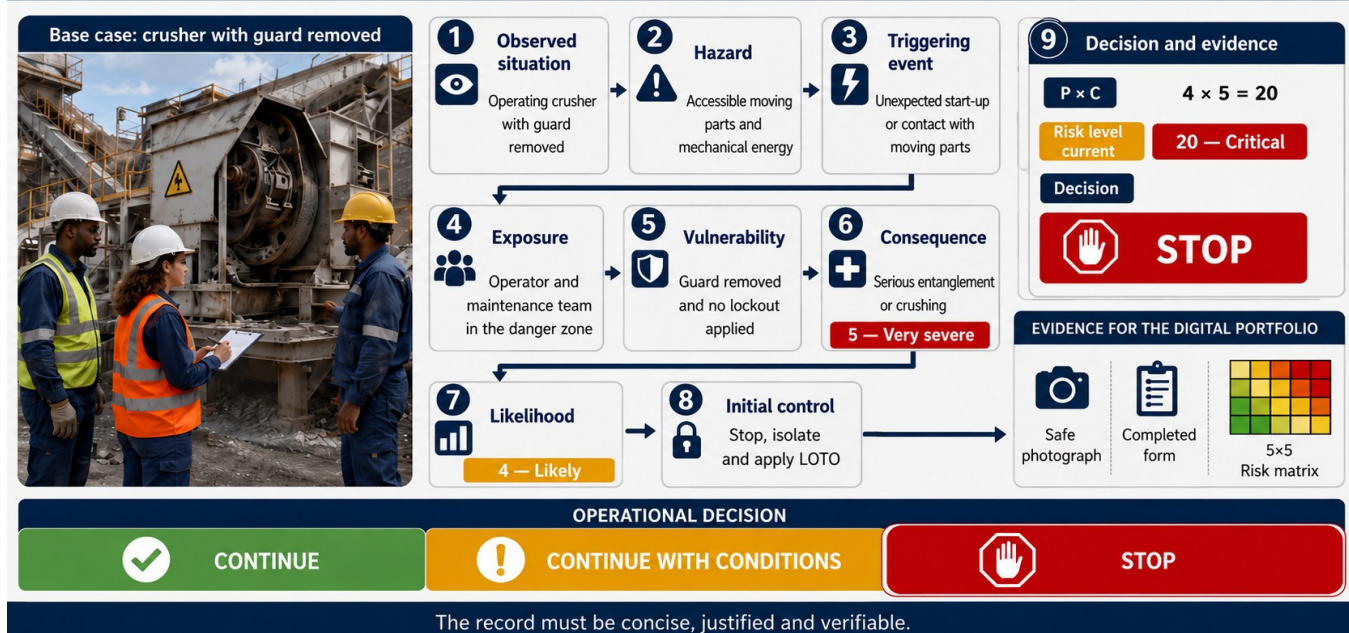


Figure 5.6 — Minimum record: from the observed situation to the initial control measure

5.2 Apply — integrative activity

This activity integrates the main elements of Chapter 5. The learner must select an observed situation, identify the hazard, recognise the triggering event, analyse exposure and vulnerability, classify the risk using a 5 × 5 risk matrix, and propose an initial control measure.

Key message

The activity does not require a long report. It requires a concise, coherent and justified assessment: observed situation → hazard → triggering event → exposure and vulnerability → risk → consequence → likelihood × consequence → current risk level → initial control measure → decision and evidence.

Proposed activity — Assessing current risk in an observed situation

The learner selects one of the following situations, or another equivalent situation observed in an image or in a supervised real-world context:

- working face showing cracks;
- mine road deteriorated after rain;
- crusher with its guard removed;
- mining haul truck operating near pedestrians;
- unlabelled chemical product in the laboratory;
- heavy dust in the crushing area;
- unstable storage arrangement;
- work at height near a bench.

To structure the assessment and record the 5 × 5 risk matrix, use [A.4 — Initial risk assessment](#). Additional training cases may be made available by the trainer on the STRIM platform.

How to complete the activity

- describe the observed situation and the location or process where it occurs;
- identify the main hazard and the event that may trigger the occurrence;
- state who or what is exposed and which vulnerability increases the risk;
- assign likelihood and consequence values from 1 to 5, justifying the scores;

- calculate the current risk level, propose the initial control measure and decide whether the activity may continue, may continue with additional controls, or must stop and be reassessed;
- retain the completed form as evidence in the digital portfolio.

Record the assessment of the selected situation in **Table 5.10**.

Table 5.10 — Integrative activity form: initial risk assessment

Field	Response
Observed situation	
Location / process	
Hazard	
Triggering event	
Exposure	
Vulnerability	
Risk	
Potential consequence	
Likelihood — 1 to 5	
Consequence — 1 to 5	
Current risk level	
Initial control measure	
Decision: continue / continue with additional controls / stop and reassess	
Evidence for the portfolio	

Practical decision rule

If the assessment indicates high or critical risk, or if likelihood, consequence, exposure or the initial control measure cannot be justified, the situation must stop and be reassessed. The matrix supports the decision; the final classification must reflect the actual conditions and the effectiveness of the controls.

5.3 Quick self-assessment

This self-assessment checks whether the learner can apply the fundamentals of risk assessment to short questions and decision cases. Answers should be brief but justified, linking the hazard, triggering event, exposure, vulnerability, likelihood, consequence, initial control measure and evidence.

Key message

An adequate response does more than identify a hazard. It should show how that hazard may generate risk, who is exposed, what consequence may result, what risk level is obtained from the 5 × 5 risk matrix and what control should be applied.

Short questions

1. What is the difference between a hazard and a risk?
2. Why does exposure change the risk level?
3. What is a triggering event?
4. What does vulnerability mean in a risk assessment?
5. How can occupational, environmental and technological risks be distinguished?
6. When should qualitative assessment be used?
7. When may quantitative assessment be required?
8. How is the risk level calculated using a 5 × 5 risk matrix?
9. Why must likelihood and consequence be justified?
10. What minimum information should be included in a risk record?

Decision cases

For each case in Table 5.11, state the decision, provide a short justification and identify the evidence to retain.

Table 5.11 — Decision cases for self-assessment

Case	Learner's decision	Short justification	Evidence to retain
Working face showing cracks and rain forecast			
Crusher with its guard removed			
Muddy mine road with mobile equipment traffic			
Crushing area with dust and poor visibility			
Unlabelled chemical product in the laboratory			
Unstable stack next to a walkway			

Self-assessment criterion

The response is adequate when it identifies the observed situation, distinguishes between hazard and risk, recognises exposure and vulnerability, assigns likelihood and consequence with justification, proposes a coherent initial control measure and identifies verifiable evidence.

Practical decision rule

When likelihood, consequence, exposure or the initial control measure cannot be justified, the response should acknowledge the uncertainty and propose continuing with additional controls or stopping and reassessing.

5.4 Practical summary

This summary brings together the essential points of Chapter 5 and helps the learner apply initial risk assessment in a concise, coherent and recordable manner. The aim is to ensure that the final decision results from the observed situation, exposure, vulnerability, likelihood, consequence and proposed initial control measure.

Key message

Assessing risk is not simply a matter of filling in numbers. It means justifying, on the basis of the actual situation, what the hazard is, who is exposed, what may trigger the harm, what consequence is plausible and what initial control measure should be applied.

What must never be forgotten

Risk assessment is not simply about identifying hazards.

Risk reflects the combination of the likelihood of occurrence and the severity of the consequence, taking account of the context, exposure, vulnerabilities and the effectiveness of existing controls.

The same situation may involve occupational, environmental and technological risks.

A 5 × 5 risk matrix is useful only when the score is justified.

Likelihood is not guesswork: it should take account of frequency, exposure, historical data, actual conditions and existing controls.

Risk classification should be based on a defined context and clear criteria: continue, continue with additional controls, or stop and reassess.

The consequence should take account of the most severe plausible harm, not only the most likely harm.

The initial control measure should address the risk identified.

Existing controls should be verified: their presence alone does not guarantee that they are suitable or effective.

The minimum record should make it possible to understand what was observed, who was exposed, what the risk was, how it was classified and what initial action was proposed.

The result should be retained in the portfolio: a form, photograph obtained without exposing the worker to risk, completed matrix or decision summary.

Practical decision rule

When the assessment does not allow likelihood, consequence, exposure or the initial control measure to be justified, the decision should not be to proceed out of habit. The situation must be reviewed and clarified and, depending on the outcome, the activity should either continue with additional controls or be stopped and reassessed.

Expected final output for Chapter 5

An initial risk assessment form integrating the observed situation, hazard, triggering event, exposure, vulnerability, risk, consequence, 5 × 5 risk matrix, initial control measure, decision and evidence for the digital portfolio. The integrated structure of this form and the elements to be recorded are shown in Figure 5.7.

FINAL INITIAL RISK ASSESSMENT FORM

Final output of Chapter 5

From observation to a recorded decision

APPLIED EXAMPLE

Intense dust at the crushing plant

1. SITUATION OBSERVED

Intense dust during material discharge into the crusher

2. LOCATION / TASK / PROCESS

Crushing area — material discharge

3. HAZARD

Respirable dust

4. TRIGGERING EVENT

Intense release of dust

5. EXPOSURE

Operators and nearby workers

6. VULNERABILITY

Insufficient control at source and continued presence in the area

7. RISK

Dust inhalation

8. CONSEQUENCE

Respiratory irritation and possible occupational disease

9. 5×5 MATRIX

		CONSEQUENCE				
		1	2	3	4	5
LIKELIHOOD	5					
	4				16	
	3					
	2					
	1					

Likelihood 4 × Consequence 4 = 16

Risk level: high

10. INITIAL CONTROL

Stop discharge, reduce dust at source and restrict access

11. DECISION

STOP AND CONTROL

Resume only after effective control

Completed form

Marked matrix

Safe photograph

Recorded decision

FINAL OUTPUTS

Observe • Justify • Control • Decide • Record

The assessment is only complete when the risk, control and decision are justified and recorded.

Figure 5.7 — Final initial risk assessment form

CHAPTER 6

Hazard identification and risk prioritisation



SAFETY TRAINING WITH
REAL IMMERSIVITY FOR MINING



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Chapter 6 — Hazard Identification and Risk Prioritisation

Chapter 5 5.1.6 Chapter 7 7.1.1 7.2 7.4 Chapter 9

Chapter overview

Section	Learning function
Before you begin	Guide the learner, clarify the guiding question, objectives, competences and expected output.
Learning pathway	Explain the Learn–Observe–Decide–Apply–Reflect sequence and the expected outputs.
Core technical content	Apply simple methods to identify hazards, collect evidence, prioritise risks and formulate verifiable corrective actions.
Apply — integrative activity	Identify hazards using evidence, select three priorities and define actions according to SMART criteria.
Quick self-assessment	Check the ability to distinguish identification, assessment, prioritisation, evidence and corrective action.
Practical summary	Consolidate the methods, decision rules and final output of the chapter.

Before you begin

Question to be answered

How can hazards be identified systematically and decisions made about which ones require immediate action at a working face, on a bench, in a workshop, warehouse, laboratory, crushing area or mine road?

Purpose of the chapter

This chapter helps the learner move from scattered observations to structured hazard identification supported by evidence, prioritisation and corrective action. The aim is to show that hazard identification should not depend solely on individual intuition: it should use simple methods, team participation, verifiable records and clear decision criteria.

The chapter uses the initial risk assessment developed in **Chapter 5 — Fundamentals of Risk Assessment** as its starting point. The focus now is to identify hazards in the field, collect sufficient evidence, select the risks requiring immediate action and propose specific, measurable, achievable, relevant and time-bound (SMART) corrective actions.

These methods form part of the risk management process: they make it possible to identify hazards and associated risks, support analysis, establish priorities, select control actions and retain records for subsequent review.

The aim is not to develop a full accident investigation or extensive risk management plans. These topics should be addressed only when they help transform a simple finding into a specific preventive action.

Key message

Hazard identification requires method, evidence and a decision. Observation leads to prevention only when it results in a clear priority and a verifiable corrective action.

Learning objectives

- apply simple hazard identification methods in real or simulated situations;
- use brief operational checklists without turning them into a mere formality;

- conduct a brief, structured brainstorming session with the work team;
- apply the 5 Whys technique to an occurrence, non-conformity or near miss;
- collect simple evidence through a photograph obtained without exposing the worker to risk, a record and observation;
- prioritise risks for immediate action using evidence, exposure, severity and risk level;
- draft SMART corrective actions;
- record the link between the hazard identified, evidence, priority, corrective action, evidence of implementation and verification of effectiveness.

Competences to be developed

Competence	Expected evidence
Observe a work area systematically	Brief list of hazards with evidence.
Use an operational checklist	Completed checklist with observations and evidence.
Gather contributions from the team	Idea-generation table with grouped hazards.
Analyse a near miss using the 5 Whys	Completed 5 Whys form.
Prioritise risks for immediate action	Prioritisation table with high, medium or low priority.
Draft a SMART corrective action	SMART form with the action, person responsible, deadline, effectiveness criterion and evidence of implementation.
Record evidence in the portfolio	Photograph obtained without exposing the worker to risk, checklist, note, sketch or decision summary.

Expected output for the chapter

The main output of Chapter 6 is the hazard identification, prioritisation and action form presented in [Table 6.8](#). The form turns a field observation into three justified priorities, actions formulated according to SMART criteria and verification of effectiveness.

Learning pathway

Stage	What the learner does	Output or evidence
Learn	Reviews simple methods for identification, evidence, prioritisation and SMART action.	Summary of the methods.
Observe	Uses a checklist, photograph obtained without exposing the worker to risk, record or virtual reality (VR) scenario.	List of hazards with evidence.
Decide	Selects the risks requiring immediate action.	Prioritised list.
Apply	Drafts a SMART corrective action for the priority risk.	Corrective action form.
Reflect	Checks whether the proposed action is clear and feasible and includes criteria for confirming effectiveness.	Entry in the digital portfolio.

Common decision criterion for the chapter

For each situation analysed, the learner must indicate which risks associated with the hazards identified require immediate action, what evidence supports that priority and what action, formulated according to SMART criteria, should be proposed. The decision and evidence must be recorded in the digital portfolio.

Links to other chapters

This chapter builds on the initial risk assessment developed in [Chapter 5 — Fundamentals of Risk Assessment](#) and uses, as application contexts, the hazards and controls presented in [Chapter 2 — Fundamentals of Occupational Hygiene](#), [Chapter 3 — Particularities of the Mining Industry](#) and [Chapter 4 — Operational Technical Safety and Maintenance](#). The results obtained — hazards identified, evidence, priorities and actions — will be used in [Chapter 7 — Risk Control and Operational Communication](#) to define and communicate control measures. Structured data collection during a technical visit and the analysis of specific risks are explored in greater depth in [Chapter 8 — Planning the Technical Visit and Operational Observation](#) and [Chapter 9 — Assessment of Specific Risks](#), respectively.

6.1 Hazard identification and risk prioritisation

Identifying hazards is the first step in deciding where to act. This section presents simple methods for observing the workplace, collecting evidence, listening to the team, understanding probable causes and selecting the risks requiring immediate action. The aim is not to produce lengthy reports, but to turn specific observations into clear priorities and verifiable corrective actions.

6.1.1 Simple hazard identification methods

Hazard identification should use simple, repeatable methods linked to actual workplace conditions. The aim is to identify conditions that may cause harm, collect sufficient evidence and prepare for risk prioritisation.

This subsection does not repeat the definition of hazard and risk or provide a complete interpretation of the mine as an operational system. The focus is on selecting practical methods to improve observation, confirm information and record what requires action.

Key message

Hazard identification does not mean looking for everything at the same time. It means observing systematically, confirming information with the team, consulting records, comparing similar situations and leaving verifiable evidence.

Simple methods to use

Direct observation of the workplace: check access routes, traffic, housekeeping, guarding, signage, stability, visibility, dust, noise, energy and interaction between people and equipment.

Brief discussion with workers: ask what commonly goes wrong, where improvisation occurs, which situations nearly caused an accident and which recent changes have altered the risk.

Review of incidents, near misses and previous records: look for recurring patterns, critical areas, recurring failures and outstanding actions.

Review of critical tasks: observe tasks involving energy, work at height, mobile equipment, maintenance, hazardous products, dust, noise, tools, pressure or instability.

Comparison with photographs, videos or previous cases: use images and examples to recognise similar conditions and prevent known hazards from being overlooked.

Identification by task or process stage: analyse preparation, execution, traffic, maintenance, cleaning, shutdown and restart of the operation.

How to apply them without overcomplicating the process

The method selected should suit the time available, the location and the purpose of the observation. A short visit may use direct observation and a photograph obtained without exposing the worker to risk. A team meeting may use a structured brainstorming session. A recurring occurrence may require review of records followed by application of the 5 Whys.

The choice of method should also take account of the complexity of the task, the experience of the team, the information already available and the degree of uncertainty. The greater the uncertainty, the greater the need to combine methods, confirm evidence and involve competent persons.

The result should always be simple: hazard identified, evidence collected and a brief observation. If the identification does not produce evidence or indicate who may be affected, it is not yet sufficient for prioritisation.

Learning output — Short form: simple hazard identification methods

Table 6.1 makes it possible to record the method used, the hazard identified, the evidence collected and a brief observation concerning the situation analysed.

Table 6.1 — Learning output — Short form: simple hazard identification methods

Method used	Hazard identified	Evidence	Brief observation
Direct observation			
Discussion with the team			
Previous record			
Review of a critical task			
Photograph, video or previous case			

Practical decision rule

A hazard identified must be linked to evidence. If the observation is vague, without a location, exposed people or a verifiable condition, it should be clarified before prioritisation. The main hazard identification methods and their relationship with evidence collection are summarised in Figure 6.1.



Figure 6.1 — Simple hazard identification methods

6.1.2 Operational checklists

An operational checklist is a systematic observation tool. It helps confirm whether essential conditions are present and record non-conformities in a concise, comparable and verifiable manner.

In this chapter, the checklist should not be used as a documentary formality. It should help identify hazards, support the workplace audit and select situations requiring prioritisation. The checklist should be brief and adapted to the task or location observed.

Key message

A checklist is useful only when it guides observation, requires evidence to be recorded and helps decide which hazards require action. It should not replace technical judgement or observation in the field.

What the checklist should cover

- safe access, clear traffic routes and unobstructed walkways;
- signage that is visible, understandable and appropriate to the location;
- traffic involving mobile equipment, pedestrians and light vehicles;
- use and suitability of personal protective equipment (PPE), where applicable;

- guards, machine guarding, guardrails and barriers in place;
- housekeeping, stacking, cleaning and control of loose materials;
- energy, moving parts, pressure, stability and uncontrolled sources of risk;
- dust, noise, visibility, lighting, ventilation and relevant environmental conditions;
- available evidence: photograph obtained without exposing the worker to risk, observation note, record or reference to a previous occurrence.

How to complete it

The “compliant” option should be used when the condition observed is satisfactory. The “non-compliant” option should be used when there is a non-conformity, hazard or absence of control. The “not applicable” option should be used only when the item is not relevant to that location or task.

A checklist does not, by itself, prove that the workplace is safe. It guides observation, makes non-conformities visible and supports the decision. Whenever an item is marked “non-compliant”, the observation should state the evidence, associated risk and required action.

Each “non-compliant” item should include a brief observation and, whenever possible, evidence. The observation should state the fact observed, not merely an opinion. For example, “material partially blocks the walkway” is more useful than “hazardous area”.

The checklist should be adapted to the working face, bench, workshop, laboratory, warehouse or crushing area. It should not repeat the technical checklists from **Chapter 4 — Operational Technical Safety and Maintenance**, such as LOTO, ladder/scaffold, portable tool or PPE selection; here, the purpose is auditing and hazard identification.

Learning output — Short operational checklist

Table 6.2 presents a short checklist for observing the workplace systematically, marking non-conformities and linking each situation to objective evidence.

Table 6.2 — Learning output — Short operational checklist

Item	Compliant	Non-compliant	Not applicable	Evidence / observation
Safe access				
Visible signage				
Separation between pedestrians and equipment				
Guards in place				
Good housekeeping and clear walkways				
Energy or moving parts controlled				
Stability of ground, stacks or structures				
Acceptable dust, noise and visibility				
Photograph obtained without exposing the worker to risk				

Practical decision rule

Any item marked “non-compliant” should be analysed according to the nature of the non-conformity and the associated risk. A single critical non-conformity — for example, uncontrolled energy, instability or a removed guard — may require immediate action; several minor non-conformities do not, by themselves, determine high priority. Use of the checklist is shown in **Figure 6.2**.

Short operational checklist

Observe • mark • record evidence

Observed work area

Observation checklist

Item	Compliant	Non-compliant	Not applicable	Observation	Evidence
1. Safe access	✓	—	—		
2. Clear road	—	✗	—	Material reduces the usable width.	Photo 01
3. Visible signage	—	✗	—	Sign partially obscured.	Photo 02
4. Segregated traffic	✓	—	—		
5. Guards in place	✓	—	—		
6. Housekeeping	—	✗	—	Materials in the passageway.	Photo 03
7. Dust control	—	—	—	No dust emission at the time of observation.	—

Checklist status

Compliant — acceptable condition

Non-compliant — deviation identified

Not applicable — item does not apply

A checklist does not replace technical judgement; it guides observation and makes deviations visible.

Figure 6.2 — Short operational checklist: how to observe and record non-conformities

6.1.3 Structured brainstorming session with the team

A structured brainstorming session with the work team is a quick way of gathering perceptions about hazards that are not always visible during a brief inspection.

The session should be simple, guided by questions and time-limited. A ten-minute session may be enough to identify recurring situations, tasks that require improvisation, unreported near misses and other close calls, and changes in conditions associated with rain, dust, vibration, traffic or production pressure.

Key message

The brainstorming session does not replace field observation. It complements observation with the team's experience and helps identify known, recurring or poorly recorded hazards.

How to run the session

The session should involve a small team, including, whenever possible, an operator, a maintenance worker, a supervisor, an experienced worker and a worker with less experience of the task. This composition combines practical knowledge, technical insight and different levels of familiarity with the activity.

The rule is simple: first list hazards without discussing solutions; then group similar themes; finally, select the hazards that appear to require initial priority. The aim is not to solve everything during the meeting, but to produce a short, verifiable list that is useful for action.

Guiding questions

- What could go wrong in this task, area or item of equipment?
- Where have near misses, non-conformities or close calls already occurred?
- Which task usually requires improvisation, excessive effort or bypassing the procedure?
- Which area changes with rain, dust, vibration, traffic, noise, poor visibility or production pressure?
- Which hazard is known to the team but rarely recorded?
- Which situation should be observed or documented before deciding its priority?

The session should end with a short table containing the hazard mentioned, who may be affected, evidence or an example, and the initial priority (Table 6.3).

Learning output — Team brainstorming table

Table 6.3 — Learning output — Team brainstorming table

Hazard mentioned by the team	Who may be affected	Evidence or example	Initial priority
			High / medium / low
			High / medium / low
			High / medium / low
			High / medium / low
			High / medium / low

Practical decision rule

An effective brainstorming session ends with a small number of well-described hazards, evidence or a specific example, and an initial priority. If the session ends only with vague statements such as “be more careful”, the information is not yet sufficient for prioritisation or action. The sequence of preparation, collection of contributions, grouping of hazards and definition of the initial priority is shown in Figure 6.3.

Figure 6.3 — Brainstorming with the work team

Short, focused and action-oriented

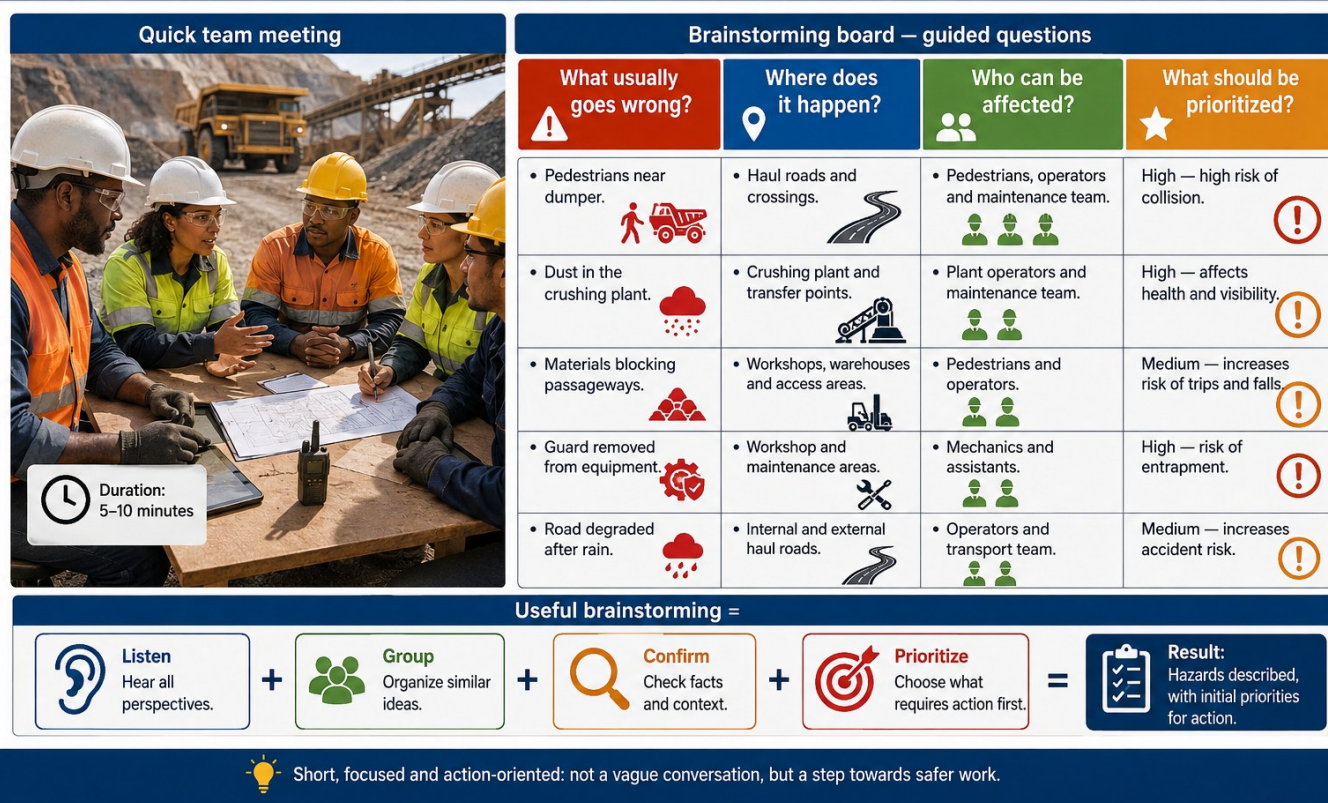


Figure 6.3 — Structured brainstorming session with the work team

6.1.4 The 5 Whys technique

The 5 Whys technique helps analyse near misses, non-conformities or recurring hazards in a simple way. It starts from an observed fact and uses successive questions to identify a likely cause that can be corrected. The aim is not to find someone to blame or to conduct a complete accident investigation. It is to understand why the situation occurred, distinguish immediate causes from technical or organisational causes, and propose a specific corrective action.

Key message

The 5 Whys should start with an observed fact and end with a correctable likely cause. If the answer ends with individual blame or “be more careful”, the analysis is still incomplete.

How to apply the technique

- Start with an observed fact: what happened, nearly happened or recurs at the workplace.
- Ask “why?” successively, using short answers based on evidence.
- Continue until a likely cause supported by evidence and amenable to intervention has been identified; exactly five questions are not mandatory. The causal hypothesis should be confirmed with people who know the task and, where necessary, through observation, records or technical verification.
- Distinguish an immediate cause, such as a visible failure or observed behaviour, from a technical or organisational cause.
- Avoid simplistic attribution of blame: the main question should be “what condition allowed this to happen?”, not “who failed?”.
- Link the likely cause to a clear, verifiable corrective action that is proportionate to the risk.

Application examples

- Worker nearly struck by a mining haul truck: analyse visibility, segregation, signage, communication and the crossing point.
- Guard removed and not refitted: analyse authorisation, time pressure, procedure, supervision and availability of parts.
- Deteriorated road not repaired: analyse inspection, reporting, maintenance priority, drainage and close-out responsibility.
- Recurring dust in the crushing area: analyse suppression, ventilation, maintenance, cleaning, exposure and system operation.
- Unsuitable PPE used out of habit: analyse selection, availability, comfort, training, compatibility and field verification.

Learning output — 5 Whys form

Table 6.4 and Figure 6.4 guide the successive application of the 5 Whys, from describing the observed problem to identifying a correctable likely cause and proposing a corrective action.

Table 6.4 — Learning output — 5 Whys form

Field	Response
Observed problem	
What happened or nearly happened?	
Why 1?	
Why 2?	
Why 3?	
Why 4?	
Why 5?	
Likely cause	
Proposed corrective action	

Methodological note: fewer or more than five questions may be needed. The analysis should end when a likely cause supported by evidence and amenable to intervention has been identified.

Figure 6.4 – The 5 Whys Technique applied to a near-miss

Go beyond the symptom — find the real root cause

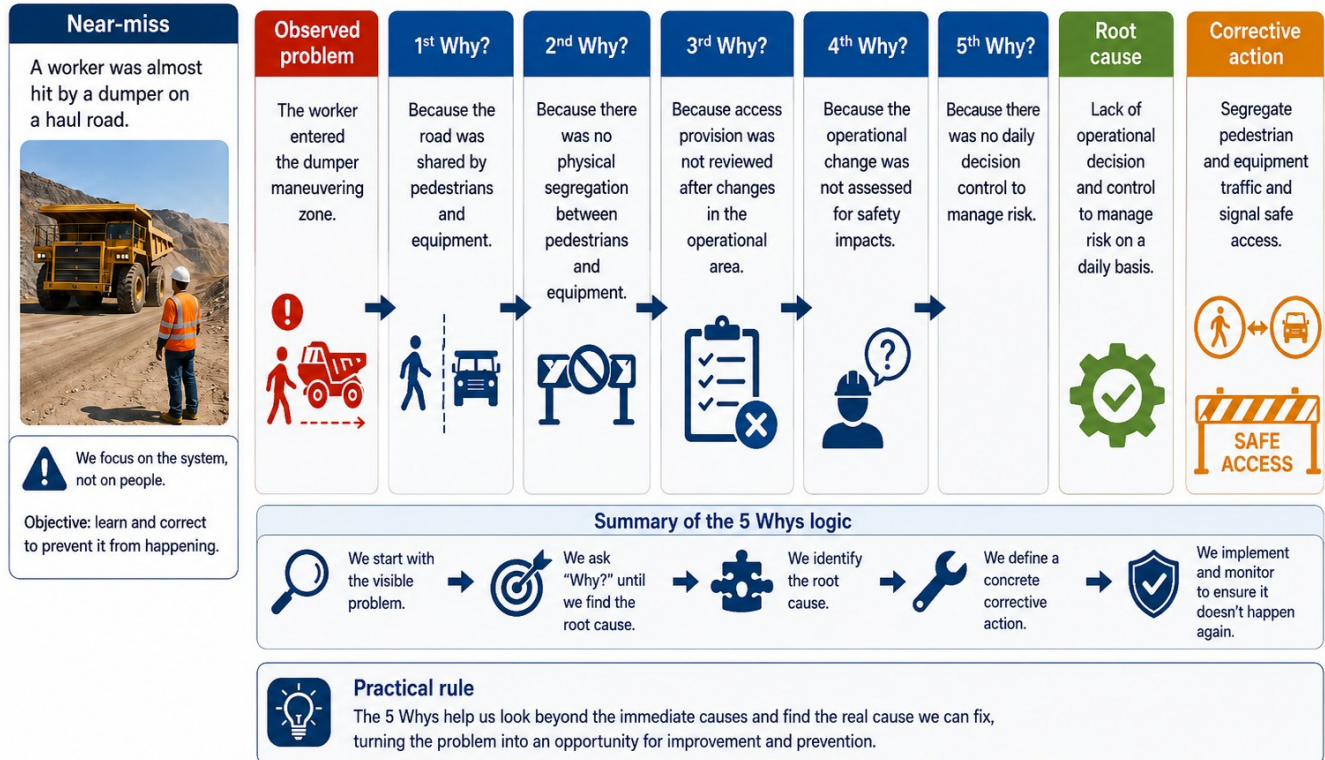


Figure 6.4 — The 5 Whys technique applied to a near miss

Practical decision rule

The likely cause should be capable of leading to a corrective action. If the analysis ends with vague expressions such as "inattention", "human error" or "lack of care", it should continue until a technical, organisational or work-related condition that can be corrected has been identified.

6.1.5 Simple evidence: photograph, record and observation

Hazard identification is useful only when it is supported by sufficient, safe and verifiable evidence. Evidence helps justify the assigned priority, communicate the situation and propose a coherent corrective action.

Evidence collection should be simple. The learner should not enter a restricted area, approach moving equipment, distract operators or expose people unnecessarily. The safety of the observer takes precedence over the photograph, record or checklist.

Key message

Evidence is not an opinion. Evidence is an observable fact recorded in a concise, safe and sufficient form to support a decision.

Photograph obtained without exposing the worker to risk

- Take photographs only from a safe and authorised location.
- Do not enter a restricted area, traffic route, unstable berm or area with uncontrolled energy.
- Do not take photographs in a way that exposes people unnecessarily or breaches internal rules.
- Do not create a distraction for operators, drivers or workers carrying out a critical task.
- Record only what is necessary to show the condition observed: obstructed access, removed guard, unstable stack, dust, spill, inadequate signage or another relevant fact.

Short record and structured observation

The record should answer simple questions: what was observed, where it occurred, when it was observed, who or what may be affected, and what evidence confirms the situation.

- Fact: describe the condition observed without exaggeration or personal judgement.
- Location: indicate the area, working face, bench, workshop, laboratory, warehouse, crushing area or road.
- Condition: indicate what is uncontrolled, deteriorated, exposed, obstructed, unstable or absent.
- Potential consequence: indicate the plausible harm to people, equipment, the environment or the operation.

Opinion or evidence?

An opinion may draw attention to a problem, but prioritisation requires evidence. The statement “the area is dangerous” is vague. A useful record would be: “material has accumulated beside the walkway, reducing its usable width and forcing pedestrians to walk close to the traffic route”.

Evidence should also state its limitations. A photograph, checklist or observation note may not show everything: a measurement, technical confirmation, information on the duration of exposure, verification of controls or validation by a competent person may be missing.

Minimum evidence for the portfolio

- photograph obtained without exposing the worker to risk;
- completed checklist;
- brief observation note;
- simple sketch of the area analysed.

Learning output — Evidence form

Table 6.5 makes it possible to document the evidence collected, the location and condition observed, exposed people or equipment, the limitations of the record and the action considered necessary.

Table 6.5 — Learning output — Evidence form

Evidence	Record
Location	
What was observed	
Type of evidence	Photograph / checklist / note / sketch / VR scenario
People or equipment exposed	
Associated risk	
Limitations or uncertainties	What could not be observed, confirmed or measured?
Required action	

Practical decision rule

If the evidence does not make it possible to understand what was observed, where it occurred, who may be affected and what action is needed, the record is incomplete. The evidence should be strengthened before the risk is prioritised or a corrective action is proposed. The ways of collecting and organising simple, safe and verifiable evidence are summarised in Figure 6.5.

Simple evidence: photograph, record and observation

Record facts without creating new risks

✓ Useful evidence



Safe photograph

- ✓ Taken outside the danger zone
- ✓ Without distracting operators

Objective observation
Accumulated material partially obstructs the passage.

Location	Haul road — crushing area
Time	Morning shift
Hazard identified	Obstructed passage
Associated risk	Pedestrians forced to walk close to the equipment route
Close-out evidence	Passage cleared + final photograph

✗ Weak or unsafe evidence



Unsafe photograph

- ✗ Taken inside the danger zone

Vague note
Dangerous area.

Image without context
No location, time or task

Opinion without an observable fact
This looks very unsafe.

No link to the hazard
Does not support prioritisation

Minimum record



Safe photograph



Brief note



Location and time



Associated risk



Close-out evidence

Evidence must be safe, objective, verifiable and useful for decision-making. |  **The observer's safety comes before the photograph.**

Figure 6.5 — Simple evidence: photograph, record and observation

6.1.6 Risk prioritisation for action

Prioritising risks means deciding where to act first. After identifying hazards and collecting evidence, it is necessary to determine the order in which risks will be addressed and define the response timeframe.

In this chapter, the risk level calculated in [Chapter 5 — Fundamentals of Risk Assessment](#) is used as an input. The 5 × 5 matrix is not repeated; the classification obtained is combined with the evidence observed to define the priority and urgency of the response.

Key message

Priority should not be based solely on individual perception. It should combine the risk level, plausible severity, exposure, absence of control, possibility of immediate occurrence, recurrence and impact on people, the environment and the operation.

Practical prioritisation criteria

- risk level already known or estimated in Chapter 5;
- plausible severity of the consequence, even when likelihood appears low;
- direct exposure of workers, pedestrians, operators, maintenance personnel, the environment or equipment;
- absence or failure of, or uncertainty concerning, existing controls;
- possibility of immediate occurrence or rapid deterioration of the situation;
- recurrence of the hazard, previous near misses or repeated non-conformities;
- feasibility of, and time required to apply, an interim control measure, without reducing the priority of risks with severe consequences for which a definitive control is more complex;
- impact on people, the environment, the operation, equipment, continuity of production or the community.

In this chapter, priority and urgency have different meanings. Priority indicates the relative order in which risks should be addressed — high, medium or low. Urgency indicates the response timeframe — immediate, scheduled or subject to monitoring.

How to determine urgency

Immediate action is required when there is a high or critical risk, direct exposure, absence of control, instability, uncontrolled energy, a removed guard or the possibility of an occurrence in the short term. Scheduled

corrective action is appropriate when the risk is temporarily controlled, a responsible person has been assigned and a deadline for correction has been set. Monitoring is acceptable only when there is sufficient evidence that the risk is controlled. When the evidence is insufficient, further verification should be carried out and, where necessary, an interim control measure applied or the activity suspended until the situation has been clarified.

Application examples

- An unstable slope, removed guard, pedestrians close to a mining haul truck or an unlabelled product require high priority when there is direct exposure or an absence of control.
- A deteriorated road, intense dust or unstable storage may require immediate action, scheduled corrective action or monitoring, depending on severity, exposure, recurrence and existing controls.
- When the evidence is insufficient to make a safe decision, the response should be conservative: continue only with additional measures and an interim control measure, or stop and reassess until the situation has been confirmed.

Learning output — Prioritisation table

Table 6.6 supports comparison of the hazards and risks identified by relating the available evidence, risk level, urgency of intervention, priority and required action.

Table 6.6 — Learning output — Prioritisation table

Hazard / risk	Evidence	Risk level	Urgency	Priority	Required action
			Immediate / scheduled / monitoring	High / medium / low	

Practical decision rule

A risk should be addressed first when it combines a plausibly severe consequence, direct exposure, absent or uncertain control, and the possibility of immediate occurrence. If there is relevant uncertainty concerning stability, energy, guarding, visibility, an unidentified product or the presence of exposed people, the priority should be high until there is evidence to the contrary. The criteria for distinguishing immediate action, scheduled corrective action and monitoring, and for assigning high, medium or low priority, are presented in Figure 6.6.

Risk prioritisation for immediate action

Combine evidence, exposure, severity, control and urgency

Order of intervention

1 — VERY HIGH PRIORITY	2 — VERY HIGH PRIORITY	3 — HIGH PRIORITY	4 — MODERATE PRIORITY
Pedestrian near a manoeuvring dumper	Guard removed from equipment	Haul road deteriorated after rain	Loose material in a passage area
			
Evidence: pedestrian in the manoeuvring zone Exposure: direct and immediate Severity: potentially fatal Control: no physical segregation Action: stop and segregate	Evidence: moving parts accessible Exposure: during operation or maintenance Severity: serious or fatal injury Control: guard absent Action: isolate and refit the guard	Evidence: ruts, mud and poor drainage Exposure: frequent equipment traffic Severity: loss of control or rollover Control: temporary signage Action: restrict access and repair	Evidence: fragments in the traffic area Exposure: pedestrians and light vehicles Severity: fall or property damage Control: area partly cordoned off Action: remove and verify
 Greater exposure +  greater severity +  less control =  higher priority			
 Prioritising means dealing first with what could cause serious harm and is least controlled.			

Figure 6.6 — Prioritisation and response urgency

6.1.7 Corrective actions formulated using SMART criteria

A corrective action formulated using SMART criteria turns a finding into a clear, verifiable and trackable action. It should state exactly what will be done, who is responsible, by when, what result is expected and how implementation and effectiveness will be verified.

In this chapter, the action formulated using SMART criteria is a specific corrective action linked to evidence. It does not replace a full risk management plan, periodic review or operational communication, which will be addressed in Chapter 7 — Risk Control and Operational Communication.

Key message

A corrective action is useful only when it is specific, verifiable, assigned, relevant to the risk and time-bound. Vague statements such as “improve the signage” do not allow tracking of whether the risk has been reduced.

How to develop a SMART action

S — specific: describes exactly what will be done, where and in relation to which condition observed.

M — measurable: defines the expected result and the criterion that will make it possible to verify implementation and effectiveness.

A — achievable: can be implemented with the available resources, competences and authority.

R — relevant: responds directly to the risk identified and contributes to its reduction.

T — time-bound: establishes an unambiguous date or deadline for completion and verification.

The action should also have a clearly designated responsible person.

From the problem to the action

The corrective action should start from a specific finding: removed guard, exposed pedestrians, deteriorated road, intense dust, unlabelled product, absent signage or another verifiable non-conformity. The wording should avoid generic expressions and specify a measure that can be implemented, tracked and closed out.

Weak example: “Improve the signage.”

SMART example: “Install two warning signs and a physical barrier at the entrance to the manoeuvring area by 17:00 on [specified date], under the responsibility of the mine operations supervisor, with a photographic record of implementation and on-site verification.”

Evidence of implementation confirms that the action has been carried out. Action close-out should be accepted only after verifying, at the workplace or by another appropriate means, that the hazardous condition has been eliminated or the risk has been reduced to the intended level.

Learning output — SMART corrective action form

Table 6.7 organises the elements required to turn an identified problem or risk into a specific, verifiable corrective action assigned to a responsible person and subject to a deadline.

Table 6.7 — Learning output — SMART corrective action form

SMART element	Completion
Problem / risk	
Specific action	
Expected result / effectiveness criterion	
Responsible person	
Deadline	
Evidence of implementation	
Verification of effectiveness	Confirm whether the hazardous condition has been eliminated or the risk has been reduced to the intended level.

Practical decision rule

An action is not adequately formulated using SMART criteria if it does not state what will be done, where, by whom, by when, what result is expected and how implementation and effectiveness will be verified. If the action does not respond to the risk identified, it should be reformulated before being accepted. The transformation of vague wording into an action that is specific, measurable, achievable, relevant and time-bound is illustrated in Figure 6.7.

SMART corrective actions

From vague wording to verifiable action

Vague wording	SMART action
 EXAMPLE 1 — PEDESTRIAN CIRCULATION Improve pedestrian circulation.	 EXAMPLE 1 — PEDESTRIAN CIRCULATION - Action: install a physical barrier and signage on haul road X. - Deadline: by Friday - Responsible: maintenance supervisor - Verification: photograph and close-out inspection
 EXAMPLE 2 — DUST AT THE CRUSHING PLANT Fix the dust.	 EXAMPLE 2 — DUST AT THE CRUSHING PLANT - Action: reactivate the dust suppression system at the crushing plant. - Timing: check operation during the morning shift - Responsible: maintenance manager - Evidence: operating record + photograph
 EXAMPLE 3 — WORKSHOP HOUSEKEEPING Organise materials.	 EXAMPLE 3 — WORKSHOP HOUSEKEEPING - Action: remove the materials obstructing the workshop passage. - Deadline: by 14:00 - Responsible: Team A - Verification: checklist + close-out photograph

SMART CRITERIA

S — Specific What will be done?	M — Measurable How will it be verified?	A — Assigned Who is responsible?	R — Realistic Can it be carried out?	T — Time-bound When will it be completed?
---	---	--	--	---

A SMART action defines what to do, who is responsible, when to complete it and how to verify it.

Figure 6.7 — Corrective actions using SMART criteria: from vague wording to a verifiable action

6.2 Apply — integrative activity

This activity integrates the methods presented in Chapter 6. The learner should select a situation, identify hazards supported by evidence, link them to risks, select three priorities and propose three SMART corrective actions.

Key message

The activity is complete only when hazard identification results in clear priorities, verifiable actions, evidence of implementation and verification of effectiveness for the portfolio.

Proposed activity — Carrying out a simple hazard identification and prioritising three corrective actions

The learner selects a real, simulated or image-based situation. The response should be concise and decision-oriented: which hazards were identified, what evidence is available, which risks should be prioritised and which actions formulated using SMART criteria should be proposed.

Possible situations

- bench showing cracks;
- deteriorated road;
- crushing area with dust;
- mining haul truck traffic close to pedestrians;
- removed guard on equipment;
- unlabelled product;
- unstable stack;
- area with inadequate signage.

To record the observation, evidence, priority, action, responsible person, deadline and verification of effectiveness, use [A.5 — Hazard identification, prioritisation and corrective action](#). Additional exercises may be made available by the trainer on the STRIM platform.

How to complete the activity

- identify the workplace observed and the method used: checklist, brainstorming session, 5 Whys or observation;
- record the hazards identified and the associated evidence;
- link each hazard to the risk that may arise;
- select three priorities, justifying the choice on the basis of evidence, exposure, severity or absence of control;
- draft an action formulated using SMART criteria for each priority;
- define the evidence of implementation and the criterion that will make it possible to verify the effectiveness of each action.

Learning output — Application form

Table 6.8 integrates the methods addressed in the chapter and makes it possible to record the hazards and evidence and, for each priority, the action, responsible person, deadline, expected result, evidence of implementation and verification of effectiveness.

Table 6.8 — Learning output — Application form

Element	Priority 1	Priority 2	Priority 3
Priority risk			
Evidence			
Specific action			
Responsible person			

Element	Priority 1	Priority 2	Priority 3
Deadline			
Expected result / effectiveness criterion			
Evidence of implementation			
Verification of effectiveness			

Practical decision rule

The activity is satisfactory when each priority has evidence, an associated risk, a specific action, a responsible person, a deadline, an effectiveness criterion and evidence of implementation. If the proposed action is vague or does not make it possible to verify risk reduction, it should be rewritten before being included in the portfolio.

6.3 Quick self-assessment

This self-assessment confirms whether the learner can apply the methods in Chapter 6 to short questions and decision cases. The answers should distinguish hazard identification, risk assessment, prioritisation, evidence and SMART corrective action.

Key message

An adequate response does not list hazards vaguely. It should indicate evidence, the associated risk, priority, an action formulated using SMART criteria, evidence of implementation and verification of effectiveness.

Short questions

1. Why is hazard identification not the same as risk assessment?
2. When is an operational checklist useful?
3. What limitations can a checklist have?
4. What is the purpose of a structured brainstorming session with the team?
5. How can a brainstorming session be prevented from becoming a vague discussion?
6. What is the purpose of the 5 Whys?
7. Why is it important to collect simple evidence?
8. Which criteria help prioritise risks?
9. What makes a corrective action SMART?
10. How can evidence of implementation be distinguished from verification of the effectiveness of a corrective action?

Decision cases

For each case in Table 6.9, the learner should indicate the decision, justify it in one or two sentences, identify the available evidence and propose the required action.

Table 6.9 — Decision cases for self-assessment

Case	Learner's decision	Brief justification	Expected evidence / action
Removed guard identified on the checklist			
Recurring near miss involving a mining haul truck			
Unstable stack beside a walkway			
Absence of preventive maintenance			
Proposed action: "be more careful"			

Self-assessment criterion

The response is satisfactory when it distinguishes hazard and risk, recognises the usefulness and limitations of the methods, uses evidence, prioritises according to criteria, and turns vague actions into verifiable SMART actions.

Practical decision rule

If the response ends with “be more careful”, “raise awareness” or “improve” without specifying a specific action, responsible person, deadline, evidence of implementation and effectiveness criterion, the action should be rewritten before being included in the portfolio.

6.4 Practical summary

This summary brings together the essential points of Chapter 6 to support practical application of hazard identification, prioritisation and corrective action methods. The aim is to ensure that field observation results in evidence, a decision and verifiable action.

Key message

Hazard identification leads to prevention only when it is supported by a method, evidence, a priority and a specific corrective action. The information collected should make it possible to decide what to do first, demonstrate implementation and verify whether the risk has actually been reduced.

What must never be forgotten

- Hazard identification requires a method, evidence and a record.
- A checklist is not bureaucracy: it supports observation.
- A structured brainstorming session captures the team’s knowledge.
- The 5 Whys help formulate likely causes supported by evidence.
- Photographs, records and observations are useful only if they are safe and verifiable.
- Prioritisation means selecting what requires action first.
- High risk, direct exposure and absence of control increase priority.
- A vague corrective action does not solve the problem.
- An action formulated using SMART criteria should state what will be done, who is responsible, by when, what result is expected and how implementation and effectiveness will be verified.
- The result should be retained in the portfolio: checklist, evidence, prioritisation and corrective action.

Expected final output for Chapter 6

Hazard identification, prioritisation and corrective action form integrating the workplace observed, method used, hazard identified, evidence collected, associated risk, priority, action formulated using SMART criteria, evidence of implementation and verification of effectiveness.

Practical decision rule

If an observation is not linked to evidence, a priority, a verifiable action and confirmation of effectiveness, prevention remains incomplete. The chapter fulfils its purpose only when the learner can move from the finding to a recorded corrective action and a reassessed risk.

CHAPTER 7

Risk control and operational communication



IDENTIFY AND ASSESS RISKS



CONTROL AND MITIGATE RISKS



COMMUNICATE AND COORDINATE



WORK AS A TEAM



SAFETY CULTURE



EFFECTIVE COMMUNICATION



ASSESS TO DECIDE



PERMIT AND VERIFY



PROTECT PEOPLE, ASSETS AND THE ENVIRONMENT



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Chapter 7 — Risk Control and Operational Communication

Chapter 6 6.1.7 8.1.3 8.1.5 Chapter 9

Chapter overview

Section	Learning function
Before you begin	Guide the learner and clarify the guiding question, objectives, competences and expected output.
Learning pathway	Explain the Learn–Observe–Decide–Apply–Communicate–Reflect sequence and the expected outputs.
Technical core of the chapter	Turn priority risks into controls, implementation conditions, communication and verification of effectiveness.
Apply — integrative activity	Turn three priorities into operational control measures, communication and verification.
Quick self-assessment	Check the ability to select, communicate and review controls that are proportionate to the risk.
Practical summary	Consolidate the hierarchy of controls, operational instruments and the final output of the chapter.

Before you begin

Question to be answered

How can a risk assessment or risk priority be turned into a clear, applicable control measure that is communicated to the team before the task is carried out?

Purpose of the chapter

This chapter helps the learner move from risk identification and prioritisation to the selection of controls, simple procedures and operational communication. The aim is to ensure that a safety decision is not merely recorded: it should be translated into specific measures, clearly assigned responsibilities, deadlines, communication to the team and subsequent verification.

Chapter 7 builds on the priority risks and proposed actions formulated in **Chapter 6 — Hazard Identification and Risk Prioritisation**. These proposals should be reviewed in the light of the hierarchy of controls to confirm whether they act sufficiently at the source, along the exposure pathway or on exposure. Only then should the operational control measure, responsible person, deadline, communication and verification of effectiveness be defined.

The aim is not to repeat hazard identification, the 5 × 5 risk matrix, cause investigation or formulation of the actions addressed in the previous chapter. The focus is operational: selecting controls, defining implementation conditions, communicating them to the team and reviewing the effectiveness of the measure.

Learning objectives

- distinguish risk control, preventive measures, mitigation measures and corrective actions;
- apply the hierarchy of controls to simple situations in the extractive industry;
- select among elimination, substitution, engineering controls and collective protection, administrative controls and PPE;
- recognise when a simple procedure or permit-to-work is required;
- develop a short risk control action plan with a responsible person, deadline, effectiveness criterion and review;
- communicate risks to the team objectively;
- prepare a pre-task safety briefing;

- record evidence of implementation, verification of effectiveness and residual risk in the digital portfolio.

Competences to be developed

Competence	Expected evidence
Select controls proportionate to the risk	Completed control form.
Apply the hierarchy of controls	Justification of the selected measure.
Recognise the limitations of PPE	Example in which PPE is insufficient as the only barrier.
Define a responsible person, deadline and review	Short risk control action plan.
Recognise the need for a permit-to-work or simple procedure	Completed simplified permit-to-work or short procedure.
Communicate risk to the team	Short message or pre-task safety briefing guide.
Verify implementation and effectiveness	Evidence of the control applied, review outcome and residual risk.

Expected output for the chapter

The main output of Chapter 7 is the comparative form presented in [Table 7.9](#). The form turns three priority risks into justified controls, responsibilities, deadlines, communication, evidence of implementation and verification of effectiveness.

Learning pathway

The chapter follows the E-book's cross-cutting pedagogical logic: learn, observe, decide, apply, communicate and reflect. This sequence helps the learner turn a risk priority into an implementable control measure that is communicated to the team.

Stage	What the learner does	Output or evidence
Learn	Reviews the logic of risk control and the hierarchy of measures.	Summary of controls.
Observe	Starts from a risk prioritised in Chapter 6 or from a simulated situation.	Input risk supported by evidence.
Decide	Selects the most appropriate control using the hierarchy of controls.	Justification of the selection.
Apply	Defines the procedure and/or permit-to-work, responsible person, deadline, evidence and effectiveness criterion.	Short action plan.
Communicate	Prepares a short message or pre-task safety briefing.	Operational communication guide.
Reflect	Verifies implementation, effectiveness and residual risk.	Entry in the digital portfolio.

Common decision criterion for the chapter

For each situation analysed, the learner should determine which control is most appropriate, why it was selected, who should implement it, by when, how it will be communicated to the team and how implementation, effectiveness and residual risk will be verified. The decision should be recorded in the digital portfolio.

This chapter builds on the priority risks identified previously and focuses on selecting, implementing, communicating and reviewing controls. Examples of specific risks are used only to apply this operational decision.

7.1 Risk control and operational communication

Controlling risk means selecting and applying measures that act at the source, along the exposure pathway, through work organisation or through personal protection. The decision should start from the priority risk and end with a measure that has been implemented, communicated and reviewed under actual conditions.

Risk level and priority are inputs, not the end of the process. The response should state what changes, who carries it out, by when, how the team is informed and how effectiveness will be verified.

Key message

A risk control is useful only when it is implemented, communicated and verifiable. If the team does not know what has changed, who is responsible or how to confirm the measure, the risk remains insufficiently controlled.

7.1.1 From risk assessment to risk control

Risk assessment makes it possible to characterise a situation, and prioritisation indicates what should be addressed first. Control translates this information into a specific change to the task, equipment, workplace, procedure or exposure.

A preventive measure acts before an occurrence, reducing the likelihood that the event will begin or that exposure will occur. A mitigation measure limits the severity of the consequences if the event occurs. A corrective action eliminates or controls the cause of a non-conformity, deviation or occurrence in order to prevent recurrence. The same control may have both preventive and mitigating functions, but its purpose should be made explicit.

Risk level is not the end of the process. It provides information for selecting a proportionate response: continue, continue with additional measures, or stop and reassess, applying controls consistent with the hierarchy of controls.

The priority defined in [Chapter 6 — Hazard Identification and Risk Prioritisation](#) should result in a clear and verifiable measure. A control should be considered complete only when its implementation has been demonstrated, its effectiveness has been verified and the residual risk is known.

Key message

Risk assessment supports the decision. Risk control means changing the task, equipment, workplace, procedure or exposure in order to reduce the possibility of harm.

From priority to control

- use priority as an input, not as the final conclusion;
- check whether the risk can be eliminated, substituted or isolated;
- prefer controls that remove or separate the hazard source before relying solely on individual behaviour;
- define a control that is proportionate to the risk and existing exposure;
- specify what evidence will demonstrate that the control has been implemented.

Learning output — Short table: from priority to control

Table 7.1 makes it possible to turn each priority risk into a specific control decision by recording the priority, the selected measure and its justification.

Table 7.1 — Learning output — Short table: from priority to control

Prioritised risk	Priority	Control decision	Justification
	High / medium / low		
	High / medium / low		
	High / medium / low		

Practical decision rule

A priority has been addressed only when it results in a control decision. If the record merely states “high risk” or “be careful”, the priority, the measure to be applied and the method for verifying its effectiveness still need to be defined.

7.1.2 Hierarchy of controls: elimination, substitution, engineering controls and collective protection, administrative controls and PPE

The hierarchy of controls helps select measures according to their capacity to reduce risk at the source, along the exposure pathway or at the point of exposure. The main question is not merely “what measure is possible?”, but “which measure is most effective and proportionate to the risk?”.

The decision should begin with the strongest controls and only then consider measures that depend more heavily on individual behaviour. PPE may be necessary, but it should not be the sole response to high risks when collective, technical or organisational alternatives are available.

Key message

The higher a control is in the hierarchy, the less it depends on individual behaviour.

Levels of control

- 1. Elimination:** permanently remove the hazard source, substance, equipment, stage or need to carry out the hazardous task. Temporary suspension may be necessary, but it is not elimination while the hazard remains.
- 2. Substitution:** replace the material, method, equipment or process with a less hazardous alternative.
- 3. Engineering controls and collective protection:** physically modify the source, process, equipment or exposure pathway, using solutions such as guards, enclosure, local exhaust ventilation, guardrails and physical segregation.
- 4. Administrative controls:** use a procedure, signage, rotation, authorisation, training, supervision or temporary demarcation.
- 5. PPE:** use personal protection as the final barrier. It may be essential, but it is insufficient when it replaces feasible collective controls.

Application examples

Table 7.2 presents examples of situations in the extractive industry and the strongest controls that should be considered before relying exclusively on administrative controls or PPE.

Table 7.2 — Examples of applying the hierarchy of controls

Situation	Strongest control to consider
Pedestrians close to a mining haul truck	Physical segregation / route alteration
Dust in crushing	Wet suppression, enclosure, ventilation, maintenance
Removed guard	Reinstatement of the guard and lockout of the operation
Deteriorated road	Repair, drainage, traffic restriction
Unlabelled product	Isolation, identification, safety data sheet and substitution where possible
Work at height	Suitable platform, guardrails, procedure and supplementary PPE

Learning output — Selecting measures using the hierarchy of controls

Table 7.3 supports comparison between elimination, substitution, engineering controls and collective protection, administrative controls and PPE, making it possible to justify the most appropriate option for each risk.

Table 7.3 — Learning output — Selecting measures using the hierarchy of controls

Risk	Eliminate?	Substitute?	Engineering controls / collective protection	Administrative controls	PPE	Best option with justification

Practical decision rule

Before proposing PPE, the learner should check whether the risk can be eliminated, substituted or controlled through engineering controls and collective protection. Where there is direct exposure, high risk or no collective barrier, PPE should be treated as a supplement rather than the primary solution. The order of preference is shown in Figure 7.1.



Figure 7.1 — Hierarchy of controls applied to the extractive industry

7.1.3 Engineering controls and collective protective equipment versus PPE

The previous section established the order of preference for controls. This section focuses on how they act: engineering controls modify the source, process or exposure pathway; collective protective equipment (CPE) provides physical protection for several people; and PPE protects the individual. A combination of measures may be required, but exclusive dependence on individual behaviour should be minimised.

Key message

PPE may be essential, but it should not be used to compensate for an avoidable failure in engineering, collective protection or work organisation.

How to distinguish the options

CPE: protects collectively through barriers or physical solutions such as guardrails, guards, enclosure, physical segregation, local exhaust ventilation and retention systems. Signage is an administrative control and, where necessary, should be combined with a physical barrier.

Engineering controls: physically modify the source, process or exposure pathway, reducing dust, noise, energy, falls, contact with moving parts or interaction between people and equipment.

PPE: protects the individual but depends on appropriate selection, correct use, maintenance, replacement and supervision. For high risks, it should rarely be the only control.

Combination of controls: is often required when a single measure does not reduce risk sufficiently or when several exposure pathways are present.

Decision criteria

- Are several people exposed to the same hazard?
- Does the risk arise from a physical source, energy, dust, traffic, a fall or a moving part?
- Can people and equipment be separated by a barrier, route or demarcated area?
- Can contact with the hazard source be prevented?
- Does the control depend too heavily on individual behaviour?
- Is PPE supplementing a collective measure, or is it inappropriately replacing a stronger solution?

Learning output — CPE, engineering controls or PPE?

Table 7.4 helps determine whether the situation requires an engineering control, collective protection, supplementary PPE or a combination of controls, taking account of the source of the risk and the people exposed.

Table 7.4 — Learning output — CPE, engineering controls or PPE?

Situation	People exposed	Possible engineering control or collective protection	PPE required	Decision
		Yes / no	Yes / no	
		Yes / no	Yes / no	
		Yes / no	Yes / no	

Practical decision rule

When a risk affects several people or has an identifiable physical source, the first step should be to seek an engineering control or collective protection. PPE should be retained where necessary, but as a supplement. The criteria are summarised in Figure 7.2.

COLLECTIVE PROTECTION, PPE AND ENGINEERING CONTROLS: WHICH SHOULD BE CHOSEN?

1 ENGINEERING CONTROL

Physically changes the source, process or exposure pathway.

Example: enclosure, ventilation, wet suppression or guarding.



 Protects several people by reducing exposure at source or along its pathway.

2 COLLECTIVE PROTECTION

Creates a barrier or separation between people and the hazard.

Example: guardrails, barriers, physical segregation.



 Protects several people at the same time.

3 PERSONAL PROTECTIVE EQUIPMENT (PPE)

Creates a barrier between the individual and the hazard.

Example: helmet, hearing and respiratory protection, gloves or harness.



 Protects the individual; it does not eliminate the hazard.

 **Whenever possible, prefer controls that act before exposure.**

Figure 7.2 — Engineering controls, collective protection and PPE: how should they be combined?

7.1.4 Permits-to-work and simple procedures

Some tasks should not begin on the basis of a verbal instruction alone. Where a task involves a specific risk, a change from routine or high exposure, a simplified permit-to-work, a short procedure or a minimum pre-start check should be in place.

In this chapter, the permit-to-work (PTW) is an administrative barrier confirming, for a specific location, period and set of conditions, that the required controls have been implemented and that the task may begin.

The procedure defines how the task should be performed safely. The permit-to-work confirms that the specific conditions have been verified. For critical tasks, both the procedure and the permit may be required; neither replaces technical control of the hazard.

Key message

A simplified permit-to-work should prevent a critical task from starting before the minimum controls have been verified.

When to use a permit-to-work or simple procedure

- work at height without permanent collective protection;
- intervention in systems involving hazardous energy, pressure or moving parts;
- entry into a confined space or restricted area subject to formal control;
- working in a hot environment, excavation, critical lifting operations or simultaneous work by several teams;
- a non-routine task or a relevant change to the conditions initially authorised;
- an activity for which the organisation's internal system requires formal authorisation.

What the simple procedure should include

A simple procedure should be concise and operational. It should specify the task, location, main risk, required controls, who will carry out the work and the conditions requiring work to stop. The permit should identify the person authorising the work, the validity period, confirmation of the controls, the conditions for suspension or revalidation and safe close-out.

The permit should be proportionate to the risk and to the organisation's internal system. Merely being present in a workshop, crushing area or mine road does not, in itself, require a permit-to-work.

Learning output — Simplified permit-to-work

Table 7.5 presents a simplified permit-to-work, including validity, confirmation of controls, conditions for suspension or revalidation and safe close-out.

Table 7.5 — Learning output — Simplified permit-to-work

Field	Response
Task and location	
Date, start time and validity period	
Main risk and critical conditions	
Mandatory controls and confirmation	
Person authorising the work	
Persons carrying out the work and confirmation of understanding	
Conditions for suspension or stopping	
Need for revalidation after a change	
Safe close-out and handback of the area/equipment	

Practical decision rule

If a task requires a permit, the minimum controls should be confirmed before work begins. Any change in conditions should lead to suspension and, where applicable, revalidation. The sequence is shown in Figure 7.3.



Figure 7.3 — Simplified permit-to-work for a critical task

7.1.5 Short risk control action plan

A short risk control action plan organises several measures related to the same problem, area or task. It makes it possible to track responsible persons, deadlines, implementation, effectiveness, review and residual risk.

In this chapter, the plan should be operational and proportionate. It does not replace a complete occupational safety and health management system; it is intended to ensure that the defined controls are implemented, verified and reviewed.

Key message

A control plan is useful only if it makes clear who does what, by when, what evidence is required and when the measure should be reviewed.

What it should include

- the risk or situation requiring control;
- the defined control, linked to the assigned priority;
- the person responsible for implementation or follow-up;
- a realistic deadline for implementation or verification;
- action status: open, in progress, completed or suspended;
- evidence of implementation, such as a photograph obtained without exposing the worker to risk, a record, form, verification or permit;
- the review point, to confirm whether the risk has been reduced and whether the control has created a new risk.

When to escalate to a higher decision-making level

The situation should be escalated to the person with the appropriate authority, technical competence or resources when the risk remains high, the deadline is not met, the control fails or conditions arise that increase exposure.

Learning output — Short risk control plan

Table 7.6 makes it possible to track the defined controls, including implementation, effectiveness criterion, status, review outcome, residual risk and any additional action.

Practical decision rule

A plan is incomplete if it does not specify a responsible person, deadline, status, evidence of implementation, effectiveness criterion and review. If effectiveness is insufficient or the residual risk remains high, an additional action should be defined and the matter escalated to the appropriate decision-making level.

Table 7.6 — Learning output — Short risk control plan

Risk	Defined control	Responsible person	Deadline	Evidence of implementation	Effectiveness criterion	Status	Review outcome and residual risk	Additional action
						Open / in progress / completed / suspended		
						Open / in progress / completed / suspended		
						Open / in progress / completed / suspended		
						Open / in progress / completed / suspended		

7.1.6 Communicating risks to the team

Risk communication to the team should be concise, objective and linked to the task. Its purpose is to ensure that everyone understands the main risk, the control to be applied and the expected behaviour before starting or continuing work.

It should be used before a critical task, when workplace conditions change or after a high risk has been identified. The message should avoid vague or blaming language and focus on what has been observed, what changes and what each person should do.

Key message

Communicating risk is not merely issuing a warning. It means ensuring that the team knows what has changed, what it should do and what behaviour is no longer acceptable.

When to communicate

- before starting a task involving a relevant risk;
- when workplace conditions change, for example because of traffic, rain, dust, poor visibility or a route change;
- after identifying a high risk, control failure, near miss or critical non-conformity;
- when an interim control changes how the task is carried out;
- when it is necessary to confirm that the team has understood the decision.

What the message should include

The message should answer five simple questions: what was observed, what the risk is, what control will be applied, what the team should do and how understanding will be confirmed.

- use short sentences directly related to the task;
- state a specific change to the route, procedure, permit, barrier, signage or use of PPE;
- confirm understanding by asking a question or having the critical instruction repeated;
- avoid generic expressions such as “be careful” or “pay attention to safety”.

Example wording

“Pedestrians have been observed moving close to the mining haul truck manoeuvring area. Until the physical barrier has been installed, pedestrians will be diverted to the signposted route. No one may cross the manoeuvring area without the supervisor’s authorisation.”

Learning output — Short risk communication message

Table 7.7 supports preparation of a short operational message by recording what was observed, the risk, the control to be applied, the expected behaviour and how the team’s understanding will be confirmed.

Table 7.7 — Learning output — Short risk communication message

Field	Response
What was observed	
What the risk is	
What control will be applied	
What the team should do	
How understanding will be confirmed	

Practical decision rule

Communication is incomplete if the team receives only a generic warning. The risk, the control to be applied, the expected behaviour and the method for confirming understanding should all be clear.

7.1.7 Pre-task safety briefing

A pre-task safety briefing is one form of operational communication. It should align the team immediately before the task is carried out, without replacing the procedure, permit-to-work, training or supervision. The briefing should be short and focused, but its duration should be proportionate to the complexity, changes and risks of the task. The two-minute example applies only to simple tasks and should not limit the communication required.

Key message

An effective pre-task briefing focuses the team’s attention on the main risk, mandatory controls, the stopping condition and confirmation of understanding.

Recommended structure

- **task for the day:** what will be done and where;
- **main risk:** what may cause harm during the task;
- **mandatory control:** what barrier, procedure, CPE, PPE or condition should be in place;
- **expected behaviour:** what the team should do or avoid;
- **stopping condition:** when the task should be interrupted;
- **final confirmation question:** how to verify that the team has understood.

Learning output — Pre-task safety briefing guide

Table 7.8 organises the essential elements of the briefing: task, main risk, mandatory control, expected behaviour, stopping condition and confirmation of understanding.

Table 7.8 — Learning output — Pre-task safety briefing guide

Element	Content
Task	
Main risk	
Mandatory control	
Expected behaviour	
Stopping condition	
Final question to the team	

Practical decision rule

The briefing is incomplete if the team does not know what the task is, what the main risk is, which control is mandatory, when it should stop and how to confirm that it has understood the message. The recommended structure is shown in Figure 7.4.



Figure 7.4 — Pre-task safety briefing

7.2 Apply — integrative activity

This activity integrates the work completed in Chapter 7. The learner should start from three priorities already defined in Chapter 6 — Hazard Identification and Risk Prioritisation and turn them into operational control measures, communication to the team and evidence of implementation.

The task is not to identify hazards again or repeat the assessment. The aim is to select proportionate controls, justify the decision using the hierarchy of controls and state how the measure will be communicated, followed up and reviewed.

Key message

The activity is complete only when each priority results in a clear operational control measure with a responsible person, deadline, communication to the team, evidence of implementation and a planned review.

Proposed activity — Transforming three priorities into operational control measures

The learner selects three risks prioritised in Chapter 6 — Hazard Identification and Risk Prioritisation or recorded in the form in A.5 — Hazard identification, prioritisation and corrective action. Real or simulated situations may be used.

Possible input risks

- pedestrians close to a mining haul truck;
- removed guard;
- deteriorated road;
- intense dust;

- unlabelled product;
- work at height;
- unstable bench;
- uncontrolled energy.

To turn each prioritised risk into an operational control measure, assign responsibilities, communicate the decision and plan verification of effectiveness, use **A.6 — Operational control and communication**. Additional cases may be made available by the trainer on the STRIM platform.

How to complete the activity

- select three risks that have already been prioritised, without repeating hazard identification;
- select the most appropriate control using the hierarchy of controls;
- justify whether the measure eliminates, substitutes, provides collective protection, changes the procedure or requires supplementary PPE;
- state whether a simple procedure or permit-to-work is required;
- define the responsible person, deadline, communication to the team, evidence of implementation and review.

Learning output — Application form

Table 7.9 integrates application of the chapter to three priority risks, including control, responsibility, deadline, communication, implementation, effectiveness, review and residual risk.

Expected output

Completed comparative form for three risks, showing the transition from priority to operational control, communication and verification of effectiveness.

Practical decision rule

The activity is satisfactory when each risk has a justified control, responsible person, deadline, communication, evidence of implementation, effectiveness criterion, review outcome and residual risk. Vague responses should be reformulated.

Table 7.9 — Learning output — Application form

Field	Risk 1	Risk 2	Risk 3
Prioritised risk			
Selected control			
Justification using the hierarchy of controls			
Procedure / permit-to-work required			
Responsible person			
Deadline			
Communication to the team			
Evidence of implementation			
Review required			
Effectiveness criterion			
Review outcome			
Residual risk			
Additional action			

7.3 Quick self-assessment

This self-assessment confirms whether the learner can apply the logic of Chapter 7 to short questions and decision cases. The responses should show that the assessed risk has been translated into a control, procedure, communication and verification.

Key message

An adequate response does not end with vague recommendations. It should state which control will be applied, why it was selected, who will implement it, how it will be communicated and what evidence will confirm implementation.

Short questions

1. Why is risk assessment alone insufficient to prevent accidents?
2. What is the difference between a preventive control and a mitigation control?
3. Why is elimination stronger than PPE?
4. When should engineering controls or collective protection be used?
5. When may PPE be insufficient?
6. What should a simplified permit-to-work include?
7. Why is it important to define a responsible person and deadline?
8. How can implementation of a control be distinguished from verification of effectiveness?
9. What should be communicated to the team before the task?
10. What makes a pre-task safety briefing effective?

Decision cases

For each case, the learner should select the most appropriate control, justify the decision and state whether communication to the team, a procedure or a permit-to-work is required (Table 7.10).

Table 7.10 — Decision cases for self-assessment

Case	Learner's decision	Brief justification	Expected control / communication
Pedestrians moving close to a mining haul truck			
Equipment guard removed			
Deteriorated road with rain forecast			
Intense dust in crushing			
Work at height without collective protection			
Unlabelled product in the warehouse			
Proposed action: "use PPE and be careful"			

Self-assessment criterion

The response is satisfactory when it distinguishes assessment, control, priority and risk level; applies the hierarchy; avoids relying solely on PPE; defines a responsible person and deadline; and provides for implementation, effectiveness and residual risk.

Practical decision rule

If the response is limited to "use PPE", "be careful" or "warn the team", without specifying a possible collective control, procedure, responsible person, deadline and verification, the decision should be reviewed before it is entered in the portfolio.

7.4 Practical summary

This summary closes Chapter 7 and consolidates the transition from risk assessment to operational control. The aim is to ensure that each priority defined in Chapter 6 — Hazard Identification and Risk Prioritisation results in a specific measure that is communicated to the team and supported by evidence of implementation.

Key message

Controlling risks means changing something in the task, workplace, equipment, procedure or exposure. The selected measure should be proportionate to the risk, communicated before the task is carried out and reviewed after implementation.

What must never be forgotten

- Risk assessment is not the same as risk control.
- The priority defined in **Chapter 6 — Hazard Identification and Risk Prioritisation** should lead to a specific measure.
- The hierarchy of controls helps select more effective measures that depend less on individual behaviour.
- Elimination or substitution is preferable to retaining the hazardous task and merely asking for greater care.
- Engineering controls and collective protection reduce reliance on PPE alone.
- PPE is essential in many tasks, but it should not be the only response to high risk.
- A simplified permit-to-work prevents critical tasks from starting before the minimum controls have been confirmed.
- A short plan should state the responsible person, deadline, evidence, action status and review.
- Communicating risk means clearly stating what changes in the task, who does what and when the task should stop.
- A pre-task safety briefing should be specific and linked to the main risk of the work that is about to begin.

Expected final output for Chapter 7

Completed operational control and communication form integrating the priority risk, control selected using the hierarchy, procedure and/or permit, responsible person, deadline, communication, evidence of implementation, effectiveness criterion, review outcome and residual risk.

Practical decision rule

If the response ends only with “use PPE”, “warn” or “be careful”, the control is incomplete. The decision should state the measure, responsible person, deadline, communication, evidence of implementation, effectiveness criterion and residual risk. The complete sequence is summarised in **Figure 7.5**.



Figure 7.5 — From prioritised risk to operational control

CHAPTER 8

Planning the technical visit and operational observation



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Chapter 8 — Planning the Technical Visit and Operational Observation

Chapter 6 Chapter 9

Chapter overview

Section	Learning function
Before you begin	Guide the learner, clarify the problem question, objectives, competences and the four expected outputs.
Learning pathway	Explain the Learn–Observe–Decide–Apply–Communicate–Reflect sequence and the expected outputs.
Technical core of the chapter	Prepare the visit, entry, movement around the site, authorised observation, data collection and the short report.
Apply — integrative activity	Produce the four interrelated records for the technical or simulated visit.
Quick self-assessment	Check understanding of planning, authorisation, movement around the site, data collection and reporting.
Practical summary	Consolidate the essential decisions and organise the final outputs for the digital portfolio.

Before you begin

Question to be answered

How can a technical visit to a production site be prepared and carried out so that useful data on risks and controls are collected without creating new risks, interfering with operations or exceeding the site's safety rules?

To prepare the visit, confirm the site safety induction, record the observation and produce the short post-visit report, use [C.1 — Technical visit tools](#).

Purpose of the chapter

This chapter helps the learner understand that a technical visit is not merely a trip to the site. It is a planned, authorised and objective-led activity in which observation must be carried out safely, systematically and in accordance with the rules of the production site being visited.

The visit should be planned and authorised before entry. The operational requirements concerning the route, site safety induction, mandatory PPE, collective protective measures and data collection are developed in [8.1 Planning the technical visit and operational observation](#).

The visit may be real or simulated. In either format, it should end with four interrelated records: a visit plan, a site safety induction checklist, an observation form and a short post-visit report.

Key message

A safe technical visit begins before entry. It begins by defining the objectives, authorisation, route, safety rules, PPE and collective protective measures, observation points and limits on data collection.

Learning objectives

- define learning and technical objectives for a visit to a production site;
- prepare contacts, authorisation, the route and observation points;
- understand the site safety induction and entry rules;
- recognise prohibited areas, safe distances and rules for movement around the site;

- confirm the mandatory PPE for the authorised route and recognise the collective protective measures, barriers and demarcations that must be respected during the visit;
- collect data using photographs obtained without exposing the worker to risk, structured notes and observation;
- organise findings, good practices and points requiring clarification in a short post-visit report;
- distinguish a technical visit from a formal audit, statutory inspection or formal risk assessment.

Competences to be developed

Competence	Expected evidence
Prepare a technical visit	Short visit plan with objectives, contact, authorisation, route and observation points.
Comply with entry rules	Site safety induction and access-rules checklist.
Move around safely	Record of authorised areas, prohibited areas and safe distances.
Confirm PPE and respect collective protective measures	Record of mandatory PPE and collective protective measures by area.
Collect data at the site	Photographs obtained without exposing the worker to risk, structured notes, a simple sketch or an observation form.
Produce a short report	Short post-visit report with findings, good practices, evidence and points requiring clarification.
Record evidence in the portfolio	Visit plan, checklist, observation form and short report organised in the digital portfolio.

Expected output for the chapter

The output of Chapter 8 is a set of four interrelated records: a visit plan, a site safety induction checklist, an observation form and a short post-visit report. Together, these records document preparation, safe entry, authorised observation and synthesis of the learning.

Output	Purpose
Visit plan	Define the objective, authorisation, route, observation points, restrictions and mandatory PPE.
Site safety induction checklist	Confirm the site representative, route, prohibited areas, movement rules, emergency arrangements, photography and understanding.
Observation form	Record facts, good practices, limitations and points requiring clarification.
Short post-visit report	Organise observations and authorised evidence, relating them to the objectives of the visit.

Learning pathway

The chapter follows the E-book's cross-cutting pedagogical logic: learn, observe, decide, apply, communicate and reflect. This sequence helps the learner move from planning the visit to safe observation, organised data collection and the short post-visit report.

Stage	What the learner does	Output or evidence
Learn	Reviews the purpose of the visit, entry rules and principles of safe observation.	Summary of visit requirements.
Observe	Analyses a plan, map, video or authorised route.	List of observation points.
Decide	Defines what may be observed, where movement is permitted and what data may be collected.	Validated visit plan.
Apply	Carries out or simulates the visit, following the site safety induction, route and safety rules.	Completed observation form.
Communicate	Records questions, findings and matters to confirm with the site representative or trainer.	List of questions and short report.
Reflect	Compares the visit objectives with the data collected and identifies learning points.	Digital portfolio entry.

Common decision criterion for the chapter

The visit should proceed only when there is a clear objective, authorisation, a defined route, a site safety induction, understood rules, confirmed mandatory PPE and a clear indication of what may and may not be recorded.

8.1 Planning the technical visit and operational observation

Planning a technical visit means defining in advance the objective, authorisation, route, observation points, safety rules and the data that may be collected. The visit should allow contact with operational reality without creating additional risk or interfering with production.

In this chapter, operational observation is a structured activity for learning and technical purposes. It does not replace a formal audit, statutory inspection, accident investigation or formal risk assessment. The learner observes, records facts, identifies good practices, formulates questions and organises evidence for subsequent discussion.

The visit should be planned and authorised before entry. The operational requirements are developed in the following subsections.

Key message

A good technical visit is not one in which everything is seen. It is one in which the essentials are observed safely, with authorisation, an organised record and respect for operations.

8.1.1 Educational and technical purpose of the visit

The technical visit connects the content of the E-book with operational reality. It allows processes, working conditions, foreseeable risks, existing controls, safe behaviours and critical areas to be observed, always within the authorised route and without interfering with production.

In this chapter, the visit should be understood as an applied learning activity. The learner observes, asks questions at the appropriate time, records facts and reflects on what was seen. The learner should not directly correct operations, enter unauthorised areas or replace the organisation's formal risk assessment.

Key message

A technical visit fulfils its purpose only when it turns observation into safe learning: seeing the process, recognising controls and recording evidence without creating new risks.

Technical visit, guided operational observation and formal audit

A technical visit has a learning purpose and helps the learner understand the reality of the production site. Guided operational observation directs attention to conditions, behaviours, controls and critical areas without producing formal conclusions. An audit is a structured process with defined criteria, specific responsibilities and formal conclusions. In this chapter, the focus is on a technical visit with guided operational observation.

Table 8.1 distinguishes the purpose and output of a technical visit, guided operational observation and a formal audit.

Table 8.1 — Technical visit, guided operational observation and formal audit

Activity	Main purpose	Expected output
Technical visit	Learn at the site by relating course content to real processes.	Observation notes, questions and a portfolio summary.
Guided operational observation	Systematically observe conditions, behaviours, controls and critical areas without producing formal conclusions.	Organised findings, limitations and authorised evidence.
Formal audit	Verify compliance against defined criteria, standards or procedures.	Formal report, conclusions and institutional recommendations.

As a learning activity

During the visit, the learner should observe processes, ask relevant questions, record facts and reflect on the relationship between what was seen and the previous chapters. The visit should support learning, not replace technical training, site supervision or the organisation's procedures.

As a technical activity

The visit also has a technical dimension. It enables the learner to recognise process stages, movement areas, equipment, observation points, existing CPE, required PPE, signage, barriers, good practices and conditions requiring subsequent clarification.

Limits of the visit

- do not interfere with production or with operators carrying out critical tasks;
- do not enter unauthorised or prohibited areas or areas requiring an escort;
- do not touch equipment, controls, products, samples or tools;
- do not photograph people, processes or facilities without authorisation;
- do not replace formal risk assessment, an audit, statutory inspection or a technical decision by the organisation;
- do not draw definitive conclusions when the observation was limited or incomplete.

Link to the digital portfolio

The outcome of the visit should be recorded in the digital portfolio. The learner should retain the visit plan, structured notes, authorised evidence, technical questions, good practices observed and a short post-visit summary. The learning value lies in the quality of the observation and record, not in the number of photographs or length of the report.

Learning output — Purpose of the visit and data to be collected

Table 8.2 relates possible visit objectives to their observation points, data to be collected and permitted forms of evidence.

Table 8.2 — Visit objectives and data to be collected

Visit objective	Observation point	Data to be collected	Permitted evidence
Understand the production process	Working face, bench, crushing area, store, workshop or laboratory.	Stage observed, equipment, movement around the site and visible controls.	Structured note, simple sketch or authorised photograph.
Recognise existing controls	Barriers, signage, guards, walkways, guardrails or segregated areas.	Type of control, location and condition observed.	Authorised photograph, note or reference in the report.
Identify good practices	Safe behaviours, workplace organisation, communication, use of PPE and collective protective measures.	Good practice observed and the context in which it occurred.	Structured note or described example.
Record points for analysis	Situation not understood or condition requiring clarification.	Technical question, limitation of the observation and question for the site representative.	List of questions or post-visit summary.

Practical decision rule

The visit should produce useful, safe and authorised observations. If the learner does not know whether movement, photography, questioning or recording of a situation is permitted, the learner should stop and confirm with the site representative before acting.

8.1.2 Planning: contacts, authorisation, route and observation points

The technical visit begins before entry to the production site. Planning should confirm who authorises the visit, who accompanies the group, where the group may move, which points will be observed and what data may be collected. Simple planning prevents improvisation, reduces unnecessary exposure and helps turn the visit into a safe activity aligned with the learning objectives. The visit should proceed only when authorisation, the route, the site representative, restrictions, mandatory PPE and the conditions applicable to data collection have been confirmed.

Key message

A well-planned visit defines, before entry, the objective, authorisation, site representative, safe route, observation points and the evidence that may be collected.

Prior contact and authorisation

Prior contact with the site should confirm whether the visit is possible, under what conditions it may take place and who will be the site representative. The date, time, meeting point, group size, accessible areas, restrictions and safety requirements should be defined.

Authorisation should be explicit. It is not sufficient to know that the site exists or that the visit is desirable. It is necessary to confirm who authorises entry, who escorts the group and which rules govern movement around the site, data collection and the use of photographs.

Minimum information before the visit

- type of production site and the main process to be observed;
- accessible areas, restricted-access areas and prohibited areas;
- site representative and person escorting the group;
- date, time, meeting point and expected duration;
- maximum group size and whether division into subgroups is required;
- mandatory PPE, CPE and other collective protective measures along the route;
- rules on photography, confidentiality and data recording;
- restrictions arising from critical operations, maintenance, blasting, traffic, weather conditions, instability or an instruction from the site representative.

Safe route and observation points

The route should be defined before the visit and confirmed during the site safety induction. The group should move only through authorised areas, accompanied by the site representative, without entering operational areas, working faces, benches, workshops, crushing areas, stores or laboratories without explicit instruction.

Observation points should be selected according to the objectives of the visit and the actual conditions at the site. They may include the entrance, a traffic route, a working face or bench, crushing area, workshop, store, laboratory, waste area, control room or another authorised location.

Criteria for limiting, changing or postponing the visit

The visit should be limited, changed or postponed when conditions do not allow safe observation. This decision rests with the site representative, the teaching team or whoever has authority to ensure the group's safety.

- heavy rain, strong winds, poor visibility, intense dust or extreme heat;
- critical operations, heavy traffic, blasting, slope instability or maintenance incompatible with the presence of visitors;
- absence of mandatory PPE, lack of authorisation, a change to the route or inability to provide an escort;
- any instruction from the site representative to interrupt, reduce or redirect the visit.

Learning output — Technical visit planning form

Table 8.3 enables the objective, authorisation, site representative, route, observation points, restrictions and safety requirements to be confirmed before the visit.

Table 8.3 — Technical visit planning form

Field	Response
Site/location to be visited	
Site representative/contact person	
Visit objective	
Authorisation confirmed	Yes / no
Date and time	
Authorised route	

Field	Response
Observation points	
Known restrictions	
Mandatory PPE and collective protective measures to be respected	
Photography rules	
Expected evidence for the portfolio	

Practical decision rule

The visit should not begin unless authorisation, the site representative, route, observation points, photography rules, mandatory PPE, collective protective measures to be respected and criteria for limiting or stopping the visit have been confirmed. The complete sequence, from defining the objective and obtaining authorisation to observation, the short report and recording in the digital portfolio, is summarised in Figure 8.1.



Figure 8.1 — From visit preparation to the digital portfolio

8.1.3 Site safety induction and entry rules

The site safety induction is the final check before entry to the production site. It should prepare visitors and learners to move around safely, follow the authorised route, recognise prohibited areas and understand the behaviour expected during the visit.

In this chapter, the site safety induction is not a pre-task safety briefing. The briefing in Chapter 7 — Risk Control and Operational Communication focuses on a specific operational task; the visit induction focuses on entry, movement around the site, observation and data collection by people who are not part of the operation.

Key message

The site safety induction is a safety barrier before the visit. Entry should occur only when the group understands who is escorting it, where it may move, which areas it must avoid, which PPE is mandatory and what to do in an emergency.

What should be explained during the site safety induction

- identification of the site representative and the person escorting the group;
- the authorised route and the points where the group may stop to observe;
- site movement rules, including the pace of movement, crossings and remaining close to the site representative;
- prohibited areas, restricted-access areas and locations that may not be entered;
- the main risks expected along the route, such as mobile equipment, crushing operations, dust, noise, slopes, energy, maintenance or internal traffic;
- mandatory PPE and the minimum conditions for its use;
- expected behaviour: do not leave the group, touch equipment, cross traffic routes without authorisation or interfere with workers carrying out critical tasks;
- rules on photography, confidentiality and data collection;
- the emergency procedure, evacuation signal, emergency assembly point and contact to notify in the event of an incident.

Confirmation of understanding and record

At the end of the site safety induction, it should be confirmed that everyone has understood the main rules. Confirmation may be obtained through a direct question, repetition of critical instructions or validation by the site representative.

Where applicable, there may be an attendance record, acceptance of the rules or confirmation that the site safety induction was received. This record does not replace supervision during the visit, but helps demonstrate that entry was prepared and communicated.

Criteria for denying entry

Entry should not be authorised when mandatory PPE is missing, there is no authorisation, the route has not been defined, the group does not understand the rules or site conditions are unsafe at the time of the visit.

Entry should also be refused or postponed when a visitor will not follow instructions, intends to leave the group, insists on taking photographs without authorisation or disregards prohibited areas.

Learning output — Site safety induction checklist

Confirmation of the essential elements of the site safety induction is supported by [Table 8.4](#).

Table 8.4 — Site safety induction checklist

Item	Confirmed?	Observations
Site representative identified	Yes / no	
Authorised route explained	Yes / no	
Prohibited areas identified	Yes / no	
Site movement rules explained	Yes / no	
Mandatory PPE confirmed	Yes / no	
Photography rules explained	Yes / no	
Emergency procedure explained	Yes / no	
Questions answered	Yes / no	

Practical decision rule

If the site safety induction does not identify the site representative, authorised route, prohibited areas, site movement rules, mandatory PPE and emergency procedure, the visit should not begin. If there is uncertainty about authorisation, photography, movement around the site or expected behaviour, entry should be postponed until the matter is clarified. The elements that should be confirmed during the site safety induction before entry to the production site are presented in [Figure 8.2](#).

Initial briefing and entry rules



 Purpose of the visit Confirm what will be observed and the expected output.	 Local person in charge Identify who authorises, accompanies and guides the group.	 Authorised route Define where to move and where to stop for observation.	 Prohibited areas Recognise the areas that must not be entered.
 Required PPE and collective protection Confirm mandatory PPE and the collective protection in place.	 Photography rules Take photographs only with authorisation and respect confidentiality.	 Emergency and assembly point Know the evacuation signal, emergency contact and assembly point.	 Expected conduct Stay with the group; do not touch equipment or interfere with operations.


The visit does not begin until the briefing is confirmed.

Figure 8.2 — Site safety induction and entry rules

8.1.4 Prohibited areas, safe distances and movement around the site

During a technical visit, movement around the site is a safety condition. The learner should observe without becoming exposed, exposing the group or interfering with operations. To achieve this, the authorised route should be followed, a safe distance should be maintained from operational areas and the instructions of the site representative should always be followed.

This subsection defines simple rules for moving around a production site, distinguishing authorised, restricted-access and prohibited areas, recognising safe distances and knowing when the visit should stop or be redirected.

Key message

During a technical visit, good observation means moving around safely. The learner should remain on the authorised route, respect prohibited areas, keep a safe distance from operational hazards and confirm any uncertainty with the site representative.

Authorised, restricted-access and prohibited areas

Before moving around the site, the group should understand that not all areas have the same level of access. Classifying the areas helps prevent inappropriate approaches to equipment, working faces, benches, slopes, workshops, crushing areas, energy sources, pressure systems or maintenance work.

- Authorised area: an area in which the group may move, accompanied and within the defined route.
- Restricted-access area: an area in which entry depends on specific authorisation, an additional control or direct escort.
- Prohibited area: an area that the group may not enter during the visit, even if PPE is available.

Rules for movement around the production site

Site movement rules should be treated as mandatory instructions. They are not general recommendations. Their purpose is to prevent the visit from creating risks for visitors, workers, operators or internal traffic.

- always follow the site representative and the authorised route;
- do not cross traffic routes without explicit authorisation;

- maintain a safe distance from mobile equipment, manoeuvring areas, conveyor belts, crushers, slopes, crests and stockpiles;
- do not enter working faces, benches, slopes, workshops, crushing areas, stores, laboratories or maintenance areas without authorisation;
- do not touch equipment, controls, samples, products, tools, guards, barriers or materials;
- respect signage, barriers, walkways, guardrails and demarcated areas;
- maintain visual contact and communication with the group and do not leave it to observe or take photographs.

Safe distances

The safe distance should be defined by the site representative and adapted to the production site being visited. Where there is no clear instruction, the learner should remain at a distance and confirm before approaching.

Particular attention is required in relation to:

- mobile equipment, mining haul trucks, loaders, light vehicles and manoeuvring areas;
- conveyor belts, rollers, entanglement points and accumulated material;
- crushers, hoppers, screens, elevated structures and projectile hazard areas;
- slopes, crests, benches, safety berms and working faces;
- stockpiles, stored-material stacks, loading areas and unloading areas;
- work at height, platforms, ladders, scaffolds and walkways;
- equipment under maintenance and systems involving energy, pressure, heat, moving parts or residual energy.

Criteria for stopping the visit

The visit should stop, be shortened or follow a different route when conditions no longer allow safe observation. The decision should follow the instruction of the site representative, teaching team or person with authority at the site.

- heavy traffic or an unexpected change in internal traffic;
- poor visibility, intense dust, noise preventing communication or insufficient lighting;
- rain, wind, mud or instability of the ground, slope or bench;
- blasting, a critical operation, ongoing maintenance or exceptional equipment movement;
- failure by any group member to comply with the rules;
- an instruction from the site representative to stop, move back, wait or change the route.

Learning output — Quick card: what I may and must not do during the visit

Table 8.5 summarises permitted and prohibited behaviour during the visit and provides a quick reference for movement around the site, observation and data collection.

Table 8.5 — Quick conduct card for the visit

I may	I must not
Move along the authorised route.	Leave the group.
Take photographs only when authorised.	Photograph people, equipment or sensitive information without authorisation.
Ask questions at the indicated time.	Interrupt operators carrying out a critical task.
Observe from a safe area.	Enter a prohibited or restricted-access area without authorisation.
Record findings.	Touch equipment, controls, products, tools or materials.

Practical decision rule

If the learner does not know whether it is permissible to move, approach, photograph, ask a question or record a situation, the learner should stop and confirm with the site representative. The visit should not continue when the group loses visual contact, disregards a prohibited area or cannot communicate safely. The distinction between

acceptable and unacceptable positions, exclusion zones and site movement rules during the visit is illustrated in Figure 8.3.



Figure 8.3 — Prohibited areas, safe distances and movement during the visit

8.1.5 Mandatory PPE and collective protective measures to be respected

The mandatory PPE for the visit should be defined by the site before entry and confirmed during the site safety induction. Visitors should also recognise and respect collective protective measures, barriers, walkways, segregated areas and restrictions along the authorised route.

This subsection does not replace the technical selection of PPE by task, already addressed in Chapter 4 — Operational Technical Safety and Maintenance, or the selection of controls using the hierarchy, developed in Chapter 7 — Risk Control and Operational Communication. Its purpose is to ensure that visitors enter only when they have the required equipment, understand the collective protective measures in place and respect the limits defined by the site.

Key message

PPE is a condition of entry, not authorisation to move around freely. The visit should take place only when personal protective equipment is available, in good condition and compatible with the site movement rules and existing collective protective measures.

PPE normally required for a visit

Mandatory PPE should be confirmed before entry and adapted to the type of production site, route and actual conditions of the visit. At extractive-industry production sites, the following may be required:

- safety helmet;
- high-visibility vest or clothing;
- safety footwear;
- safety glasses;
- hearing protection in noisy areas;

- respiratory protection where there is dust, fume, gas or a site instruction;
- gloves only when justified by the visit or an authorised task;
- other PPE defined by the site or site representative.

Existing collective protective measures and demarcations to be respected

During the visit, existing collective protective measures and demarcations form part of the safety conditions. The learner should recognise and respect them and should not cross them to obtain a better view or take photographs.

- barriers, fences, guardrails and demarcated areas;
- walkways, platforms, fixed ladders and safe observation points;
- traffic, hazard, mandatory-action, prohibition and emergency signage;
- segregated routes for pedestrians, mobile equipment and light vehicles;
- equipment protection systems, guards, panels, exclusion zones and temporary restrictions.

Minimum conditions before entry

Before the visit begins, it should be confirmed that every group member has the mandatory PPE, that the equipment is in good condition and that the different items of protection have minimum compatibility. The site representative may deny entry when these conditions have not been verified.

- visitors without mandatory PPE should not enter operational areas;
- damaged, unsuitable, poorly fitting or incompatible PPE should be replaced before entry;
- the absence of a collective protective measure, barrier or walkway should be treated as a movement restriction;
- PPE does not authorise entry to a prohibited area, approaching mobile equipment or leaving the authorised route.

Learning output — Mandatory PPE and collective protective measures by visit area

Mandatory PPE, existing collective protective measures and the access decision for each area are recorded in Table 8.6.

Table 8.6 — Mandatory PPE and collective protective measures by visit area

Area / observation point	Foreseeable risk	Mandatory PPE	Existing collective protective measure	Entry permitted?
				Yes / no / subject to conditions
				Yes / no / subject to conditions
				Yes / no / subject to conditions
				Yes / no / subject to conditions

Practical decision rule

If any group member does not have the mandatory PPE, if the PPE is in poor condition, if the collective protective measure is absent or if the area has not been authorised, the visit should not proceed to that point. The safe decision is to rectify the issue before entry, change the route or await an instruction from the site representative. The PPE normally required, the collective protective measures to be respected and the limitations on their use during the visit are summarised in Figure 8.4.

Mandatory PPE and collective protection measures must be observed

MANDATORY PPE							COLLECTIVE PROTECTION AND SAFETY MEASURES		
Safety helmet	Safety glasses	Hearing protection	Respiratory protection	Protective gloves	Safety footwear	High visibility vest	Guardrails and barriers	Safety signage	Cones and markings
Always in the mine area	Always when applicable	Always when applicable	Always when applicable	Always when applicable	Always in the mine area	Always in the mine area	Physical barriers and blockades	Access control	Fall hazard protection

CORRECT USE OF PPE					DO NOT USE / PROHIBITED		
Use correctly, inspect before entry and replace if damaged.					Do not remove PPE in the work area and do not replace it with unsafe alternatives.		



To ensure a safe visit, wear PPE and do not stray from the authorised route

Figure 8.4 — PPE and collective protective measures during the visit: requirements, limitations and correct use

8.1.6 Data collection: photographs, structured notes and observation

During a technical visit, data collection should be carried out safely, with authorisation, and in a way that is useful for the short post-visit report. The learner should observe without interfering with operations, without approaching prohibited areas and without creating risks for workers, operators or visitors.

The data collected should help the learner understand the process, existing controls, good practices observed and points requiring clarification. The record should distinguish observed facts, questions, interpretations and limitations of the observation.

Key message

Collecting data during a technical visit does not mean photographing everything or carrying out an audit. It means observing safely, recording useful facts and retaining authorised evidence to support the short post-visit report.

What to collect

The visit should collect only information relevant to the defined objectives and the short report. The record should be simple but sufficient to support subsequent analysis.

- the area observed and authorised observation point;
- the process, task or activity visible from a safe area;
- the relevant condition observed, without personal judgement;
- an existing control, such as a barrier, signage, walkway, PPE, CPE, a visible procedure or site escort;
- a safe behaviour or good practice observed;
- a technical question to be clarified with the site representative;
- photographic evidence, a note or a sketch, only where permitted;
- a specific question for subsequent clarification.

Photograph obtained without exposing the worker to risk

A photograph can provide useful evidence, but should be taken only when authorised and when doing so does not alter people's behaviour, expose sensitive information or create additional risk.

- take photographs only with authorisation from the production site and the site representative;
- take photographs only from a safe location and within the authorised route;
- do not identify people without consent or without a defined anonymisation rule;
- do not enter a prohibited area, approach equipment or cross barriers to obtain a better image;
- do not distract operators, drivers or workers carrying out critical tasks;
- do not record confidential information, control panels, documents, sensitive facilities or internal data without authorisation.

Structured notes

Notes should record observable facts rather than vague opinions. A good note makes it possible to understand what was seen, where it was seen, what control was in place and what question remained to be clarified.

- record observed facts, avoiding general expressions such as “dangerous area” or “lack of care”;
- distinguish the finding, technical question and learner’s interpretation;
- indicate when observation is limited by distance, noise, dust, visibility, the duration of the visit or lack of information;
- record good practices, not only non-conformities or critical situations;
- formulate short questions to ask the site representative at the appropriate time.

Observation without interfering with operations

During the visit, the learner observes, records and asks questions when authorised. The learner should not touch equipment, directly correct operations, interrupt critical tasks or alter operations to confirm a hypothesis.

- do not touch equipment, controls, samples, products, tools, guards or materials;
- do not interfere with operators, maintenance, traffic, loading, crushing operations, laboratory work or control-room activities;
- do not intervene directly to correct a situation during the visit; in the event of an immediate hazard, notify the site representative immediately;
- respect the operating pace of the production site, the authorised route and the instructions received;
- record only what can be observed safely and acknowledge what remains to be confirmed.

Learning output — Technical visit observation form

Table 8.7 provides a structure for recording observed facts, existing controls and good practices, limitations of the observation and points requiring clarification.

Table 8.7 — Technical visit observation form

Field	Record
Observation point	
Process / task observed	
Condition observed	
Existing control	
Good practice observed	
Situation requiring clarification	
Evidence collected	Photograph / note / sketch / none
Limitation of the observation	
Question for the site representative	

Practical decision rule

If data collection requires leaving the authorised route, approaching equipment, taking photographs without authorisation, identifying people without consent or interrupting operations, collection should stop. Evidence is valid only when it is safe, authorised and useful for the report. Acceptable and unacceptable conditions for taking

photographs, preparing structured notes and observing without interfering with operations are presented in Figure 8.5.

Safe data collection: photography, notes and observation

Safe photography

✓ Permitted	✗ Not permitted

- Take photographs only with authorisation.
- From a safe, authorised observation point.
- Without identifying people or recording sensitive information.

Structured notes

Observation without interference

✓ Permitted	✗ Not permitted

- Observe from a safe area.
- Record information and ask questions when authorised.

Evidence must be collected **safely, with authorisation, and be useful for the report.**

Figure 8.5 — Safe data collection: photographs, notes and observation

8.1.7 Short post-visit report

The short post-visit report transforms the observation carried out into a simple learning and portfolio output. It should organise facts, good practices, questions and authorised evidence without assuming the role of an audit, statutory inspection or formal risk assessment.

Key message

A short report should show what was observed, what evidence was collected, what good practices were recognised and what questions should be clarified after the visit.

Purpose of the report

The post-visit report should consolidate learning and allow the visit to be discussed objectively. It should relate the observations to the content of the E-book without repeating the risk assessment or proposing measures when there is insufficient information.

- consolidate the learning achieved during the visit;
- organise findings in a concise and verifiable form;
- record good practices observed at the site;
- identify technical or operational questions for subsequent clarification;
- relate observations to the content of the E-book;
- prepare for classroom discussion, independent work or the digital portfolio.

Recommended structure

The structure should be simple and repeatable. The report should indicate where the visit took place, what was intended to be observed, what route was followed, what rules were applied and what findings resulted from the observation.

- visit details: location, date, group and site representative;
- the objective of the visit and related E-book content;
- the route followed and observation points;
- safety rules applied: site safety induction, PPE, movement around the site and prohibited areas;
- main findings, described as observed facts;
- good practices observed, including controls, organisation, communication or signage;
- situations requiring clarification and technical questions;
- evidence collected: authorised photographs, notes or sketches;
- final summary and link to the digital portfolio.

Limitations of the report

The report should acknowledge the limitations of the observation. The visit has a learning purpose and does not replace formal audit, inspection, investigation or risk-assessment processes.

- it is not an audit report;
- it is not a statutory inspection report;
- it should not accuse individuals or teams;
- it should not publish unauthorised photographs or confidential information;
- it should not propose definitive measures without acknowledging the limitations of the observation;
- it should distinguish observed facts, questions and the learner's interpretations.

Learning output — Short post-visit report template

Table 8.8 presents the recommended structure for briefly and objectively organising the visit details, route, findings, good practices, questions, evidence and final summary.

Table 8.8 — Short post-visit report template

Section	Expected content
Visit details	Location, date, group and site representative.
Objective	What was intended to be observed.
Route	Areas visited and observation points.
Safety rules applied	Site safety induction, PPE, movement around the site and prohibited areas.
Main findings	Observed facts, without personal judgement.
Good practices observed	Controls, organisation, communication, signage or safe behaviour.
Points requiring clarification	Technical or operational questions.
Evidence	Authorised photographs, notes, sketches or other permitted records.
Final summary	What was learned and how it relates to the course and portfolio.

Practical decision rule

The report is incomplete if it does not indicate the objective, route, rules applied, findings, good practices, questions and evidence. If the information collected is limited, this limitation should be recorded explicitly. The transformation of site observation into evidence, findings, a short report and an output for the digital portfolio is summarised in Figure 8.6.

From the field to the short post-visit report



Figure 8.6 — From the site visit to the short post-visit report

8.2 Apply — integrative activity

This activity brings together the main outputs of Chapter 8. The learner should prepare a real, simulated or video-based visit, following the entry rules, authorised route and safe data-collection requirements.

Key message

The activity is complete only when the visit produces four interrelated outputs: a visit plan, a site safety induction checklist, an observation form and a short post-visit report.

Proposed activity — Preparing and carrying out a technical visit or a simulated visit to a production site

The learner should prepare a real, simulated or video-based visit. The activity is not intended to repeat the risk assessment, but to practise preparation, safe entry, site observation and the organisation of findings for the digital portfolio.

The activity should end with four outputs:

- a visit plan;
- a site safety induction checklist;
- an observation form;
- a short post-visit report.

How to complete the activity

- define the objective of the visit;
- confirm the contact, authorisation and route;
- identify observation points;
- confirm the entry rules, mandatory PPE and collective protective measures to be respected;
- collect authorised data;
- organise the findings;
- produce the short report;

- retain the outputs in the digital portfolio.

Learning output — Integrated framework for the visit outputs

The four outputs of the activity and the stage at which they are produced are organised in **Table 8.9**.

Table 8.9 — Outputs by stage of the integrative activity

Stage	Output
Before the visit	Visit plan
Entry	Site safety induction checklist
During the visit	Observation form
After the visit	Short post-visit report
Portfolio	Organised evidence

Expected output

The final output should demonstrate that the learner prepared the visit, confirmed the entry rules, observed without interfering with operations, collected authorised data and transformed the findings into a short report that supports learning and subsequent discussion.

Practical decision rule

The activity is adequate when the four outputs are consistent with one another. The objective defined before the visit should be reflected in the observation points, data collected and final summary of the short post-visit report.

8.3 Quick self-assessment

This self-assessment confirms whether the learner can apply the logic of Chapter 8 to short questions and decision cases. The answers should demonstrate that the visit was planned, authorised, carried out along a safe route and transformed into a useful record for the portfolio.

Key message

An adequate answer does not merely describe the visit. It should show that the learner understands authorisation, the site safety induction, the route, prohibited areas, PPE and collective protective measures, data collection and the short post-visit report.

Short questions

1. Why should a technical visit be planned before entry?
2. What information should be confirmed with the production site before the visit?
3. What is the purpose of the site safety induction?
4. Why does PPE not authorise entry to prohibited areas?
5. What behaviours are expected during the visit?
6. What data may be collected at the site?
7. What precautions should be taken when taking photographs?
8. What is the difference between a finding and an opinion?
9. Why should the post-visit report be brief?
10. Why does a technical visit not replace a formal audit?

Decision cases

The decision cases for self-assessment are presented in **Table 8.10**. For each case, the learner should state the decision, justify it in one or two sentences and identify the expected evidence for the portfolio.

Table 8.10 — Decision cases for self-assessment

Case	Learner's decision	Brief justification	Expected evidence
Visitor without mandatory PPE			
The group intends to leave the authorised route			
An operator is carrying out a critical task and someone wants to ask questions			
Unauthorised photograph of workers			
Area with intense dust and poor visibility			
Observation point without adequate physical segregation next to a mobile-equipment manoeuvring area			

Self-assessment criterion

The answer is adequate when it demonstrates that the learner understands authorisation, the site safety induction, the route, prohibited areas, mandatory PPE and collective protective measures, safe observation, data collection and the short report. It should also distinguish a technical visit from a formal audit or statutory inspection.

Practical decision rule

When an answer disregards authorisation, the route, mandatory PPE, prohibited areas or photography rules, the visit has not yet been adequately prepared. The decision should be corrected before entering a real or simulated operational context.

8.4 Practical summary

The final summary brings together the essential decisions from Chapter 8. It recalls that a technical visit should be planned, authorised and accompanied, carried out using a systematic approach to observation, and transformed into an interrelated set of outputs for the digital portfolio.

Key message

A technical visit is useful only when it begins with planning, proceeds with safe movement around the site, collects authorised data and ends with a short, factual and well-organised report.

What must never be forgotten

- A technical visit begins before entry to the production site.
- Objectives, authorisation, the route and observation points should be defined.
- The site safety induction is a safety barrier.
- Visitors should follow the authorised route and the instructions of the site representative.
- PPE is mandatory when specified, but does not authorise entry to a prohibited area.
- Prohibited areas, safe distances and movement rules should be respected.
- Data collection should be safe, authorised and structured.
- Taking photographs must not create risk, expose people or breach internal rules.
- The short post-visit report should record observed facts, good practices and questions.
- A technical visit does not replace an audit, statutory inspection or formal risk assessment.

Expected final output for Chapter 8

The four final outputs and their purposes are summarised in [Table 8.11](#). At the end of the chapter, the learner should integrate them into the digital portfolio.

Table 8.11 — Final outputs for Chapter 8

Output	Purpose
Visit plan	Define the objective, authorisation, route, observation points, restrictions, mandatory PPE and collective protective measures to be respected.
Site safety induction checklist	Confirm entry rules, the site representative, prohibited areas, emergency arrangements, photography rules and understanding of the rules.
Observation form	Record authorised data, findings, good practices, limitations of the observation and points requiring clarification.
Short post-visit report	Organise facts, evidence, questions and a reasoned summary without replacing an audit or formal risk assessment.

Practical decision rule

The visit is complete when there is organised evidence of preparation, safe entry, authorised observation and a short report containing facts, good practices, questions and links to the course.



Assessment of specific risks



DUST



NOISE

INTERACTION
WITH VEHICLESSLOPE
INSTABILITYCHEMICAL
AGENTSFALLS FROM
HEIGHTPHYSICAL
EXERTION

5x5 RISK MATRIX					
PROBABILITY	5				
	4				
	3				
	2				
	1				
SEVERITY / CONSEQUENCE					
	1	2	3	4	5



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Chapter 9 — Assessment of Specific Risks

Chapter 6 Chapter 8

Chapter overview

Section	Learning function
Before you begin	Present the problem question, purpose, objectives, competencies, and expected output.
Learning pathway	Explain the Learn–Observe–Decide–Apply–Communicate–Reflect sequence and the expected outputs.
Technical core of the chapter	Characterise exposure and link hazardous agents, exposed people, warning signs, controls, uncertainty and decision-making.
Apply — integrative activity	Transform an observed task into a short specific risk assessment.
Quick self-assessment	Check the ability to relate exposure, warning signs, immediate action and evidence.
Practical summary	Consolidate the essential principles and the final output of the chapter.

Before you begin

Question to be answered

How can exposure to chemical agents and dust, biological agents, noise, vibration, solar radiation, the thermal environment, ergonomic demands and psychosocial factors be recognised and assessed in a specific extractive-industry task, in order to decide when to continue, continue with additional measures, or stop and reassess, requesting technical support where necessary?

Purpose of the chapter

This chapter helps the learner move from observing a task to technically interpreting exposure. The aim is to recognise the hazardous agent or risk factor, identify who is exposed, characterise the route, duration, frequency and estimated intensity, consider warning signs and define a preventive decision.

The chapter addresses chemical agents and dust, biological agents, physical agents, ergonomic risk factors and psychosocial factors in real extractive-industry situations. The working face is used as an integrating example, without excluding crushing operations, maintenance, workshops, laboratories, stores, transport, cleaning and sampling.

The assessment presented is initial and operational. It does not replace measurements, safety data sheets, medical assessment, specific ergonomic assessment methods or specialist assessment where these are required. When data are missing or relevant warning signs exist, the uncertainty should be recorded and the task should be reassessed before continuing.

Key message

A specific risk is not assessed solely by naming the agent. The decision depends on the task, exposed people, route, duration, frequency, estimated intensity, existing controls, warning signs and available information.

Learning objectives

- distinguish the hazardous agent or risk factor, source, route of exposure, exposed person and potential consequence;
- recognise chemical agents and dust, biological agents, physical agents, ergonomic risk factors and psychosocial factors in extractive-industry tasks;
- characterise exposure by route, duration, frequency, estimated intensity and number of people exposed;

- recognise warning signs without formulating diagnoses;
- identify existing controls and their limitations;
- propose simple measures that reduce exposure without creating new risks;
- integrate the information into the 5 × 5 risk matrix, distinguishing the risk level from the intervention priority;
- record uncertainties and decide when to continue, continue with additional measures, or stop and reassess.

Competences to be developed

Competence	Expected evidence
Interpret a task in terms of exposure	Form recording the agent/factor, source, route, duration, frequency and exposed people.
Recognise warning signs	Prudent record of the sign, task, immediate action and person to be informed.
Compare existing and expected controls	Identification of the existing control, its limitation and the improvement required.
Assess specific risks using the matrix	Justified likelihood and consequence, risk level and intervention priority.
Record uncertainty	Clear indication of the measurement, technical information or validation that is missing.
Communicate the decision	Short message indicating whether to continue, continue with additional measures, or stop and reassess.
Produce evidence for the portfolio	Completed form, authorised photograph, observation note or video record.

Learning pathway

The chapter follows the cross-cutting sequence learn, observe, decide, apply, communicate and reflect. This sequence should lead the learner from identifying the hazardous agent or risk factor to characterising exposure and recording a preventive decision.

Stage	What the learner does	Output or evidence
Learn	Reviews the elements of exposure and the families of specific risks.	Summary of the essential concepts.
Observe	Analyses a task, image, video or case.	Short list of agents, exposed people, warning signs and controls.
Decide	Compares exposure, warning signs, controls and uncertainty.	Decision: continue; continue with additional measures; stop and reassess.
Apply	Completes the form and integrates the information into the matrix.	Justified risk level and intervention priority.
Communicate	Indicates who should be informed and what change is required.	Short message and record of the action.
Reflect	Checks limitations, missing information and the suitability of the proposed measure.	Entry in the digital portfolio.

Common decision criterion for the chapter

For each situation, the learner should conclude whether the task may continue, may continue only after additional measures have been applied, or should stop and be reassessed. The decision should be justified by the characterised exposure, existing controls, warning signs and recorded uncertainty.

Links to previous chapters

Chapter	How it should be used in Chapter 9
Chapter 2 — Fundamentals of Occupational Hygiene	Use the concepts of exposure and occupational hygiene without repeating the development of the agents.
Chapter 5 — Fundamentals of Risk Assessment	Use the 5 × 5 risk matrix and the classification already defined, without explaining the scales again.
Chapter 6 — Hazard Identification and Risk Prioritisation	Use identified hazards and evidence already collected as input information.

Chapter	How it should be used in Chapter 9
Chapter 7 — Risk Control and Operational Communication	Use existing controls and operational decisions without repeating the hierarchy of controls.
Chapter 8 — Planning the Technical Visit and Operational Observation	Use observations and visit records to interpret exposure technically.

9.1 Specific risk assessment

Specific risk assessment requires more than identifying a hazardous situation. It is necessary to understand which hazardous agent or risk factor is involved, who is exposed, for how long, at what intensity, how frequently, and which signs indicate that exposure may be excessive.

It is not sufficient to record “dust”, “noise”, “heat” or “awkward posture”. The analysis should show how exposure occurs during a specific task and what decision should follow from that assessment: continue, continue with additional measures, or stop and reassess, requesting technical support where necessary. The sequence linking the observed task, the hazardous agent or risk factor, the route and characteristics of exposure, the people exposed, the warning signs and the preventive decision is summarised in Figure 9.1.



Figure 9.1 — From the task to specific exposure

The working face should be used as an integrative example because it may combine dust, noise, vibration, heat, physical effort, time pressure, equipment movement and operational stress. It is therefore an appropriate setting in which to practise a combined assessment of specific risks rather than treating them as isolated problems.

In this section, occupational exposure limits should be used only conceptually. The learner should understand that technical reference values exist for comparing measured or estimated exposure, but does not need to memorise numbers. The essential point is to know when observation is no longer sufficient and when measurement, confirmation or specialist support is required.

Key message

A specific risk is adequately assessed when four questions can be answered: what is the hazardous agent or risk factor, who is exposed, how does exposure occur, and what preventive decision should be taken?

Table 9.1 sets out the minimum elements required to characterise a specific exposure, linking each element to an operational question and to an example applied to the working face.

Table 9.1 — Brief technical assessment of exposure

Element	Operational question	Example at the working face
Hazardous agent or risk factor	What is present?	Respirable dust, noise, vibration, heat, a chemical agent, physical effort or operational pressure.
Source or origin	How is it generated?	Drilling, blasting, loading, movement of mining haul trucks, mobile crushing, cleaning or maintenance.
Exposed person	Who may be affected?	Operator, banksman, maintenance worker, supervisor, authorised visitor or nearby team.
Duration	For how long does exposure occur?	Minutes, several hours, a full shift or repeated exposure during work cycles.
Intensity	Does exposure appear low, moderate or high?	A persistent dust cloud, noise requiring raised voices, intense heat or vibration felt in the body.
Frequency	How regularly does it recur?	Occasional, daily, during each drilling/loading cycle or whenever traffic is heavy.
Warning signs	Which signs indicate possible excessive exposure?	Coughing, eye irritation, shortness of breath, tinnitus, dizziness, fatigue, cramps, lower-back pain or irritability.
Preventive decision	What should change before work continues?	Reduce exposure, move people away, alternate tasks, wet down, improve local ventilation, communicate, record or request measurement.

Practical decision rule

If the agent or factor, exposed person, duration, intensity, frequency and warning sign cannot be specified, the assessment is not yet ready to be integrated into the risk matrix.

9.1.1 Chemical agents and dust

This subsection helps the learner recognise chemical agents and dust associated with actual extractive-industry tasks. The aim is not to provide an extensive lesson in occupational hygiene, but to support a rapid assessment of exposure: which agent is present, by which route it may enter the body, who is exposed, and which simple control measure can reduce the risk.

Key message

Operational question: can exposure occur during this task, by this route and for long enough to require control?

What to observe during the task

At working faces, crushing areas, haul roads, workshops, laboratories, stores and treatment areas, the most frequent agents include mineral dust, dust containing respirable crystalline silica, fumes, gases, fuel vapours, lubricants, reagents, cleaning products, explosives and other hazardous substances. The main tasks and critical areas, routes of exposure, warning signs and simple measures applicable to dust and chemical agents are presented in [Figure 9.2](#).

Dust should be considered in two simple fractions: inhalable dust, which may enter through the nose or mouth, and finer respirable dust, which may reach deep regions of the respiratory tract. Where the rock or material contains quartz, the presence of respirable crystalline silica should be treated as a signal requiring technical attention, even without memorising numerical values.

[Table 9.2](#) links the main sources of dust and chemical agents to the locations where they may arise, the predominant routes of exposure and the questions that should guide observation.

Table 9.2 — Chemical agents and dust: operational assessment

Agent or source	Where it may arise	Main route	Operational question
Inhalable and respirable dust	Drilling, blasting, crushing, loading, transport and dry sweeping.	Inhalation.	Does dust enter the worker's breathing zone?
Dust containing respirable crystalline silica	Quartz-bearing rock, drilling, cutting, crushing and cleaning of fines.	Inhalation of fine particles.	Is siliceous material present and is fine dust persistent?
Fumes and gases	Diesel engines, blasting, combustion, welding and poorly ventilated spaces.	Inhalation.	Are there odours, irritation, visible fumes or inadequate ventilation?
Fuels, lubricants and cleaning products	Workshop, refuelling, maintenance, parts washing and storage.	Skin and eye contact and inhalation of vapours.	Is there direct contact, a spill, vapours or poorly identified containers?

Agent or source	Where it may arise	Main route	Operational question
Reagents and hazardous substances	Laboratory, reagent preparation, mineral treatment and storage.	Skin or eye contact, inhalation or accidental ingestion.	Is the safety data sheet known and is preparation controlled?
Explosives and blasting residues	Storage, authorised transport, preparation and post-blast activities.	Inhalation of gases, contact or indirect exposure.	Has the area been ventilated and cleared before re-entry to the face?

DUST AND CHEMICAL AGENTS: ROUTES OF EXPOSURE AND CRITICAL TASKS

Identify the source, exposure route and warning signs before deciding.

DRILLING AND CRUSHING

- Inhalable dust
- Respirable dust
- Respirable crystalline silica — specialist assessment

HAUL ROAD

- Road dust
- Fumes and gases

WORKSHOP AND REFUELLING

- Fuels • Lubricants • Solvents
- Chemicals

LABORATORY AND REAGENTS

- Reagents • Vapours • Splashes
- Contaminated waste

ROUTES OF EXPOSURE

- Inhalation
- Skin/eyes
- Accidental ingestion

WARNING SIGNS

- Cough
- Irritation
- Strong odour
- Dizziness
- Spill

SIMPLE CONTROLS

- Wetting
- Ventilation
- Labelled containers
- Cleaning
- Segregation of areas

The absence of measurement does not mean the absence of risk.

Figure 9.2 — Dust and chemical agents: routes of exposure and critical tasks

Routes of exposure

Exposure may occur through inhalation, skin or eye contact, and accidental ingestion. In the extractive industry, inhalation is particularly relevant for dust, fumes and gases. Skin or eye contact is more likely during maintenance, refuelling, cleaning, laboratory work and reagent preparation. Accidental ingestion may occur when workers smoke, eat or drink with contaminated hands in dirty areas.

Odour may be a warning sign, but it does not identify the agent or indicate its concentration. The absence of odour does not demonstrate the absence of a contaminant; where there is doubt, exposure should be reduced, the situation communicated and an appropriate assessment requested.

Table 9.3 summarises the main routes of exposure to chemical agents and dust and gives examples of how they may occur during extractive-industry tasks.

Table 9.3 — Routes of exposure and practical examples

Route of exposure	How it may occur	Operational example
Inhalation	Dust, fumes, gases or vapours enter through breathing.	Drilling with visible dust; return to the face after blasting without adequate ventilation.
Skin or eye contact	Contact with the skin, eyes or contaminated clothing.	Maintenance involving oils, fuels, solvents or reagents; parts cleaning.
Accidental ingestion	Indirect contamination through hands, water, food or objects.	Eating, drinking or smoking without washing hands after handling products or dust.

Occupational exposure limits: conceptual overview

Occupational exposure limits need not be memorised in this chapter. They should be understood as technical reference values that help determine whether exposure should be measured, reduced, monitored or reported to a competent person.

The absence of measurement does not mean that there is no risk. Where there is persistent fine dust, fumes, gases, odours, irritation, spills or handling of hazardous substances, the preventive decision should be based on the task, the route of exposure and the observable warning signs.

Links to actual tasks

Table 9.4 illustrates the links between actual tasks, likely agents, observable warning signs and simple measures that may reduce exposure.

Table 9.4 — Examples linking the task, agent and warning sign

Task	Likely agent	Warning sign	Possible simple measure
Drilling, blasting and crushing	Mineral dust; possible respirable crystalline silica; post-blast fumes.	Persistent fine dust, reduced visibility, odour or irritation.	Wet down, ventilate, keep non-involved persons away and confirm clearance for re-entry.
Loading, transport and cleaning	Road dust, accumulated dust and exhaust fumes.	Dust clouds, dust on structures or clothing, and fumes in poorly ventilated areas.	Wet down haul roads, reduce speed, avoid dry sweeping and use wet cleaning methods.
Maintenance, workshop and refuelling	Oils, lubricants, fuels, solvents, cleaning products and fumes.	Spills, open containers, missing labels, odour or direct contact.	Identify products, contain spills, ventilate and keep containers closed.
Laboratory, treatment and reagent preparation	Reagents, vapours, splashes and contaminated waste.	Missing safety data sheet (SDS), improvised mixing, an unlabelled container or splashes.	Consult the SDS, label, segregate incompatible substances, ventilate and keep a spill kit available.

Learning output

Form 9.1-A — Brief identification of chemical agents and dust by task. The learner should complete one row for each observed task.

Form 9.1-A records the task, chemical agent or dust, route of exposure, existing control, warning sign and proposed simple measure.

Form 9.1-A — Chemical agents and dust by task

Task	Chemical agent/dust	Route of exposure	Existing control	Warning sign	Simple measure
Drilling at the face	Respirable dust; possible respirable crystalline silica.	Inhalation.	Partial wetting.	Visible dust in the breathing zone.	Increase wetting and keep non-involved workers away.

Practical decision rule

If the agent may be inhaled, contact the skin or eyes, or contaminate hands, water or food, exposure is possible. Where there is no visible and understood control, a simple measure should be defined before work continues.

9.1.2 Biological agents

Biological agents may also be present in the extractive industry. They arise mainly where there is contact with contaminated water, mud, organic waste, degraded sanitary facilities, animals, insects, fungi, moulds or accumulated organic matter. The aim of this subsection is to recognise exposure situations and select simple preventive measures.

Key message

Operational question: can the task bring the worker into contact with water, waste, animals, insects, moulds, wounds or potentially contaminated fluids?

What to observe during the task

Observation should focus on the work situation. Attention should be paid to areas with stagnant water, ditches, mud, effluent, waste, sanitary facilities, workshops, stores, degraded areas, confined spaces, dirty equipment, damp materials and vectors such as insects, rodents or other animals. The sources and contexts of biological exposure, the main routes of contact, warning signs and essential preventive measures are summarised in Figure 9.3.

Table 9.5 organises the main biological exposure situations, identifying possible agents, routes of contact, people who may be exposed and applicable preventive measures.

Table 9.5 — Biological agents: exposure situations and prevention

Situation	Possible biological agent	Likely exposure	Who may be exposed	Preventive measure
Stagnant water, mud or effluent	Microorganisms in water or organic matter.	Contact with the skin, eyes, wounds or contaminated clothing.	Operators, maintenance, cleaning, inspection and support personnel.	Avoid direct contact, use gloves where justified, protect wounds and wash hands.
Organic waste or sanitary facilities	Bacteria, fungi or contaminated matter.	Contact during cleaning, collection, transport or maintenance.	Cleaning and maintenance teams and nearby workers.	Segregate waste, clean critical areas, ensure drinking water and define a disposal point.
Insects, rodents or animals	Vectors, bites, stings or indirect contamination.	Stings, bites, or contact with droppings or nests.	Workers at faces, stores, workshops and degraded areas.	Control vectors, maintain housekeeping, report bites or stings and avoid contact with animals.
Fungi, moulds and organic matter in facilities or equipment	Fungi, moulds and organic dust.	Inhalation or contact when cleaning, opening, dismantling or moving materials.	Maintenance, cleaning, laboratory, stores and operations personnel.	Ventilate, clean without raising dust, remove degraded material and use suitable protection.
First aid, cleaning and maintenance	Blood, bodily fluids, contaminated waste or dirty surfaces.	Direct contact with bodily fluids, wounds, tools or surfaces.	First-aiders, supervisors, maintenance and cleaning personnel.	Use gloves where justified, cover wounds, wash hands and dispose of waste safely.



Figure 9.3 — Biological agents in extractive-industry settings

Simple preventive measures

Measures should be proportionate to the situation observed. In many cases, prevention begins with hand hygiene, protecting wounds, regular cleaning, waste management, available drinking water, vector control, gloves where justified, and immediate reporting of bites, stings, cuts or contact with contaminated material. Vaccination may be relevant where applicable and in accordance with local guidance.

Links to actual tasks

Biological agents may be encountered during apparently simple tasks: cleaning ditches, maintaining pumps, removing mud, providing first aid, cleaning sanitary facilities, working in damp stores, inspecting abandoned areas, or entering confined spaces containing organic matter. The assessment should specify the actual situation rather than merely recording “biological risk”.

Form 9.2-A records the situation, possible biological agent, likely exposure, exposed people and preventive measure.

Form 9.2-A — Biological agents by situation

Situation	Possible biological agent	Likely exposure	Who may be exposed	Preventive measure
Cleaning a ditch containing stagnant water	Microorganisms in water/mud.	Contact with the skin, eyes or wounds.	Cleaning worker and nearby support personnel.	Avoid direct contact, use gloves where justified, protect wounds and wash hands.

Learning output

Form 9.2-A — Brief identification of biological agents by situation, recording the situation, possible biological agent, likely exposure, exposed people and a simple preventive measure.

Practical decision rule

Where there is stagnant water, organic waste, animals, insects, moulds, wounds or bodily fluids, the possibility of biological exposure should be assessed and at least one simple preventive measure defined. The form should record the likely source, route of transmission, exposed people, existing controls and proposed preventive measure.

9.1.3 Physical agents: noise, vibration, solar radiation and the thermal environment

Physical agents arise from exposure to energy or environmental conditions that may affect hearing, the body, thermal balance and the ability to remain attentive. In the extractive industry, they occur during drilling, crushing, operation of mobile equipment, workshop activities, work near compressors, outdoor work and activities at working faces.

The assessment should link each physical agent to the actual task. It is not sufficient to record “noise”, “vibration” or “heat”. The assessment should indicate where exposure occurs, who is exposed, for how long, which signs arise and which simple measure may reduce exposure.

Key message

Operational question: is the worker exposed to noise, vibration, solar radiation or the thermal environment at an intensity, duration or frequency sufficient to require a preventive decision?

What to observe during the task

Observation should begin with the source of exposure: operating equipment, a vibrating tool, an uneven route, an unshaded area, a hot face, a damp area, wind, or work during an extended shift. It should then be checked whether the worker shows warning signs or whether the task requires additional effort to communicate, drive, maintain posture, remain hydrated or recover. The relationship between tasks, indications of exposure, warning signs and simple measures for noise, vibration, solar radiation and the thermal environment is presented in Figure 9.4.

Table 9.6 links each physical agent to tasks or areas where it may occur, indications of exposure, existing controls and simple actions to consider.

PHYSICAL HAZARDS IN EXTRACTIVE OPERATIONS

Noise, vibration, solar radiation and thermal environment

NOISE	VIBRATION	SOLAR/UV RADIATION	THERMAL ENVIRONMENT
			
 TASK/AREA Drilling · Crushing · Mobile equipment	 TASK/AREA Vibrating tool · Dumper on an uneven haul road	 TASK/AREA Outdoor work on the bench	 TASK/AREA Outdoor work or prolonged shift work
 EXPOSURE INDICATOR Difficulty communicating	 EXPOSURE INDICATOR Hand-arm · Whole-body	 EXPOSURE INDICATOR Direct sun · No shade · Prolonged exposure	 EXPOSURE INDICATOR Heat · Humidity · Wind · Cold
 WARNING SIGNS Tinnitus · Need to speak loudly	 WARNING SIGNS Numbness · Tingling · Pain · Fatigue	 WARNING SIGNS Reddened skin · Fatigue · Eye discomfort	 WARNING SIGNS Intense thirst · Dizziness · Cramps · Exhaustion



Temporary discomfort is not the same as a **health risk**; **duration, intensity** and **warning signs** change the decision.

Figure 9.4 — Physical agents: noise, vibration, solar radiation and the thermal environment

Table 9.6 — Physical agents: operational assessment

Physical agent	Task/area	Indication of exposure	Existing control	Simple action
Noise	Drilling, crushing, mobile equipment, workshops and compressors.	Difficulty communicating, need to raise the voice, tinnitus or fatigue.	Distance, barriers, cab, maintenance or specified hearing protection.	Keep non-involved persons away, reduce time in the area and confirm the applicable control.
Hand-arm vibration	Hammers, drills, vibrating tools and maintenance.	Tremor, numbness, tingling, loss of strength or discomfort in the hands.	Tool in good condition, task rotation or breaks.	Limit continuous duration, alternate tasks and report excessive vibration.
Whole-body vibration	Mining haul truck, loader, truck, drill rig and uneven haul roads.	Fatigue, lower-back pain, discomfort after driving or difficulty maintaining control.	Adjusted seat, controlled speed and haul-road maintenance.	Reduce speed, improve the road surface and report abnormal vibration.
Solar/ultraviolet (UV) radiation	Outdoor work on slopes, yards, access routes and unshaded areas.	Sunburn, redness, glare, headache or dehydration.	Shade, drinking water, work scheduling and sun protection.	Provide shade, reinforce hydration and protect the skin and eyes.
Heat, cold, humidity and wind	Working face, washing, pumping, workshop, outdoor areas and extended shifts.	Dizziness, cramps, chills, shivering, severe fatigue or heat exhaustion.	Breaks, shelter, drinking water, suitable clothing and supervision.	Adjust the pace, increase breaks and remove from the task anyone showing warning signs.

Occupational exposure limits and action values: conceptual overview

Occupational exposure limits, action values or technical reference criteria may exist for noise, vibration, radiation and the thermal environment. Numerical values need not be memorised in this chapter. The essential point is to understand that these values help determine when exposure should be measured, reduced, monitored or reviewed by a competent professional.

Where there are repeated complaints, difficulty communicating, tinnitus, intense vibration, excessive heat, disabling cold or symptoms during the task, the situation should not be treated as a minor discomfort. It may indicate relevant exposure and justify preventive action.

Discomfort or health risk

Discomfort is a transient sensation that improves rapidly when exposure ends. A health risk exists when exposure is intense, frequent, prolonged, repeated over several shifts or accompanied by warning signs. The decision should consider the task, exposure time, environmental conditions and the worker's actual ability to recover.

Warning signs

Signs such as difficulty communicating, tinnitus, abnormal fatigue, tremor, numbness, dizziness, cramps, very hot skin, confusion, chills, shivering or heat exhaustion should be taken seriously. These signs do not replace measurements, but they help determine when to stop, reduce exposure, communicate the situation or request a technical assessment.

Links to actual tasks

At the working face, a drill rig may combine noise, vibration, dust, heat and operational pressure. In crushing areas, continuous noise may impair communication and increase fatigue. When driving off-highway trucks, whole-body vibration may be aggravated by degraded haul roads, inappropriate speed or a poorly adjusted seat. During outdoor work, sun, heat, wind and humidity may turn a simple task into a health risk.

Form 9.3-A records the physical agent, task or area, indication of exposure, existing control and simple action.

Form 9.3-A — Physical agents by task or area

Physical agent	Task/area	Indication of exposure	Existing control	Simple action
Noise and vibration	Drill rig at the working face.	Difficulty communicating; tingling in the hands.	Specified hearing protection; tool/equipment subject to planned maintenance.	Keep non-involved persons away, limit continuous duration and report abnormal vibration.

Learning output

Form 9.3-A — Brief identification of physical agents by task or area, recording the physical agent, task, indication of exposure, existing control and simple action.

Practical decision rule

Where there is difficulty communicating, tinnitus, tremor, numbness, dizziness, cramps, heat exhaustion or prolonged exposure to heat, cold, sunlight or vibration, the physical agent should be treated as a warning sign and not merely as discomfort.

9.1.4 Ergonomic risk factors and musculoskeletal disorders

Ergonomic risk factors arise when a task requires the worker to maintain awkward postures, repeat movements, exert force, carry loads, remain standing or seated for too long, or work in locations with difficult access. In the extractive industry, these factors occur during inspections, maintenance, equipment operation, sampling, cleaning and parts replacement.

The assessment should link the task to the actual physical effort. It is not sufficient to recommend “good posture”. It is necessary to understand which movement is performed, for how long, how frequently, which part of the body is placed under strain and which simple improvement may reduce the physical load.

Key message

Operational question: does the task require the worker to exert force, repeat movements, maintain a posture, twist, reach awkwardly or experience vibration for long enough to cause pain, fatigue or injury?

What to observe during the task

Observation should focus on posture, force, repetition, duration, access and recovery. Situations requiring attention include working while bent, twisted, kneeling or with the arms raised; working in a confined space; using heavy tools; working on uneven ground; operating in a poorly adjusted cab; or handling loads without mechanical assistance.

Table 9.7 presents the main observable ergonomic factors, the tasks in which they may occur, the areas of the body most affected and applicable simple improvements.

Table 9.7 — Ergonomic risk factors: operational assessment

Ergonomic factor	Task or situation	Indication of exposure	Area of the body most affected	Simple improvement
Awkward posture	Inspection of conveyors, pumps, valves, slopes, elevated points or confined areas.	Working bent over, twisted, kneeling or with the arms raised.	Lower back, neck, shoulder and knee.	Improve access, use a platform, adjust the height or reduce continuous duration.
Repetitive movement	Sampling, manual screening, cleaning, tightening bolts or small assembly work.	Repetition of the same action for several minutes or shifts.	Wrist, elbow, shoulder and neck.	Alternate tasks, introduce short breaks and use a suitable tool.
Manual lifting and carrying	Replacing parts and moving hoses, buckets, bags, tools or samples.	Heavy load, difficult grip, carrying on uneven ground or lifting while twisting.	Lower back, shoulder, knee and wrist.	Use a mechanical handling aid, divide the load, keep it close to the body and organise the route.
Prolonged sitting or standing	Driving off-highway trucks or loaders, control-room work, watchkeeping or sorting.	Little variation in posture, fatigue, lower-back discomfort or tired legs.	Lower back, neck, legs and shoulders.	Adjust the seat, change position, plan breaks and adjust the controls/monitor.
Difficult maintenance access	Work at low points, inside equipment, in areas with limited clearance or poor lighting.	Additional effort to reach, see, tighten, dismantle or clean.	Shoulder, neck, lower back, wrist and knee.	Reorganise access, improve lighting, prepare tools and plan the intervention.
Vibration combined with posture	Operating mobile equipment, using a vibrating tool or driving on degraded haul roads.	Fixed posture combined with vibration, impacts or a poorly adjusted seat.	Lower back, neck, hands and arms.	Adjust the seat, improve haul roads, limit continuous exposure and alternate tasks.

Musculoskeletal disorders: warning signs

Musculoskeletal disorders may be indicated by lower-back, shoulder, neck, wrist or knee pain, tingling, loss of strength, stiffness, persistent tiredness or difficulty repeating the task. A sign is more relevant when it appears during the task, recurs over several shifts or improves only after prolonged rest.

Applicable simple controls

Improvements should begin with the task and the workplace. They may include adjusting the working height, task rotation, short breaks, mechanical handling aids, better workplace organisation, advance preparation of tools, improved access, reduced manual carrying and selection of a suitable tool. Posture training may help, but it does not replace correction of the task where the physical effort is imposed by work organisation.

Links to actual tasks

At the working face, inspection may require walking on uneven ground, observing elevated points, collecting samples and remaining standing in hot conditions. During maintenance, parts replacement may combine weight, awkward posture, difficult reach and time pressure. During mobile-equipment operation, vibration, prolonged sitting and limited visibility may aggravate lower-back and neck fatigue.

Form 9.4-A records the task, observed posture or effort, affected area of the body, aggravating factor and simple improvement.

Form 9.4-A — Ergonomic risk factors by task

Task	Observed posture/effort	Affected area of the body	Aggravating factor	Simple improvement
Replacing a part on mobile equipment	Working bent over, exerting force and lifting manually.	Lower back, shoulder and wrist.	Restricted access, heavy part and pressure to resume operations.	Use a mechanical handling aid, prepare the tool and divide the task.
Inspection at the working face	Walking on uneven ground, prolonged observation and carrying samples.	Knee, lower back and shoulder.	Heat, distance, manual load and exposure time.	Reduce the load, plan the route and schedule short breaks.

Learning output

Form 9.4-A — Brief identification of ergonomic risk factors by task, recording the observed posture or effort, affected area of the body, aggravating factor and possible simple improvement.

Practical decision rule

If the task requires force, repetition, twisting, raised arms, a maintained posture, difficult access or vibration, the improvement should act on the task rather than merely asking the worker to “use good posture”.

9.1.5 Psychosocial risks: stress, harassment and occupational burnout

Psychosocial risks arise from the way work is organised, communicated, supervised and experienced by teams. In the extractive industry, they may occur during tasks involving production pressure, extended shifts, isolation, poor communication, conflict, intimidation or humiliation.

The aim of this subsection is not to provide a general discussion of organisational climate. The focus is on recognising situations that affect attention, communication, safe decision-making and the ability to report problems before an accident occurs.

Key message

Stress, fatigue, conflict and harassment may become safety risks when they reduce attention, increase errors, hinder communication or prevent the reporting of hazardous situations.

What to observe during the task

Observation should consider the pace of work, time pressure, shift duration, breaks, lone working, clarity of instructions, quality of communication and behaviour between people. Signs of humiliation, discrimination, threats, intimidation or repeated conflict should also be taken seriously.

Operational stress may arise in an isolated situation, for example during a breakdown, a production stoppage or a rapid change at the working face. Occupational burnout is a prolonged process associated with high demands, insufficient recovery and a persistent sense of depletion.

Table 9.8 sets out the main psychosocial factors, linking them to operational situations, possible effects on safety, warning signs and preventive actions.

Table 9.8 — Psychosocial risks: operational assessment

Psychosocial factor	Operational situation	Possible effect	Warning sign	Preventive action
Operational stress	Breakdown, production delay, unstable face or rapid change in the plan.	Rushing, incomplete decision-making and reduced attention to the main risk.	Irritability, errors, or brief or confused communication.	Pause to confirm the priority, redistribute tasks and reinforce supervision.
Production pressure	Rapid restart after a stoppage, tight targets or a sequence of interdependent operations.	Shortcuts, omitted checks or reduced reporting of doubts.	Hurried work, resistance to stopping or a tendency to ignore warning signs.	Clarify that the task may continue only after the minimum conditions have been confirmed.
Fatigue, shifts and insufficient recovery	Long shifts, night work, heat, prolonged driving or urgent maintenance.	Reduced attention, longer reaction time and increased errors.	Drowsiness, persistent fatigue, difficulty concentrating or absenteeism.	Plan breaks, adjust shifts, limit critical tasks and encourage fatigue reporting.
Isolation and poor communication	Work in a remote area, a lone operator, unclear radio communication or incomplete instructions.	Delayed request for help, decisions without confirmation or coordination failure.	Prolonged silence, unresolved doubts or contradictory messages.	Define regular safety check-ins, confirm critical messages and ensure a reliable communication channel.
Conflict, harassment, intimidation or discrimination	Humiliation, threats, discriminatory comments, undue pressure or exclusion from the team.	Fear of reporting, loss of trust and deterioration of cooperation.	Isolation, anxiety, absenteeism, irritability or avoidance of people/areas.	Report through an appropriate channel, protect the exposed person and ensure competent management.
Burnout	Prolonged exposure to high demands, insufficient recovery and lack of support.	Persistent depletion, reduced engagement and greater likelihood of error.	Exhaustion, disengagement, loss of concentration or cynicism.	Review workload, shifts, management support, breaks and the need for referral.

Stress, fatigue and safety

Stress and fatigue should not be regarded solely as individual discomfort. When they affect attention, memory, coordination, communication or judgement, they interfere directly with task safety. A fatigued or pressured team communicates less effectively, confirms less information and is more likely to accept shortcuts.

Harassment, intimidation and discrimination

Harassment, intimidation, discrimination or humiliation should be treated as serious psychosocial risks. Their management requires reporting through an appropriate channel, protection of the exposed person, confidentiality where applicable and action by someone with responsibility to intervene. The learner should recognise the situation and understand that it should not be normalised.

Applicable simple measures

Preventive measures should be simple and applicable: short breaks, confirmation of instructions, close supervision during critical tasks, shift planning, rotation where justified, regular safety check-ins for lone working, respectful communication, reporting of serious situations and access to support channels. For psychosocial risks, early communication may prevent operational error and personal harm.

Links to actual tasks

At the working face, pressure to maintain production may coincide with dust, noise, heat, equipment movement and rapid decisions. During maintenance, urgency to return equipment to service may increase stress and reduce checking. During prolonged driving or lone working, fatigue and poor communication may delay the response to a critical situation. Examples of ergonomic and psychosocial factors in actual tasks, their warning signs and simple work-organisation measures are presented in Figure 9.5.

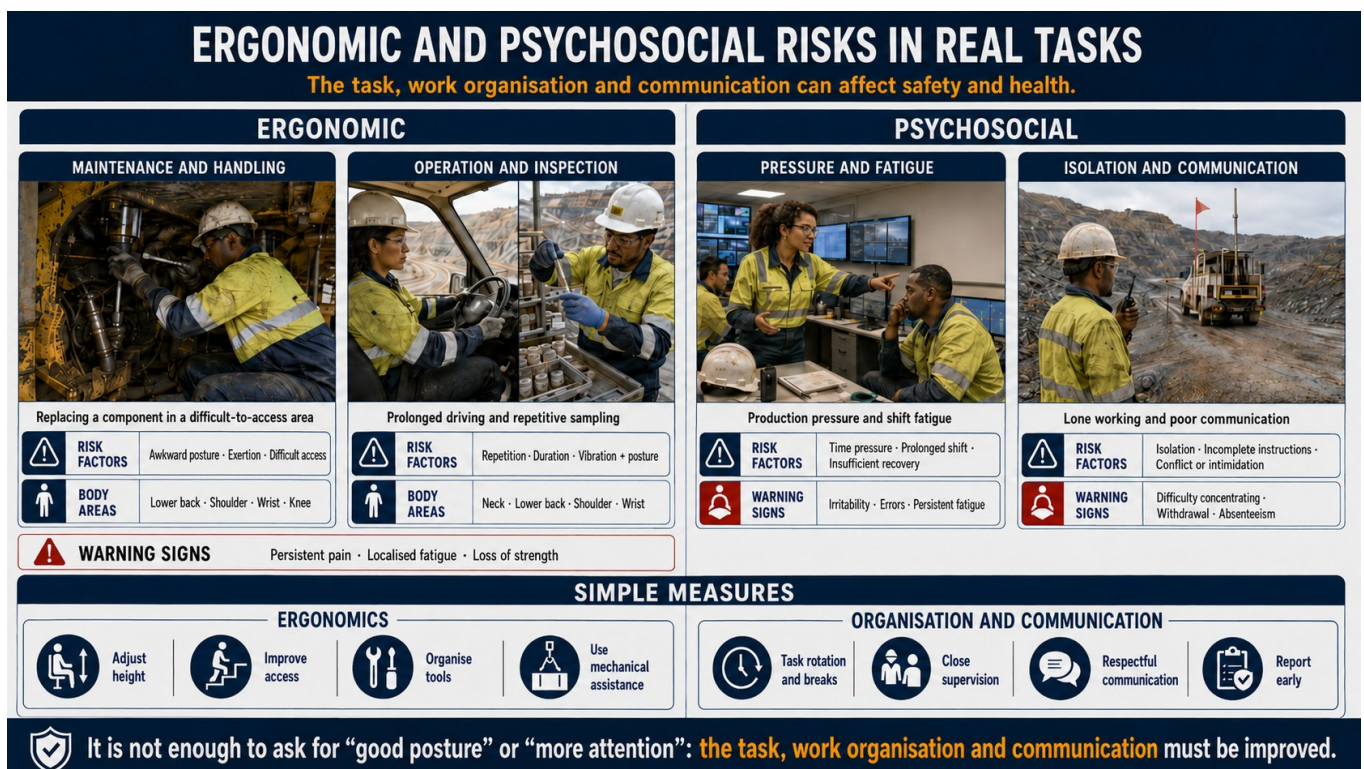


Figure 9.5 — Ergonomic and psychosocial risk factors in actual tasks

Form 9.5-A records the psychosocial factor, operational situation, possible effect, warning sign and preventive action.

Form 9.5-A — Psychosocial factors by operational situation

Psychosocial factor	Operational situation	Possible effect	Warning sign	Preventive action
Production pressure	Restart of crushing after a stoppage or delay.	Shortcut, incomplete communication or omitted check.	Visible rushing, irritability or refusal to stop.	Confirm the minimum conditions and distribute responsibilities.
Fatigue and isolation	Operator on a long shift or at a remote post.	Reduced attention and delayed request for help.	Drowsiness, prolonged silence or difficulty concentrating.	Breaks, regular safety check-ins and a confirmed communication channel.

Learning output

Form 9.5-A — Brief identification of psychosocial factors in an operational situation, recording the possible effect, warning sign and simple preventive action.

Practical decision rule

If stress, fatigue, conflict, harassment or poor communication reduces attention, affects decision-making or prevents reporting, the situation should be treated as a safety risk and not merely as an individual problem.

9.1.6 Warning signs associated with exposure

Warning signs may indicate that the exposure, the demands of the task or the organisation of work need to be reviewed. They do not, in themselves, confirm overexposure or replace medical or technical assessment. They should be linked to the task, the location, the duration, the existing controls and the progression of the signs.

The assessment should link the sign observed to the task, the location, the duration of exposure and the conditions present. An isolated sign may have several causes; repeated or severe signs, or signs associated with the task, require communication, exposure reduction and reassessment. The main warning signs by risk family and the decisions to observe, communicate, monitor or stop are summarised in [Figure 9.6](#).

Key message

A warning sign is not a diagnosis. It is an operational indication to stop, reduce exposure, communicate and seek support when necessary.

What to observe during the task

Changes during or after the task should be observed: coughing, irritation, difficulty hearing, dizziness, cramps, numbness, nausea, persistent pain, extreme fatigue, irritability or isolation. The main question is simple: did the sign arise or worsen during the exposure?

When several workers report similar signs in the same area or task, the situation should be analysed as a possible collective exposure issue, even if measurements are not yet available.

[Table 9.9](#) links different warning signs associated with exposure to possible risks, immediate actions, the people to inform and the evidence that should be recorded.

SIGNS OF OVEREXPOSURE: WHEN TO REPORT OR STOP

Recognise the signs, report them and decide without making a medical diagnosis.



Figure 9.6 — Warning signs associated with exposure: when to communicate or stop

Table 9.9 — Warning signs associated with exposure: operational assessment

Observed sign	Possible risk	Immediate action	Who to inform	Evidence to record
Coughing, irritation, shortness of breath.	Dust, silica, fumes or gases.	Move away from the source, reduce exposure and check the task conditions.	Supervisor, Occupational Safety and Health (OSH) team or first aid if severe.	Task, location, duration, visible dust/fumes and existing measures.
Tinnitus, difficulty hearing, need to speak loudly.	Excessive noise.	Move to a quieter area and review the applicable control.	Supervisor or OSH team.	Equipment/area, exposure time and protection used.
Intense thirst, dizziness, cramps, confusion, exhaustion.	Heat, solar radiation or heat strain.	Stop, move to shade/a cool place, hydrate and seek support.	Supervisor and first aid; emergency response if confusion is present.	Perceived temperature, task, breaks, available water and time of day.
Numbness, tingling, pain or tremor.	Vibration, awkward posture or repetitive effort.	Stop or alternate the task and reduce use of the tool/equipment.	Supervisor or OSH team.	Tool/equipment, duration, posture and affected body area.
Irritation, strong odour, dizziness, nausea, burning sensation.	Chemicals, fuels, gases or fumes.	Move away from the source, avoid contact and follow emergency instructions.	Supervisor, OSH team or internal emergency response.	Product/source, location, ventilation, spill or odour, and likely route.
Persistent pain, localised fatigue, loss of strength.	Ergonomic overload or musculoskeletal disorder.	Stop, adjust the task and seek support before the condition worsens.	Supervisor or occupational health support.	Movement, load, repetition, duration and affected area.
Extreme fatigue, irritability, anxiety, isolation.	Stress, fatigue, conflict or prolonged psychosocial exposure.	Communicate, seek support and reassess whether the task can continue safely.	Supervisor, support channel or OSH team, as appropriate.	Operational situation, shift, communication, signs observed and action taken.

Stopping and communication criterion

The task should stop or be reassessed when the sign affects breathing, balance, consciousness, the ability to hear instructions, concentration, coordination, strength or the ability to communicate. The situation should also be communicated when there is a strong odour, sudden irritation, extreme heat, repeated complaints or similar signs in several workers.

When in doubt, the safe decision is to reduce exposure and inform the appropriate person. Continuing the task while ignoring warning signs may turn a controllable exposure into a critical situation.

Cautious wording

Use expressions such as “may indicate”, “should be communicated” and “requires appropriate assessment”. The learner should not diagnose diseases or replace medical assessment.

Links to actual tasks

During drilling and crushing, coughing, irritation and tinnitus may indicate combined exposure to dust and noise. At the working face, dizziness or cramps may be linked to heat, physical effort and solar radiation. During maintenance, strong odour, burning or nausea may be associated with fuels, lubricants, solvents or gases. During prolonged equipment operation, numbness, pain and fatigue may result from vibration, posture and long shifts.

Form 9.6-A records the warning sign, the possible risk, the immediate action, the person to inform and the evidence to retain.

Form 9.6-A — Warning signs and communication

Observed sign	Possible risk	Immediate action	Who to inform	Evidence to record
Dizziness while working in the sun.	Heat/heat strain.	Stop, move to shade and hydrate.	Supervisor and first aid if it persists.	Time, task, duration, water/breaks and progression of the sign.
Tinnitus after crushing.	Noise.	Move away from the noisy area and review the control.	Supervisor/OSH team.	Area, equipment, exposure time and protection used.
Irritation and strong odour in the workshop.	Chemical/fumes.	Move away, ventilate if safe and avoid contact.	Supervisor/OSH team.	Likely product, location, ventilation and action taken.

Learning output

Form 9.6-A — Brief record of a warning sign associated with exposure, the possible risk, the immediate action, the person to inform and the evidence to retain in the portfolio.

Practical decision rule

If the sign affects the ability to work, communicate, hear instructions, breathe, maintain balance, concentrate or make safe decisions, the task should stop or be reassessed before continuing.

9.1.7 Low-cost control measures

Many specific risks can be reduced through simple measures, provided that the measure acts on the source, the exposure pathway, the duration, the intensity or the number of people exposed. The aim is not to replace necessary technical solutions, but to prevent known risks from continuing without any practical improvement.

A low-cost measure is useful only if it is specific, verifiable and appropriate to the task. Saying “be careful” does not reduce dust, noise, heat, vibration, physical effort or operational stress. The question should be: what changes in the task to reduce exposure?

Key message

A simple measure should reduce actual exposure. If it does not change the source, pathway, time, intensity or organisation of the task, it is probably not sufficient control.

What to observe during the task

Observation should begin at the point where exposure originates or accumulates: dust on the floor, dry material, an area without ventilation, a working face without shade, a poorly maintained tool, a badly positioned load, a degraded route, a poorly organised chemical product or unclear instructions. The next step is to identify a simple improvement that can be applied without creating a new risk.

The selected measure should have a known limitation. Wet suppression may reduce dust, but it does not resolve high exposure if the source remains intense. Breaks and water help in hot conditions, but they do not authorise work to continue when there are signs of exhaustion. Rotation reduces exposure duration, but it does not eliminate a hazardous source. **Figure 9.7** presents examples of low-cost measures, their purpose, their limitations and the evidence needed to verify exposure reduction.

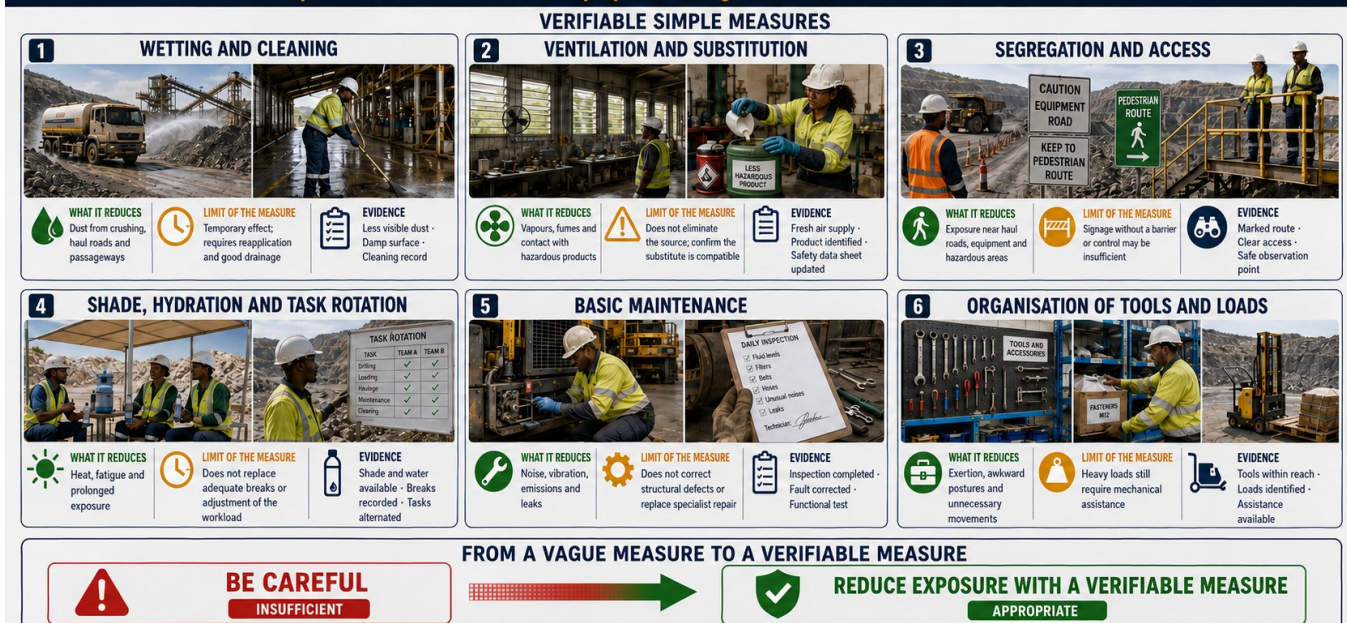
Table 9.10 presents low-cost control measures for different specific risks, indicating what each measure may reduce, its limitations and the evidence needed to verify its implementation.

Table 9.10 — Low-cost measures: operational assessment

Specific risk	Low-cost measure	What it reduces	Limitation of the measure	Evidence
Dust during drilling, loading, cleaning or crushing.	Localised wet suppression, wet cleaning and avoiding dry sweeping.	Dust emission and resuspension.	May be insufficient if the source is intense or ventilation/extraction is absent.	Wetted area, task record and authorised photograph.
Fumes or gases near equipment, a workshop or a combustion area.	Improve air circulation, move non-essential people away and avoid idling engines near the team.	Local accumulation and exposure time.	Does not replace fault repair, measurement or control in a confined space.	Record of the change, ventilated area and identified equipment.
Noise during crushing, drilling, compressor operation or workshop tasks.	Segregate the noisy area, provide warning signs and move non-essential tasks away.	Number of people exposed and time spent in the area.	Does not reduce the noise source and may require technical assessment.	Signs, demarcation and record of time spent in the area.
Heat, solar radiation or humidity during outdoor work.	Short breaks, shade, hydration and a simple adjustment of working hours where possible.	Heat load, fatigue and dehydration.	Not sufficient when there are signs of exhaustion, confusion or persistent cramps.	Available water, shaded area, time and recorded breaks.
Vibration during driving or use of hand tools.	Basic maintenance, seat adjustment, checking tyres/roads and reducing speed on degraded surfaces.	Vibration intensity and associated fatigue.	Does not replace structural repair or replacement of unsuitable equipment.	Checklist, road/equipment record and action completed.
Physical effort, loads and awkward postures.	Organise tools and loads, use a simple mechanical handling aid and improve working height or access.	Applied force, difficult reach and adverse posture.	Does not resolve tasks that remain excessively heavy or inaccessible.	Before/after record of the organisation, changed task and validation by the team.
Hazardous chemical in a workshop, store or treatment area.	Replace it with a less hazardous alternative where technically possible, label it and separate incompatible products.	Hazard level, accidental contact and errors in use.	Requires validation of the alternative and consultation of the safety data sheet.	Identified product, label, safety data sheet and substitution record.
Fatigue, operational stress or poor communication.	Breaks, rotation, brief confirmation of instructions and communication of warning signs.	Errors due to fatigue, time pressure and communication failure.	Does not resolve harassment, serious conflict or chronic overload without appropriate management.	Communication record, shift adjustment or report submitted.

LOW-COST CONTROL MEASURES TO REDUCE EXPOSURE

Simple measures must have a clear purpose, a recognised limitation and verifiable evidence.



 A simple measure is only a control when it has a **purpose**, a **limitation** and **evidence**.

Figure 9.7 — Low-cost control measures to reduce exposure

Simple measures by type of exposure

Low-cost measures should be selected according to their expected effect. For dust, the aim is to reduce emission and resuspension. For chemicals, it is important to prevent contact, improper mixing and disorganised storage. For noise, vibration and heat, the duration, intensity or number of people exposed should be reduced. For ergonomic and psychosocial factors, the improvement should act on task organisation, the effort required, recovery and communication.

Limitation of the measure

A simple measure should not create a false sense of safety. If the risk remains high, if there are warning signs associated with exposure, if the task is critical or if the exposure is unknown, a technical assessment should be requested and the measure should be reviewed. Low cost is an advantage, not an excuse for maintaining a hazardous situation.

Links to actual tasks

At the working face, wet suppression may reduce visible dust, but it should be accompanied by observation of the wind, the time spent in the area and the workers exposed. During crushing, segregation reduces unnecessary presence in noisy areas. During maintenance, tool organisation reduces effort and time spent in an awkward posture. On hot days, breaks, shade and water should be planned before dizziness or cramps occur.

Form 9.7-A enables the learner to select a low-cost measure, state what it reduces, recognise the limitation of the measure and define the evidence.

Specific risk	Low-cost measure	What it reduces	Limitation of the measure	Evidence
Dust during cleaning of a dry floor.	Wet cleaning and organised waste collection.	Dust resuspension.	Does not resolve a continuous dust source.	Authorised record/photo before and after.
Heat during a prolonged inspection.	Break in the shade and water available.	Heat load and fatigue.	Stop if there is dizziness, confusion or cramps.	Time, duration, break and location recorded.
Heavy load during maintenance.	Use a trolley, workbench or simple mechanical handling aid.	Effort and awkward posture.	Does not resolve an excessive load without appropriate assistance.	Change made and validation by the supervisor.

Learning output

Form 9.7-A — Selection of a low-cost measure for a specific risk, indicating what it reduces, the limitation of the measure and the evidence to retain in the portfolio.

Practical decision rule

If the measure does not reduce exposure, it is not a control measure. It should be possible to explain what changes in the task, who is less exposed and what evidence demonstrates the improvement.

9.1.8 Integration of specific risks into the risk matrix

The risk matrix receives the information collected about exposure. This subsection does not explain the 5 × 5 scale again; the matrix is used as a synthesis tool to estimate likelihood and consequence and determine the risk level according to the classification adopted in [Chapter 5 — Fundamentals of Risk Assessment](#). The intervention priority is then defined, taking into account warning signs, uncertainty, the number of people exposed, and the need for immediate control.

When assessing specific risks, attention should not be limited to immediate accidents. Dust, noise, vibration, chemicals, heat, physical effort and psychosocial factors may cause harm through repeated or prolonged exposure. Chronic effects and harm that develop through repeated or prolonged exposure should therefore be considered when assessing the consequences and setting the intervention priority.

Key message

The matrix is useful only if it summarises actual exposure: who is exposed, for how long, how often, at what estimated intensity, what control exists and what warning signs have been observed.

What to consider before determining the risk level and intervention priority

Likelihood should take account of task frequency, exposure duration, the number of people exposed, proximity to the source, variability of conditions and effectiveness of existing controls. Daily, prolonged exposure or exposure involving several people should carry more weight than an isolated, well-controlled situation.

The consequence should take into account the potential severity of harm to health, including chronic effects. The absence of an immediate accident does not mean that the risk is low. Respirable dust, high noise levels, prolonged vibration, intense heat or repeated chemical exposure may justify a high priority even when the harm is not visible at the time.

When measurements, safety data sheets, information on duration or confirmation of control effectiveness are unavailable, the uncertainty should be recorded. The correct response is not to ignore the doubt, but to identify it and define what information is missing.

Table 9.11 illustrates the integration of exposure characterisation into the risk matrix, including existing controls, likelihood, consequence, risk level, intervention priority and information limitations.

Table 9.11 — Integration of specific risks into the matrix

Specific risk	Observed exposure and existing control	Likelihood and consequence	Risk level	Intervention priority	Uncertainty/limitation
Respirable dust / silica	Exposure: Drilling, loading or cleaning with visible dust and time spent close to the source. Control: Partial wet suppression; mask available; limited segregation.	Likelihood: Consider frequency, duration and number of people exposed. Consequence: Consider respiratory disease and chronic harm.	Determine using the adopted matrix.	Determine considering the risk level, warning signs, uncertainty and need for control.	No measurement; variable wind; uncertain control effectiveness.
Noise	Exposure: Crushing, drilling, workshop, compressor or mobile equipment with difficult communication. Control: Hearing protection; partial separation; irregular maintenance.	Likelihood: Consider time spent in the area and repetition during the shift. Consequence: Consider hearing loss, fatigue and communication difficulty.	Determine using the adopted matrix.	Determine considering the risk level, warning signs, uncertainty and need for control.	No dosimetry; intermittent noise; several workers exposed.
Heat / solar radiation	Exposure: Outdoor work, physical effort, little shade or a shift during the hottest part of the day. Control: Water, breaks and partial shade.	Likelihood: Consider duration, effort, humidity, wind and acclimatisation. Consequence: Consider heat exhaustion, cramps, dizziness or confusion.	Determine using the adopted matrix.	Determine considering the risk level, warning signs, uncertainty and need for control.	No heat index; conditions change throughout the day.
Vibration and posture	Exposure: Prolonged driving on an irregular surface or use of a vibrating tool in an awkward posture. Control: Partial maintenance; breaks not systematic.	Likelihood: Consider exposure hours and equipment condition. Consequence: Consider lower-back pain, numbness, loss of strength and chronic disorders.	Determine using the adopted matrix.	Determine considering the risk level, warning signs, uncertainty and need for control.	Actual duration not confirmed; road/equipment condition varies.
Chemical / fumes / gases	Exposure: Maintenance, workshop, refuelling, blasting or an area with a strong odour and poor ventilation. Control: Partial labelling; natural ventilation; gloves where justified.	Likelihood: Consider proximity, ventilation, contact and repetition. Consequence: Consider irritation, poisoning, burns or systemic effects.	Determine using the adopted matrix.	Determine considering the risk level, warning signs, uncertainty and need for control.	Missing SDS; unknown composition; no atmospheric assessment.

How to avoid underestimating invisible risks

Invisible or less immediate risks should be treated carefully. Fine dust, respirable crystalline silica, noise, vibration, gases, solvents, accumulated heat, fatigue and stress may not cause an instantaneous injury, but they may increase the likelihood of error or harm over time.

Warning signs associated with exposure should inform the matrix. Repeated coughing, tinnitus, dizziness, numbness, nausea, persistent pain, extreme fatigue or irritability may indicate that exposure is poorly controlled and that the priority should be reviewed.

Link to the working face

At the working face, the matrix should integrate combined factors: dust generated by drilling or traffic, equipment noise, vibration, heat, physical effort, time pressure and machinery movement. The final priority should reflect the combined exposure and not only the most visible hazard.

Form 9.8-A enables exposure, controls, risk level, intervention priority and uncertainty to be summarised.

Form 9.8-A — Summary of a specific risk for the matrix

Specific risk	Observed exposure and existing control	Likelihood and consequence	Risk level	Intervention priority	Uncertainty/limitation
	Exposure: Control:	Likelihood: Consequence:		Determine considering the risk level, warning signs, uncertainty and need for control.	
	Exposure: Control:	Likelihood: Consequence:		Determine considering the risk level, warning signs, uncertainty and need for control.	
	Exposure: Control:	Likelihood: Consequence:		Determine considering the risk level, warning signs, uncertainty and need for control.	

Learning output

Completed Form 9.8-A for three specific risks observed in a real, simulated or video-based task, including observed exposure, the existing control, risk level, intervention priority and the recorded uncertainty or limitation.

Practical decision rule

If the risk level and intervention priority were defined without considering exposure, duration, frequency, the number of people exposed, the existing control, warning signs and uncertainty, the matrix is incomplete. The transition from exposure characterisation to estimation of likelihood, consequence, risk level and intervention priority is summarised in Figure 9.8.

9.2 Apply — integrative activity

The integrative activity consists of assessing specific risks in a real, simulated or video-based task. The aim is to combine observation of the task, assessment of exposure, warning signs, existing controls and integration into the risk matrix.

To characterise exposure and record chemical agents, dust, biological agents, physical agents, ergonomic risk factors, or psychosocial risks, use the forms in [C.2 — Specific risk assessment forms](#). Finally, complete *Form C.2.6* to integrate the situation into the 5 × 5 matrix.

The learner should select a task or work area, such as drilling, loading, crushing, maintenance, inspection, cleaning, sampling or haulage. A brief specific risk assessment form should then be completed and saved in the digital portfolio.

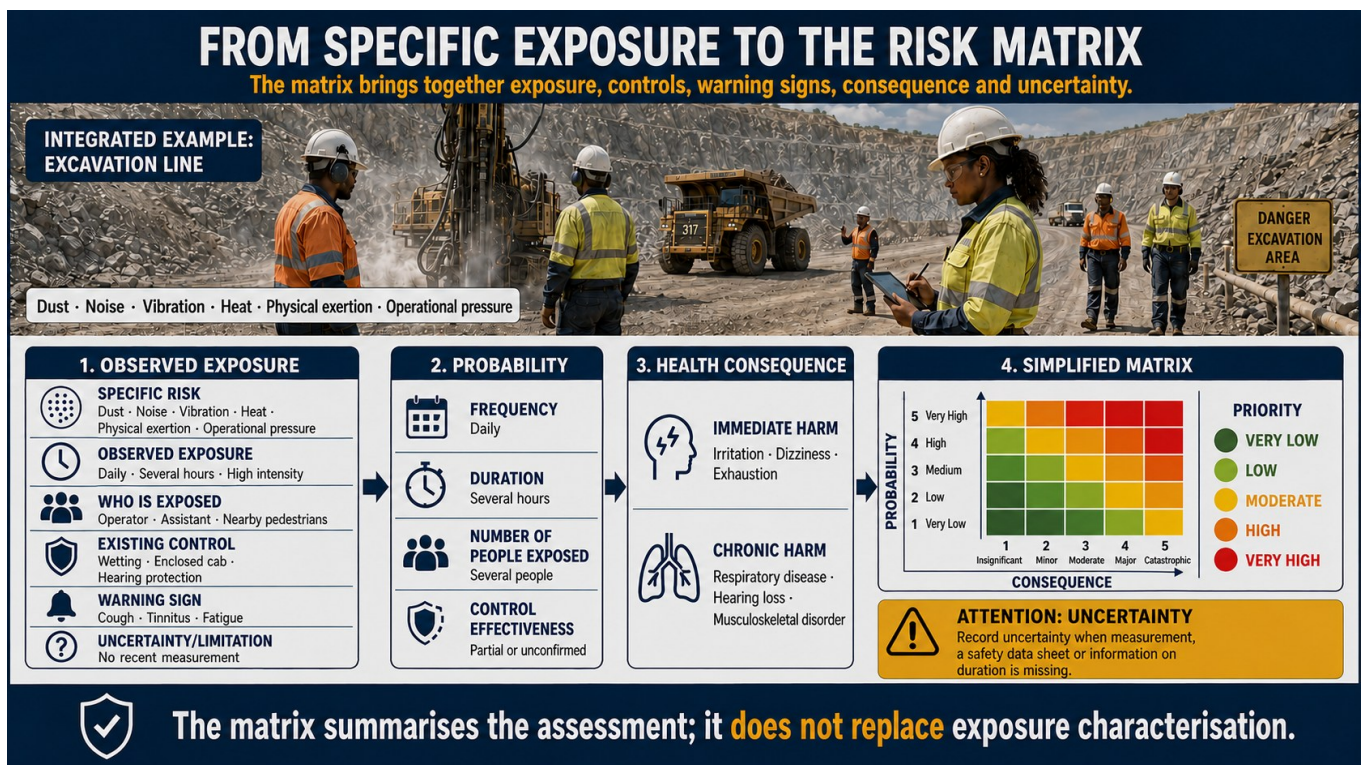


Figure 9.8 — From specific exposure to the risk matrix

Key message

The activity is complete only when the observed task is transformed into a decision: what specific risk exists, who is exposed, how exposure occurs, what sign or evidence exists, what control is already in place and what simple improvement is needed.

How to complete the activity

The activity should use brief, verifiable information. A long report is not required. The important point is to link the task, exposure, warning sign, control and priority.

Table 9.12 describes the nine stages of the integrative activity and identifies the expected output or result for each stage.

Table 9.12 — Integrative activity

Step	What to do	Expected output
1. Select a task or area	Select a real, simulated or video-based task.	Task or area defined.
2. Identify specific risks	Indicate the hazardous agents or risk factors present.	Dust, noise, vibration, heat, chemicals, ergonomics or operational stress.
3. Identify exposed people	Identify who may be exposed during the task.	Operator, assistant, maintenance worker, inspector, driver or nearby team.
4. Characterise exposure	Describe the route, duration, frequency and estimated intensity.	Isolated, repeated or prolonged exposure.
5. Recognise signs	Record warning signs associated with exposure.	Coughing, tinnitus, dizziness, numbness, pain, fatigue or irritability.
6. Check controls	Identify existing controls and their limitations.	Wet suppression, ventilation, segregation, breaks, maintenance or site organisation.
7. Propose an improvement	Indicate a simple and applicable measure.	Low-cost measure that reduces exposure.
8. Integrate into the matrix	Summarise likelihood, consequence, risk level and intervention priority.	Record prepared for the risk matrix.
9. Save in the portfolio	File the completed brief form.	Learning evidence.

Form 9.9-A integrates the brief assessment of specific risks in a task or area.

Form 9.9-A — Brief specific risk assessment

Field	Learner's response
Task or area assessed	
Specific hazardous agents or risk factors	
Workers exposed	
How exposure occurs	Route, duration, frequency and estimated intensity.
Warning signs observed or possible	
Existing controls	
Limitations of existing controls	
Simple measures proposed	
Integration into the risk matrix	Likelihood, consequence, risk level and intervention priority.
Doubts or missing information	
Evidence for the portfolio	
Final summary	

Learning output

Completed *Form 9.9-A* for a real, simulated or video-based task. The form should be brief, objective and saved in the digital portfolio as evidence of application.

Practical decision rule

If the form does not show who is exposed, how exposure occurs, what sign or evidence exists and what simple measure reduces the risk, the assessment is still incomplete.

9.3 Quick self-assessment

The quick self-assessment helps the learner confirm whether they can recognise specific risks, interpret exposure, identify warning signs and transform observation into a simple decision. It does not replace medical assessment, technical measurement or validation by the safety representative.

Answers should be brief. The aim is to verify whether the learner can link the risk to the task, the person exposed, the sign observed, the immediate action and the evidence to record.

Key message

A good answer does not merely list hazards. It should show that the learner understands exposure and can decide whether to continue, continue with additional measures or stop and reassess, while also indicating what should be integrated into the risk matrix.

Table 9.13 brings together the questions used to verify whether the learner understands the relationship between specific risk, exposure, warning signs, preventive measures and integration into the matrix.

Table 9.13 — Short self-assessment questions

No.	Question
1	What distinguishes a specific risk from a general hazard?
2	Why is exposure central to specific risk assessment?
3	What tasks may generate respirable dust?
4	What warning signs may be associated with relevant noise exposure?
5	Why can heat be a critical risk?
6	What examples of ergonomic risk factors exist in maintenance?
7	How can operational stress affect safety?
8	Why should chronic effects be considered in the assessment?
9	What role do occupational exposure limits play?
10	How can a specific risk be integrated into the matrix without repeating the entire assessment?

Decision cases

The following cases should be resolved with a brief decision. For each case, the learner should indicate whether the task may continue, may continue with additional measures or should stop and be reassessed (Table 9.14).

Table 9.14 — Decision cases for self-assessment

Case	Learner's decision	Brief justification	Expected evidence
Visible dust during crushing			
Worker exposed to high noise levels			
Operator showing signs of heat strain			

Case	Learner's decision	Brief justification	Expected evidence
Maintenance task involving an awkward posture			
Repetitive work involving vibration			
Team under pressure to complete the task			
Chemical product without clear information			

How to review the self-assessment

The answer should be considered sufficient when it identifies the specific risk, the likely exposure, the available sign or evidence, the immediate action and the information that should be recorded. Answers such as “be careful”, “use PPE” or “warn someone” are insufficient if they do not indicate what changes in the task.

Form 9.10-A records the main difficulties and decisions arising from the self-assessment.

Form 9.10-A — Quick self-assessment

Field	Learner's response
Question that was most difficult	
Specific risk that needs to be reviewed	
Most critical decision case	
Warning sign requiring immediate communication	
Aspect to improve in the assessment form	

Practical decision rule

If the learner cannot link the observed sign, possible risk, exposure, immediate action and evidence, they should review the relevant technical section before completing the Chapter 9 form.

9.4 Practical summary

Specific risk assessment is useful only when it supports a decision. The learner should complete this chapter able to recognise hazardous agents and risk factors, characterise exposure, identify warning signs, propose simple measures and record the essential information for the matrix and the digital portfolio.

This summary does not replace technical measurements, medical assessment or formal procedures when these are required. It supports an initial operational assessment and a clear preventive decision.

Key message

A specific risk is not simply “there is a hazard”. Exposure, the people involved, warning signs, existing controls and the limitations of the available information must be understood.

Table 9.15 summarises the essential principles of the chapter and indicates how each should be applied in specific risk assessment.

Table 9.15 — Key points to remember

Key point	Practical application
Specific risks depend on exposure.	The presence of a hazard is not sufficient; frequency, duration, intensity and the people exposed must be considered.
Dust, noise, vibration, heat and chemicals may cause harm without an immediate accident.	Consider chronic effects even when there is no visible injury at the time.
Occupational exposure limits are technical references.	Understand that they guide prevention; memorising numbers is not required in this chapter.
Warning signs associated with exposure require a response.	Continue with additional measures or stop and reassess the task when relevant signs are present.
Ergonomic risk factors are cumulative.	Link posture, effort, repetition and duration to a possible improvement in the task.

Key point	Practical application
Psychosocial risks affect safety.	Stress, fatigue, pressure and poor communication increase errors and reduce attention.
Simple measures may reduce exposure.	Apply low-cost measures while recognising their limitations.
The matrix should receive exposure information.	Consider frequency, duration, intensity, the existing control and the consequence for health.
The brief assessment does not replace technical measurement.	Record uncertainty when data, measurements or reliable information are missing.
The final output should support the decision.	The form should be brief, clear and useful for prevention, communication and review.

Expected final output for Chapter 9

The final output is *Form 9.11-A* — Specific Risk Assessment, integrated into the digital portfolio. It should bring together exposure, warning signs, controls, uncertainty, risk level, intervention priority and the operational decision.

Form 9.11-A is the final output for the chapter and brings together the brief specific risk assessment.

Form 9.11-A — Final output for Chapter 9

Field	Expected record
Task or area analysed	Drilling, crushing, maintenance, inspection, cleaning, sampling, loading, haulage or another defined task.
Specific risks identified	Dust, chemicals, noise, vibration, heat, ergonomics, psychosocial factors or other applicable risks.
Likely exposure	Route, duration, frequency, approximate intensity and number of people exposed.
Warning signs	Signs observed or reported that may indicate relevant exposure or control failure.
Existing controls	Measures already in place and their limitations.
Simple measures proposed	Low-cost or immediate actions that reduce exposure.
Integration into the matrix	Likelihood, consequence, risk level, intervention priority and uncertainty, without repeating the 5 × 5 scale.
Evidence for the portfolio	Completed form, authorised photograph, observation note, video record or brief summary.

Practical decision rule

If the form does not answer three questions — who is exposed, to what, and what simple measure reduces the exposure — the assessment is not yet sufficiently clear.

STRIM E-book Annexes



SAFETY TRAINING WITH
REAL IMMERSIVITY FOR MINING



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SUPPORTING
DOCUMENTS



PRACTICAL
TOOLS



SAFETY
FIRST



BEHAVIOURS AND
COMPETENCIES



CONTINUOUS
IMPROVEMENT

Reusable tools, checklists and quick guides

Editorial note

Principle of use

The following annexes bring together reusable tools for applying the contents of the E-book: cross-cutting forms, checklists, technical visit forms, specific risk assessment forms and portfolio tools. The theoretical explanations, examples, integrative activities and self-assessments are provided in the corresponding chapters. These tools support learning and record-keeping, but do not replace formal risk assessment, the organisation's procedures, competent supervision or applicable legal requirements.

Contents of the annexes

Block	Contents	Structure
Annex A	Cross-cutting application forms	A.1 to A.6
Annex B	Operational checklists	B.1 to B.7
Annex C	Technical visits and specific risks	C.1 and C.2
Annex D	Portfolio and learning evidence	D.1 and D.2
Supplementary resources	Technical manual, case bank, questionnaires and digital resources	Final page



SAFETY TRAINING WITH
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ANNEX A — CROSS-CUTTING APPLICATION FORMS

Purpose

To provide single, reusable forms for reporting occurrences, characterising exposure, preparing tasks, assessing risks, prioritising actions and defining operational controls.

A.1 — Reporting and analysis of a hazard or occurrence

above above Chapter 1 3.1.5

Use this form to record an observed situation, a hazard, an incident, a near miss or an accident and to substantiate the preventive decision.

Field	Record / response
Observed situation	
Location / process / task	
Type of occurrence	Observed hazard / hazardous condition / unsafe act / incident / near miss / accident
What happened or could have happened?	
Main hazard	
Likely triggering event	
Main risk	
People exposed	
Potential or actual consequence	
Existing controls and their adequacy	
Immediate action taken	
Priority preventive measure	
Additional measure	
Person or role to be informed	
Final decision	Continue / continue with additional measures / stop and reassess
Evidence to retain	Authorised photograph / checklist / communication / record / form / other
Main learning point	

Note on use

The report should be objective and based on observable facts. Where harm has occurred or support is required, the organisation's emergency and reporting procedures should be applied.

A.2 — Occupational exposure analysis

Use this form to provide an initial characterisation of a task involving exposure to chemical agents, dust, noise, vibration, biological agents or other occupational hygiene factors.

Field	Record / response
Task analysed	
Agent or factor	Chemical / dust / noise / vibration / biological / other physical agent
Source of the agent or factor	
Route of exposure or transmission	Inhalation / dermal contact / accidental ingestion / noise exposure / hand-arm vibration / whole-body vibration / contact / inoculation / other
People exposed	
Duration	Short / prolonged / unknown
Frequency	Occasional / repeated / frequent / unknown
Intensity or apparent level	Low / moderate / high / unknown; state the available evidence
Potential consequence	
Source-based technical controls	
Organisational controls	
Complementary PPE	
Verification or monitoring required	SDS / measurement / inspection / maintenance / vaccination / other
Missing information or uncertainty	
Priority measure	
Evidence to retain	

Note on use

This form supports an initial characterisation. It does not replace measurements, specialist assessment, health surveillance or application of legally established exposure limits.

A.3 — Safe preparation of a technical task

4.2

Complete before carrying out an operation, cleaning, maintenance, repair or work-at-height task, or before using a tool.

Field	Record / response
Technical task	
Location	
Equipment / facility / tool	
Critical condition observed	
Energy sources or technical hazards	Electrical / mechanical / hydraulic / pneumatic / thermal / gravitational / chemical / other
People exposed	
Required prior control	
Existing controls and observed effectiveness	
Are isolation, lockout and tagout required?	Yes / no; justify
Work at height?	Yes / no; state the required control
Are the tool and access suitable?	Yes / no; state any non-conformities
Required PPE	
Current fitness for work and fatigue	Fit / requires adjustment, a break or replacement by another worker / insufficient information
Final decision	Continue / continue with additional measures / stop and reassess
Evidence to retain	

A.4 — Initial risk assessment

5.2

Use this form to structure an initial semi-quantitative assessment using a 5 × 5 matrix and to justify the decision taken.

Field	Record / response
Observed situation	
Location / process / task	
Hazard	
Triggering event	
Exposure	Who, how frequently, for how long and under what conditions?
Vulnerability	
Risk	
Potential consequence	
Likelihood — 1 to 5	Score and justification
Severity — 1 to 5	Score and justification
Risk level	Likelihood × severity
Qualitative classification	Low / moderate / significant / high / critical
Existing controls and observed effectiveness	
Initial control measure	
Decision	Continue / continue with additional measures / stop and reassess
Uncertainties or limitations	
Evidence to retain	

Note on use

The scales, classification ranges and decision rules should be consistent with those adopted in **Chapter 5**.

A.5 — Hazard identification, prioritisation and corrective action

6.2 7.2

Use this form to transform an observation into a specific, assigned, time-bound and verifiable action.

Field	Record / response
Observed situation	
Method used	Observation / checklist / structured brainstorming session / 5 Whys / database / other
Observed fact or non-conformity	
Hazard identified	
Evidence supporting the identification	
Associated risk	
People exposed	
Priority	High/medium / low; justify
Likely cause supported by evidence, where applicable	
Specific action	
Person responsible for implementation	
Deadline	
Effectiveness criterion	What should change for the action to be considered effective?
Evidence of implementation	
Outcome of the effectiveness verification	
Residual risk	
Action status	Open / in progress / implemented / verified / requires review

Note on use

The action should be specific, measurable, achievable, relevant and time-bound. The responsible person is recorded in a separate field.

A.6 — Operational control and communication

7.2

Use this form to transform a prioritised risk into an operational control measure, an assigned responsibility and a clear message for the team.

Field	Record / response
Prioritised risk	
Priority	High / medium / low
People exposed	
Control selected	Elimination / substitution / engineering control or collective protection / administrative control / complementary PPE
Justification using the hierarchy of controls	
Engineering control or collective protection	
Administrative control	
Complementary PPE	
Procedure required?	Yes / no; specify
Permit-to-work required?	Yes / no; specify
Responsible person	
Deadline	
Message to communicate to the team	
Condition for stopping the task	
Evidence of implementation	
Verification of effectiveness	
Residual risk	
Review date or condition	

ANNEX B — OPERATIONAL CHECKLISTS

How to use

The checklists should support observation, comparison with the expected condition, decision-making and record-keeping. A completed checklist does not, by itself, demonstrate that the situation is safe.

B.1 — General checklist

Apply before any field observation, image, video, technical visit or task.

No.	Item to check	Status	Observation or evidence
1	Task, location, stage and equipment identified.	Yes / No / N/A	Record the context and purpose of the observation.
2	Actual conditions compared with the plan or procedure.	Yes / No / N/A	Record differences that may alter the risk.
3	Changes since the previous observation or shift checked.	Yes / No / N/A	Consider rain, mud, dust, traffic, maintenance, failures or changes at the working face.
4	People exposed identified.	Yes / No / N/A	Consider operators, pedestrians, maintenance personnel, supervisors, visitors, third parties and the community.
5	Existing controls active and adequate.	Yes / No / N/A	Confirm barriers, guards, segregation, ventilation, road wetting, signs and other controls.
6	Communication functional.	Yes / No / N/A	Confirm radio, signals, responsible person and stopping criterion.
7	Uncertainties and missing information recorded.	Yes / No / N/A	Do not assume that risk is low when data are missing.
8	Evidence recorded.	Yes / No / N/A	Authorised photograph, form, communication, inspection record or summary.

Final decision

Continue / continue with additional measures / stop and reassess

B.2 — Working face and bench

Use before moving, parking, drilling, loading, observing or remaining near working faces and benches.

No.	Item to check	Status	Observation or evidence
1	Working face and bench inspected.	Yes / No / N/A	Check for cracks, loose blocks, overhanging material, recent rockfall and adequate scaling.
2	Crest and berm in suitable condition.	Yes / No / N/A	Check continuity, deterioration, cracks and the proximity of equipment.
3	Toe of the slope free from unauthorised presence.	Yes / No / N/A	Keep people and vehicles out of the rockfall zone.
4	Working platform stable.	Yes / No / N/A	Confirm width, level, mud, water, ruts and bearing capacity.
5	Exclusion zone defined and visible.	Yes / No / N/A	Confirm demarcation, communication and access control.
6	Equipment positioned at a safe distance.	Yes / No / N/A	Apply internal procedures and consider the actual ground conditions.
7	Visibility and communication adequate.	Yes / No / N/A	Dust, noise or lighting must not prevent hazards from being perceived.
8	Simultaneous activities coordinated.	Yes / No / N/A	Consider drilling, loading, traffic, maintenance and blasting.
9	Stopping criterion known.	Yes / No / N/A	Stop if there is uncertainty about stability, distance, access or authorisation.

Final decision

Continue / continue with additional measures / stop and reassess

B.3 — Roads, ramps and traffic

Use on internal roads, ramps, junctions, bends, holding areas and interfaces with pedestrians or light vehicles.

No.	Item to check	Status	Observation or evidence
1	Road and ramp inspected.	Yes / No / N/A	Confirm surface condition, width, gradient, bends, junctions and drainage.
2	Surface free from excessive mud, deep ruts or uncontrolled water.	Yes / No / N/A	Record conditions that may cause loss of traction or overturning.
3	Berms and edges checked.	Yes / No / N/A	Confirm continuity, height and strength near changes in level.
4	Visibility sufficient.	Yes / No / N/A	Consider dust, fog, lighting, bends and obstacles.
5	Speed adjusted to actual conditions.	Yes / No / N/A	Reduce speed on gradients, in rain or dust, and at junctions and loading areas.
6	Directions of travel and priorities defined.	Yes / No / N/A	Confirm signs, holding areas and crossing rules.
7	Pedestrians segregated.	Yes / No / N/A	Use authorised routes and prevent entry into manoeuvring areas.
8	Fallen material and spills controlled.	Yes / No / N/A	Remove obstacles and communicate changes.
9	Road changes communicated and recorded.	Yes / No / N/A	Record closure, restriction, repair and authorisation to resume operations.

Final decision

Continue / continue with additional measures / stop and reassess

B.4 — Loading, haulage and mobile equipment

Use at the interface between the working face, loading equipment, mining haul trucks, light vehicles and pedestrians.

No.	Item to check	Status	Observation or evidence
1	Loading area demarcated.	Yes / No / N/A	Confirm access routes, holding area, exclusion zone and responsible person.
2	Working face or stockpile checked.	Yes / No / N/A	Observe instability, oversize blocks and falling material.
3	Equipment operating radius clear.	Yes / No / N/A	Keep people and vehicles clear of the boom, bucket, dump body and slewing area.
4	Blind spots controlled.	Yes / No / N/A	Use segregation, radio, cameras, signals and a safe waiting position.
5	Loading area surface stable.	Yes / No / N/A	Check gradient, mud, water, ruts and obstacles.
6	Approach, loading and departure sequence defined.	Yes / No / N/A	The vehicle should move forward only when authorised by the responsible operator.
7	Load stable and within limits.	Yes / No / N/A	Avoid overloading, uneven distribution and protruding material.
8	Speed and safe distance adequate.	Yes / No / N/A	Adjust to ground, visibility, mass and traffic.
9	Communication between operators confirmed.	Yes / No / N/A	Stop if communication is lost or there is any doubt.
10	Pre-use inspection completed and defects recorded.	Yes / No / N/A	Confirm brakes, steering, tyres, alarms, lighting and leaks.

Final decision

Continue / continue with additional measures / stop and reassess

B.5 — Crushing, screening and conveyor belts

Use in processing plants, hoppers, transfer points, platforms, cleaning operations and maintenance interventions.

No.	Item to check	Status	Observation or evidence
1	Guards and protective devices installed.	Yes / No / N/A	Prevent access to moving parts, rollers, drives and entanglement points.
2	Emergency stop devices accessible.	Yes / No / N/A	Confirm identification, access and apparent condition.
3	Accumulated material and spills controlled.	Yes / No / N/A	Do not approach moving equipment for cleaning or clearing blockages.
4	Access routes, platforms and guardrails in suitable condition.	Yes / No / N/A	Confirm surface condition, stairs, lighting and fall protection.
5	Dust controlled at source.	Yes / No / N/A	Check dust extraction, enclosure, wetting and cleaning.
6	Noise and communication considered.	Yes / No / N/A	Ensure suitable protection and means of communication.
7	Interventions subject to isolation and lockout.	Yes / No / N/A	Confirm a zero-energy state before entering the danger zone.
8	Falling and projected material controlled.	Yes / No / N/A	Demarcate discharge points, hoppers and lower areas.
9	Signs and exclusion zones respected.	Yes / No / N/A	Control access during operation and maintenance.
10	Restart after intervention verified.	Yes / No / N/A	Confirm guards have been replaced, tools removed and authorisation granted.

Final decision

Continue / continue with additional measures / stop and reassess

B.6 — Underground operations

Use in drifts, working faces, ramps, stopes, loading areas, workshops and other underground areas.

No.	Item to check	Status	Observation or evidence
1	Ventilation operating and adequate.	Yes / No / N/A	Confirm airflow, obstructions, gases, dust and local instructions.
2	Atmospheric conditions checked where applicable.	Yes / No / N/A	Do not enter or remain if there is an alarm, uncertainty or a required measurement is unavailable.
3	Ground stability and support inspected.	Yes / No / N/A	Check loose blocks, deformation, water and damage to support.
4	Lighting sufficient.	Yes / No / N/A	Ensure fixed, equipment-mounted and personal lighting where required.
5	Traffic routes and refuge bays identified.	Yes / No / N/A	Confirm priority, segregation, blind spots and places of refuge.
6	Communication functional.	Yes / No / N/A	Confirm radio, coverage, signals and contact with supervision.
7	Evacuation routes and emergency arrangements known.	Yes / No / N/A	Identify exits, refuge bays, emergency equipment and the assembly point.
8	Equipment and hazardous energy controlled.	Yes / No / N/A	Apply prior inspection, lockout and authorisation where necessary.
9	Withdrawal criterion known.	Yes / No / N/A	Withdraw and report any change in atmosphere, stability, ventilation or communication.

Final decision

Continue / continue with additional measures / stop and reassess

B.7 — Legacy areas, mine closure and community interface

Use in abandoned areas, areas undergoing rehabilitation, waste dumps, peripheral access routes and locations close to communities.

No.	Item to check	Status	Observation or evidence
1	Unauthorised access controlled.	Yes / No / N/A	Check barriers, signs, fencing and informal access paths.
2	Excavations, shafts and changes in level protected.	Yes / No / N/A	Confirm covering, guarding, restriction or elimination of access.
3	Stability of slopes, stockpiles and structures inspected.	Yes / No / N/A	Record erosion, cracks, subsidence and falling material.
4	Water and drainage controlled.	Yes / No / N/A	Observe accumulation, contamination, erosion and discharge off site.
5	Waste and hazardous materials identified.	Yes / No / N/A	Confirm containment, segregation, labelling and destination.
6	Dust, noise and traffic with potential off-site impact considered.	Yes / No / N/A	Observe the proximity of homes, schools, roads and local activities.
7	Communication with stakeholders defined.	Yes / No / N/A	Refer complaints, observations and urgent situations through the appropriate channel.
8	Rehabilitation measures preserved.	Yes / No / N/A	Avoid damage to vegetation, drainage, covers and restored areas.
9	Need for access restriction or specialist assessment recorded.	Yes / No / N/A	Stop if there are voids, instability, contamination or unsafe access.

Final decision

Continue / continue with additional measures / stop and reassess

ANNEX C — TECHNICAL VISITS AND SPECIFIC RISKS

Structure

C.1 provides the minimum set of tools for planning, carrying out and documenting a technical visit. C.2 provides forms for characterising specific exposures without making a medical diagnosis.

C.1 — Technical visit tools

Chapter 8

C.1.1 — Visit planning

Complete before entering the site.

Field	Record / response
Site or location	
Site representative and contact details	
Purpose of the visit	
Authorisation confirmed	Yes / no
Date and time	
Meeting point	
Authorised route	
Observation points	
Restricted-access or prohibited areas	
Known restrictions	
Mandatory PPE	
Collective protective measures along the route	
Photography and confidentiality rules	
Questions for the site representative	
Expected evidence	

C.1.2 — Site safety induction

Confirm before the visit begins.

No.	Item to check	Status	Observation or evidence
1	Site representative identified.	Yes / No / N/A	Name and contact method.
2	Authorised route explained.	Yes / No / N/A	Observation points and limits.
3	Prohibited areas indicated.	Yes / No / N/A	Barriers, signs and safe distances.
4	Site movement rules explained.	Yes / No / N/A	Group movement, crossings, mobile equipment and blind spots.
5	Mandatory PPE confirmed.	Yes / No / N/A	Condition, fit and use.
6	Photography and confidentiality rules explained.	Yes / No / N/A	What may be recorded and disclosed.
7	Emergency procedure explained.	Yes / No / N/A	Alarm, evacuation and assistance.
8	Emergency assembly point indicated.	Yes / No / N/A	Location and means of regrouping.
9	Questions answered.	Yes / No / N/A	Record limitations or missing information.
10	Participation or acknowledgement of the rules recorded.	Yes / No / N/A	In accordance with the site procedure.

Final decision

Continue / continue with additional measures / stop and reassess

C.1.3 — Quick conduct card for the visit

The visitor should follow the site representative, remain on the authorised route and respect barriers, signs and safe distances.

I may	I must not
Move along the authorised route.	Move away from the group or change the route without authorisation.
Take photographs only when authorised.	Photograph people, equipment or sensitive information without authorisation.
Ask questions at the indicated time.	Interrupt operators during a critical task.
Observe from a safe area.	Enter a prohibited area or a restricted-access area without authorisation.
Record facts, good practices and questions.	Touch equipment, controls, samples, products or tools.
Respect barriers and instructions.	Cross roads or approach mobile equipment without authorisation.
Report discomfort or an unsafe condition.	Ignore warning signs or continue alone.
Retain only authorised evidence.	Disclose information without validation.

C.1.4 — Technical visit observation

Complete during the visit, when authorised, or immediately after leaving the operational area.

Field	Record / response
Area, process or task observed	
Date and time	
Observed fact	
Good practice identified	
Non-conformity, question or condition requiring further investigation	
People potentially exposed	
Existing control	
Limitation of the observation	Distance / time / noise / dust / visibility / insufficient information / other
Information to confirm with the site representative	
Decision during the visit	Continue observation / change route / move away / stop and communicate
Authorised evidence	
Main learning point	

C.1.5 — Short post-visit report template

The report should be concise, factual and proportionate to the purpose of the visit.

Section	Content to include
1. Visit details	Location, date, group, site representative and route followed.
2. Purpose	Educational and technical purpose of the visit.
3. Areas and processes observed	Summary of the route and observation points.
4. Good practices	Observed practices that contribute to prevention.
5. Matters requiring further investigation	Questions, limitations or conditions requiring additional information.
6. Learning recommendations	Measures or topics for further study, without replacing the organisation's decision.
7. Authorised evidence	Photographs, notes or documents whose use was authorised.
8. Final summary	Main learning points and links to the chapters of the E-book.

C.2 — Specific risk assessment forms

9.2

Warning

Observed or reported signs do not constitute a medical diagnosis. Where relevant signs are present, the situation should be reported and assessed by a competent person.

C.2.1 — Chemical agents and dust

Use when the task may involve mineral dust, respirable crystalline silica, fumes, gases, fuels, lubricants, reagents or other hazardous substances.

Field	Record / response
Task or area	
Chemical agent or dust	Inhalable dust / respirable dust / silica / fumes / gas / chemical product / other
Likely source	
Route of exposure	Inhalation / dermal contact / accidental ingestion / eye contact
People exposed	
Duration and frequency	
Apparent or unknown intensity	State the evidence; odour does not demonstrate safety or measure exposure.
Existing control	
Warning sign observed or reported	
Simple measure proposed	
Need for measurement or specialist assessment	
Evidence to retain	

C.2.2 — Biological agents

Use where there is stagnant water, organic waste, animals, vectors, fungi, contaminated materials, sanitary facilities or contact with biological agents.

Field	Record / response
Task or area	
Likely agent or source	Water / waste / animal / vector / fungi / biological material / other
Route of transmission	Inhalation / contact / ingestion / inoculation / bite or sting / other
People exposed	
Duration and frequency	
Contributing conditions	Humidity / stagnant water / waste / ventilation / cleaning / presence of animals / other
Signs or indications observed	Without making a diagnosis
Existing controls	Cleaning / drainage / containment / vaccination / hygiene / vector control / PPE / other
Limitation of the control	
Preventive measure proposed	
Need for specialist assessment or medical support	
Evidence to retain	

C.2.3 — Physical agents

Use for noise, vibration, solar radiation, heat, cold, lighting and other physical factors.

Field	Record / response
Task or area	
Main physical agent	Noise / hand-arm vibration / whole-body vibration / solar/UV radiation / heat / cold / lighting / other
Source or situation	
People exposed	
Duration and frequency	
Indication or warning sign	Difficulty communicating, tinnitus, numbness, dizziness, cramps, fatigue or other
Existing control	Distance / barrier / maintenance / cab / shade / hydration / breaks / rotation / other
Limitation of the control	
Simple action proposed	
Need for measurement or specialist assessment	
Evidence to retain	

C.2.4 — Ergonomic risk factors

Use when the task involves awkward posture, exertion, repetition, manual handling of loads, difficult access or prolonged work.

Field	Record / response
Task or area	
Posture or exertion observed	Flexion / twisting / raised arm / squatting / force / load / repetition / other
Body area potentially affected	Lower back / neck / shoulder / wrist / knee / leg / whole body
Load, force or frequency	
Duration	
Aggravating factors	Access / space / vibration / pace / grip / height / temperature / other
Signs or difficulties reported	Without making a diagnosis
Existing control	Mechanical handling aid / adjustment / rotation / break / training / other
Possible improvement	
Need for specialist ergonomic assessment	
Evidence to retain	

C.2.5 — Psychosocial risks

Use to analyse demands arising from the task and the organisation of work, without clinically assessing the person.

Field	Record / response
Task or context	
Main factor	Time pressure / workload / fatigue / isolation / conflict / harassment / poor communication / other
Observable or reported situation	
People or team exposed	
Duration and frequency	
Potential consequence for the task and safety	
Warning signs	Extreme fatigue / anxiety / isolation / irritability / difficulty concentrating / other
Existing resources and support	Supervision / breaks / team / communication channels / specialist support / other
Limitation of the controls	
Organisational measure proposed	
Need for referral or specialist support	
Evidence to retain, respecting confidentiality	

C.2.6 — Summary and integration into the 5 × 5 matrix

Use after completing one of Forms C.2.1 to C.2.5.

Field	Record / response
Task or area	
Hazardous agent or risk factor	
Exposure characterised	Route / duration / frequency / intensity / people exposed
Existing controls and observed effectiveness	
Warning signs or evidence	
Likelihood — 1 to 5	Justify
Severity — 1 to 5	Justify
Risk level	Likelihood × severity
Qualitative classification	Low / moderate / significant / high / critical
Uncertainty	Low / moderate / high; justify
Decision	Continue / continue with additional measures / stop and reassess
Priority measure	
Need for specialist assessment	
Evidence to retain	

ANNEX D — PORTFOLIO AND LEARNING EVIDENCE

3.2 3.3

Purpose

To bring together in a single form the observed situation, preventive analysis, decision, evidence and reflection that can be transferred to other operations.

D.1 — Forms

D.1.1 — Integrated portfolio form: situation and analysis

Page 1 — Identify and analyse a real or simulated situation.

Field	Record / response
Title of the situation	
Source of the observation	Field / image / video / case
Date or time	
Location / sector / critical area	
Process stage	
Equipment or facility	
People exposed	
Changed condition or warning sign	
Hazard	
Triggering event	
Risk and consequence	
Existing controls	
Priority measure	
Decision	Continue / continue with additional measures / stop and reassess
Uncertainties or missing information	

D.1.2 — Integrated portfolio form: evidence and reflection

Page 2 — Record what was communicated, implemented, verified and learned.

Field	Record / response
Evidence collected	
Authorisation to use the evidence	Yes / no / not applicable
Information communicated to the team or supervision	
Action implemented or proposed	
Responsible person and deadline	
Outcome observed	
Verification of effectiveness	
Residual risk	
Main learning point	
Application to another mining situation	
Limitations of the analysis	
Aspects requiring specialist confirmation	

D.2 — Minimum portfolio quality criteria

Criterion	Adequate when...	Adequate / needs improvement
Situation identified	The context, task and critical area are clear.	
Observable evidence	The analysis uses facts, records or verifiable signs.	
Hazard and risk distinguished	The source or condition is not confused with the occurrence or consequence.	
Decision justified	The decision to continue, continue with additional measures, or stop and reassess follows from the evidence.	
Specific measure	The action states what should be done, who should act and how it will be verified.	
Limitations recognised	The form records missing information and the need for support.	
Transferable learning	The reflection shows how the knowledge can be applied in another context.	