2. Risk management: the three step process

The OSH Regulations contain a specific requirement for employers to undertake a risk management process.

See regulation 3.1 of the OSH Regulations.

This involves a three-step process to:

- identify hazards;
- assess risks of injury or harm arising from each identified hazard; and
- control risks through implementation of control measures to eliminate or reduce them.

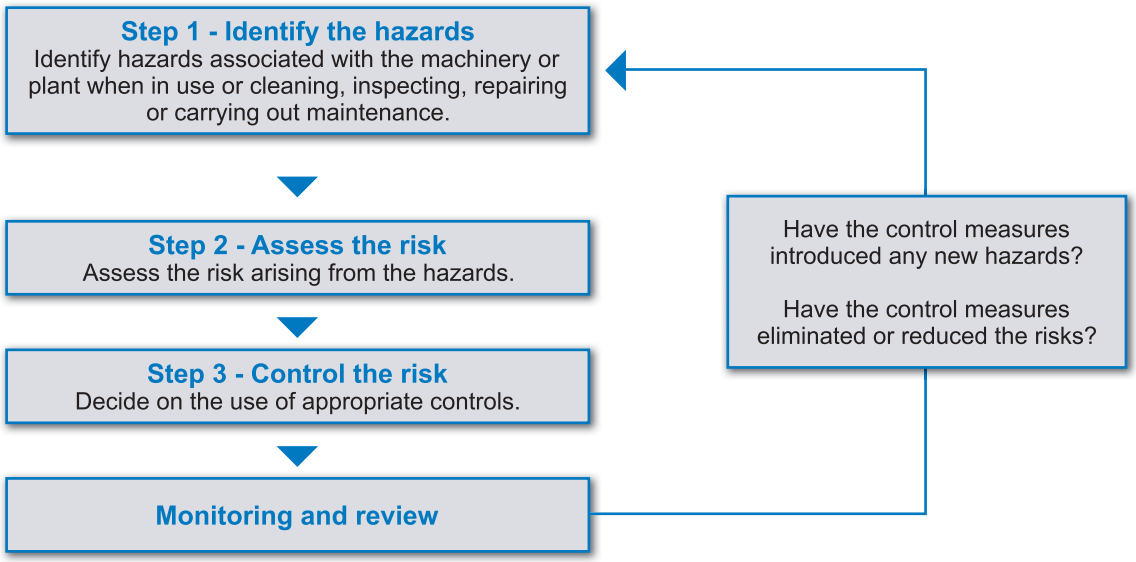

Illustration 1. Risk management steps.

For workplaces covered by the MSI Act, the risk management process should be undertaken to ensure employers comply with their 'duty of care' obligations to provide a safe workplace.

See Section 9 of the MSI Act.

The risk management process should be conducted and monitored on an ongoing basis to ensure control measures are working and no new hazards have been introduced. For example, conducting it when new machinery or plant is introduced, modifications are made to existing plant or machinery or changes are made to systems of work.

Workers and, where they exist, safety and health representatives must be consulted on safety and health matters. Their involvement in the risk management process is important, as they are most likely to know about the risks associated with their work.

See Sections 19(1)(c), 23D, 23E and 23F of the OSH Act and Section 9(1)(c) of the MSI Act.

See also the Commission's guide, *Plant in the Workplace: Making it safe: A guide for employers, self-employed persons and employees* and WorkSafe's *Machinery and equipment safety: An introduction.*

2.1 Step 1: Hazard identification

The first step in the risk management process is identifying hazards. This involves identifying anything that may cause injury or harm to the health of a person.

Identify all machinery and plant used

Start by identifying all items of machinery and plant used at the workplace. An inspection should be carried out looking for any of these items. Include common items that may not normally be thought of as 'machines' or 'plant'.

Identify the hazards

Once all machinery and plant have been identified, the hazards associated with them can be identified.

Three broad sources of hazards

There are three broad sources of hazards relevant to machinery and plant. They are:

- hazards related to the machinery or plant, materials or items being processed or internal sources of energy, for example:
  - drawing in or trapping hazards;
  - entanglement hazards;
  - shearing hazards;
  - cutting hazards;
  - impact hazards;
  - crushing hazards;
  - stabbing and puncturing hazards;
  - friction and abrasion hazards;
  - hot or cold hazards;
  - ejection hazards;
  - other contact hazards;
  - noise hazards; and
  - release of hazardous substances;
- hazards related to the location of the machine or plant, for example:
  - its stability, for instance, whether it could roll or fall over;
  - the environment in which it operates; and
  - its proximity to other structures; and
- hazards related to systems of work associated with the machine or plant, for example manual handling injuries caused when putting materials into them. See Appendix 6.

Critically inspect each piece of machinery and plant and the way it is operated to identify any parts, processes, operating procedures or workplace activities and any related danger zones, such as moving parts of machinery and plant, that may cause harm.

One process to identify hazards is shown in the following diagram.

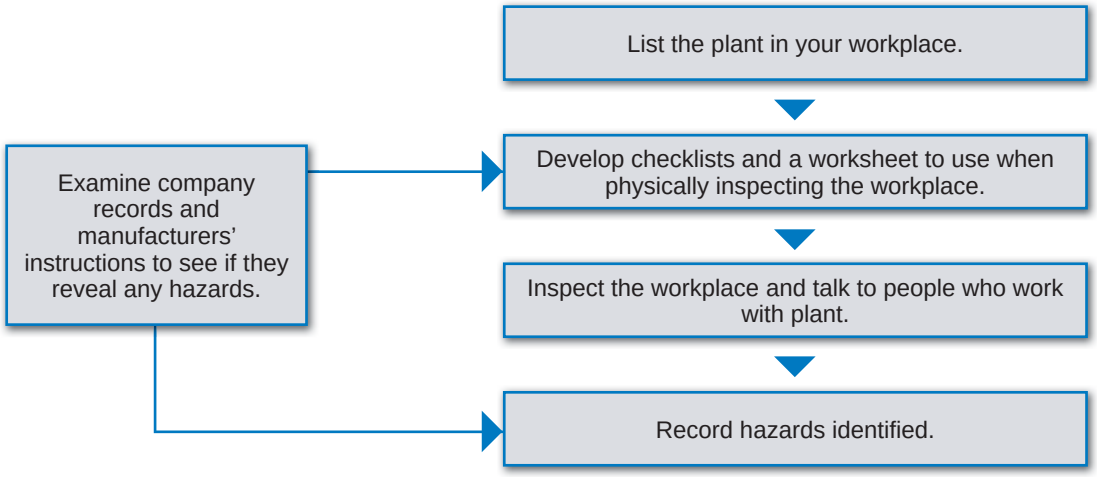

Illustration 2. A process to identify hazards.

Common injuries associated with machines are crushing, cutting, shearing, puncturing, abrasion, burns, tearing, stretching or a combination of two or more of these. Other common injuries include electric shock, hearing loss and ill health from the release of hazardous substances or lack of oxygen.

Common situations resulting in injury or harm to people include:

- coming into contact or entanglement with parts of a machine or plant, for example a worker being drawn into a machine or item of plant or being drawn into a position where they might sustain further injury;
- being caught between a moving section of machine or plant and the material being used to manufacture a product;
- coming into contact or entanglement with material being used in the machine or plant to manufacture a product;
- being caught between a machine, plant, machine part or plant part and a fixed structure such as a wall, column or fixed machine;
- being struck by parts of the machine or plant during its failure or break-up;
- being struck by material ejected from the machine or item of plant; and
- being struck as a result of a release of potential energy in machine components or materials being processed.

Useful guidance on the principles of machinery and equipment safety and risk control can be found in the Worksafe document, *Machinery and equipment safety: An introduction.*

Factors to consider in identifying machinery and plant hazards

Consider:

- tasks undertaken such as operating, clearing blockages, cleaning, adjusting, setting up, maintaining, repairing or working on a machine or item of plant;
- location such as proximity to other machines and work processes, fixed plant, portable plant and tools;
- installation of the machinery or plant so it is safe and has been done correctly;
- production processes such as forming and finishing;
- walkways and pedestrian access in the vicinity of plant, including access for routing operating and maintenance activities;
- use of mobile plant;
- safe transportation of mobile plant; and
- if appropriate, individual factors such as age, background and self management skills of those who might be operating or come into contact with the machinery or plant and levels of instruction, training and supervision that might be required.

Identifying less obvious hazards

Where machinery and plant hazards are not immediately obvious, activities to help identify them include:

- testing, particularly of plant and other equipment and noise levels;
- using scientific or technical evaluation;
- consulting workers;
- analysing records and data including workers' compensation data, incidents and near misses, hazard reports, sick leave and staff turnover;
- obtaining information from designers, manufacturers and suppliers;
- obtaining information from other organisations such as WorkSafe, Resources Safety, unions, employer bodies and occupational safety and health consultants;
- obtaining specific safety information such as safety alerts or significant incident reports and relevant codes or guides from WorkSafe and Resources Safety;
- in situations where more technical information is sought, using risk assessment techniques, such as Failure Mode Effect Analysis, Hazards and operability (HAZOP) studies and Fault Tree Analysis; and
- carrying out environmental and medical monitoring where required.

Use a wide range of information sources to help identify hazards

Sources of information to help in identifying hazards include:

- consulting workers and, where they exist, safety and health representatives working with the machinery or plant;
- Australian and Australia/New Zealand Standards;
- manufacturers' instructions and advice;
- maintenance logs of machinery or plant;
- documentation relating to safe work practices and their effectiveness;
- injury or incident information and hazard alerts;
- relevant reports from occupational safety and health agencies, unions, employer and professional bodies;
- articles from safety and health journals; and
- safety information from safety authorities on the Internet.

2.1.1 Examples of hazards

Hazards may include, but are not limited to, those shown in the following pages.

Note that the machines and items of plant are shown in their unguarded state to demonstrate the hazards and danger zones.

Drawing-in or trapping hazards

In the context of machinery and plant, 'nip-point' means a point in or around the machine or item of plant with the potential to nip a body part.

Injuries can be caused when a part of the body is drawn into a 'nip-point', formed by:

- in-running nips between two counter-rotating parts, for example meshing gears, rolling mills, mixing rolls and press rolls;
- in-running nips between a rotating surface and a tangentially moving surface, for example a power transmission belt and its pulley, a chain and its chain wheel, and a rack and its pinion;
- running nips between a rotating surface and a tangentially moving surface where material, for example metal, paper, cable or rope, runs on to a reel, drum or shaft; and
- nips between rotating and fixed parts, which create a shearing, crushing or abrading action, as in spoked hand-wheels, flywheels and screw conveyors.

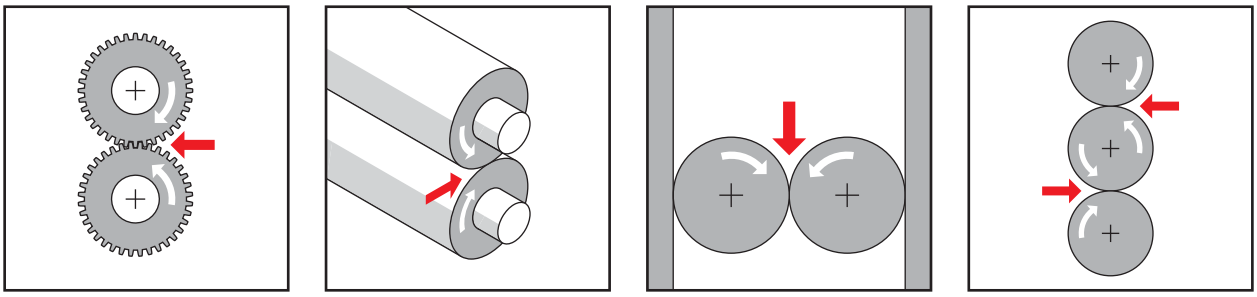

Illustration 3. Drawing-in hazards between counter-rotating parts.
Solid red arrows = where a part of the body could be drawn into a 'nip-point'.
White arrows = movement of machine parts.

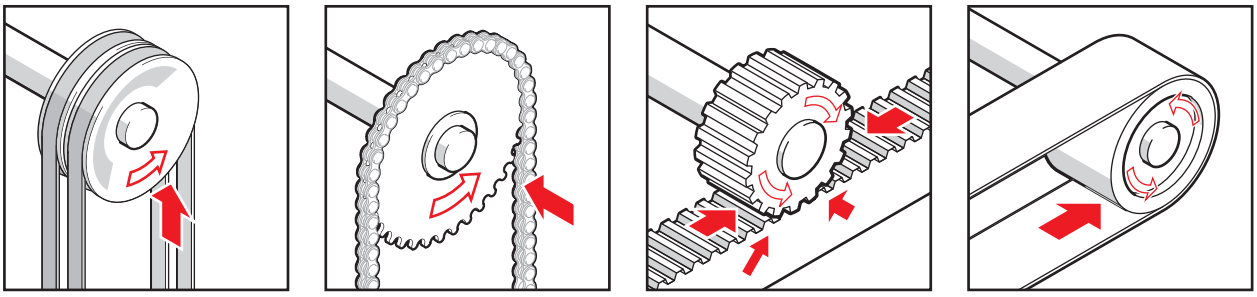

Illustration 4. 'Nip-points' (drawing in hazards).
Solid red arrows = 'nip-points'. White arrows = movement of machine parts.

Entanglement hazards

Entanglement involves being caught in a machine by loose items such as clothing, gloves, ties, jewellery, long hair, cleaning rags, bandages or rough material being fed into the machine. The types of body contact that may lead to entanglement include:

- contact with a single rotating surface, for example plain shafting, couplings, spindles, chucks, leadscrews, mandrels or rotating work pieces including plain bar material;

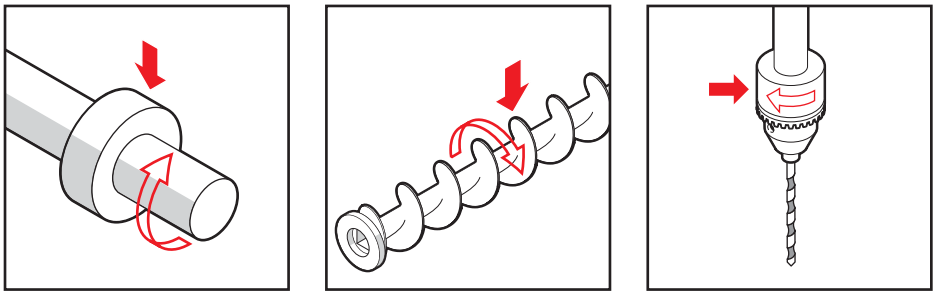

Illustration 5. Contact with single rotating surface.
Solid red arrows = where entanglement can occur. White arrows = movement of machine parts.

- being caught on projections or in gaps. Belt fasteners and other projecting items, such as keys, set screws and cotter pins, are typical projection hazards. Fan blades, spoked wheels such as pulleys, sprockets, gear wheels and flywheels, mixer and beater arms and spiked cylinders are gap related hazards;

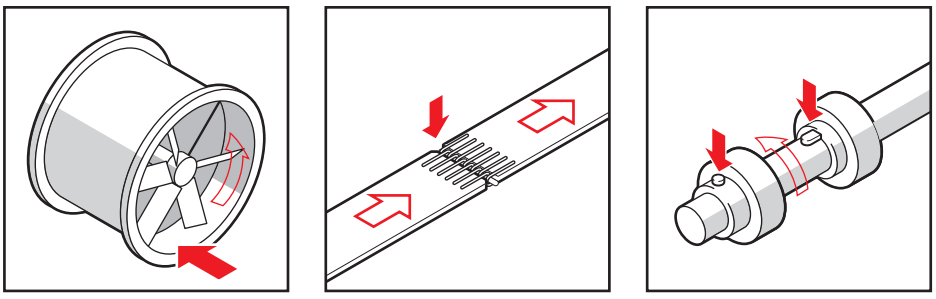

Illustration 6. Catching on projections or gaps.
Solid red arrows = where entanglement can occur. White arrows = movement of machine parts.

- contact with materials in motion such as in centrifuges, tumble driers and dough mixers or swarf from machining operations;
- contact between counter rotating parts, for example gear wheels or rolling mills;
- contact between rotating and tangentially moving parts, for example a power transmission belt and its pulley, a chain and chain wheel, a rack and pinion, a conveyor belt and any of its pulleys and a rope and its storage reel; and
- contact between rotating and fixed parts, for example spoked handwheels or flywheels and the machinery bed, screw or worm conveyors and their casings, revolving mixer and mincing mechanisms in casings having unprotected openings, mixers, extruder screw and barrel or the periphery of an abrasive wheel and an incorrectly adjusted work rest.

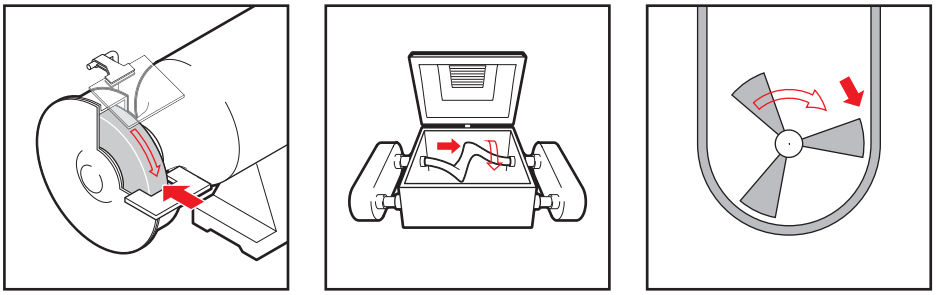

Illustration 7. Catching between rotating and fixed parts.
Solid red arrows = where entanglement can occur. White arrows = movement of machine parts.

No loose clothing, jewellery or long hair

To start addressing the risks from entanglements, requirements that workers not wear loose clothing or jewellery and tie back long hair or wear head covering should be introduced.

Shearing hazards

Shearing action involves applying power to a slide or knife in order to trim or shear metal or other materials. Shear points occur where stock is actually inserted, held and withdrawn.

Parts of the human body can be sheared:

- between two machine parts, for example the table of a metal planing machine (shaper) and its bed, the table and blade of a guillotine or power press, nip points between connecting rods or links and rotating wheels or between parts that oscillate; and
- between a machine part and a work piece, for example the tool of a broaching machine and the part being broached.

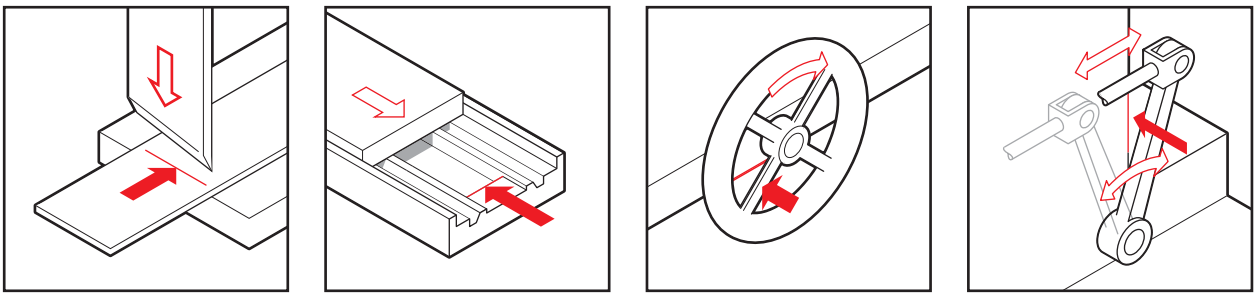

Illustration 8. Shear hazards between two machine parts.
Solid red arrows = where parts of the body can be sheared. White arrows = movement of machine parts.

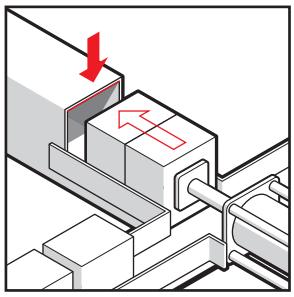

Illustration 9. Shear hazards between a machinery part and a workpiece.
Solid red arrows = where parts of the body could be sheared. White arrows = movement of machinery part.

Cutting hazards

Cutting hazards are present at the point of operation in cutting wood, metal, or other materials. Examples of mechanisms involving cutting hazards are all kinds of cutting tools, band and circular saws, boring or drilling machines, planing and tenoning machines, milling machines, water jet cutting, high energy lasers or moving sheet material in a machine.

Cutting hazards may involve rotating, reciprocating, or transverse motion. The danger of cutting action exists at the point of operation where finger, arm and body injuries can occur and where flying chips or scrap material can strike the head, particularly in the area of the eyes or face. The cutting effect may be aggravated by the body being unable to move away from the cutter.

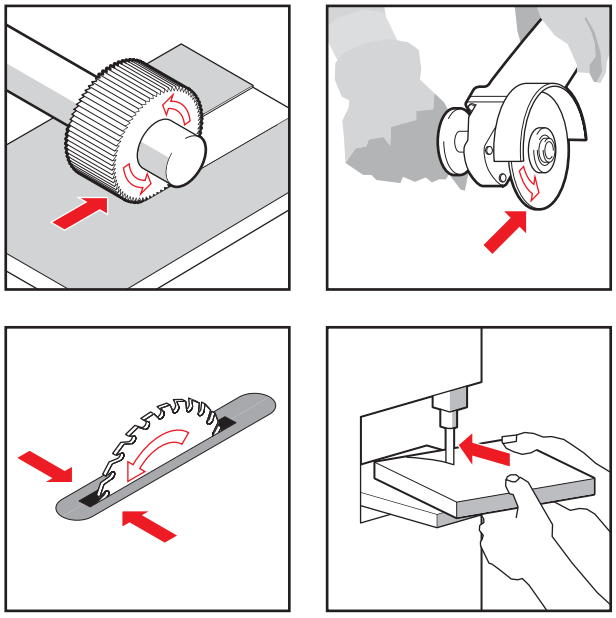

Illustration 10. Typical cutting hazards.
Solid red arrows = where parts of the body could be cut. White arrows = movement of machinery part

Impact hazards

Impact hazards relate to objects that strike the human body, but do not penetrate it. Examples include the rotating arm of a robot, the reciprocating bed of a metal planing machine and the pendulum movement of the arms of a wool scouring machine.

Impact hazards are different to crush hazards although the machines involved may be the same. Impact hazards operate against the inertia of the body whereas crush hazards involve the trapping of the body between two machine parts or between a machine part and a fixed structure.

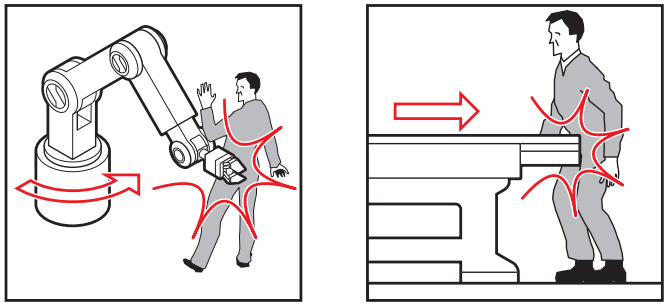

Illustration 11. Impact hazards.
Solid white arrows = movement of machine part.

Crushing hazards

Crushing occurs when a part of the body is caught:

- between a fixed and moving part of a machine such as the bed and tool of a power press;
- between two moving parts of a machine such as the support arms of a scissor lift platform; and
- between a moving part of a machine and a fixed structure such as a counterweight and the floor.

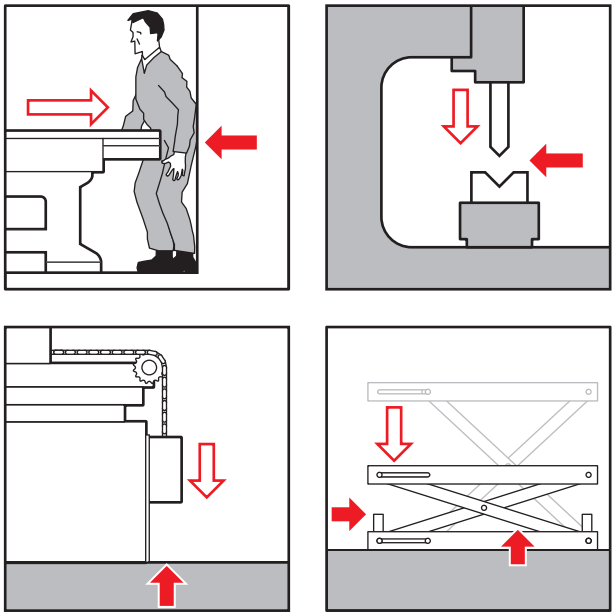

Illustration 12. Crushing hazards.
Solid red arrows = where a part of the body could be crushed. White arrows = movement of machine part.

Stabbing and puncturing hazards

The human body can be penetrated by:

- flying objects such as:
  - parts of a machine, for example a loose tool in a lathe, broken tooling on a press or the breaking-up of an abrasive wheel; and
  - material ejected from a machine, for example swarf, timber from a bench saw, a work piece, molten metal from a diecasting machine, sparks from a welding process, a bolt from an explosive-powered tool or debris thrown by rotary mowers and hedgecutters. Injection of fluids through the skin can cause tissue damage similar to crushing; and
- rapidly moving parts of machinery or pieces of material, for example the needle of a sewing machine, the drill of a drilling machine or the arm of a robot.

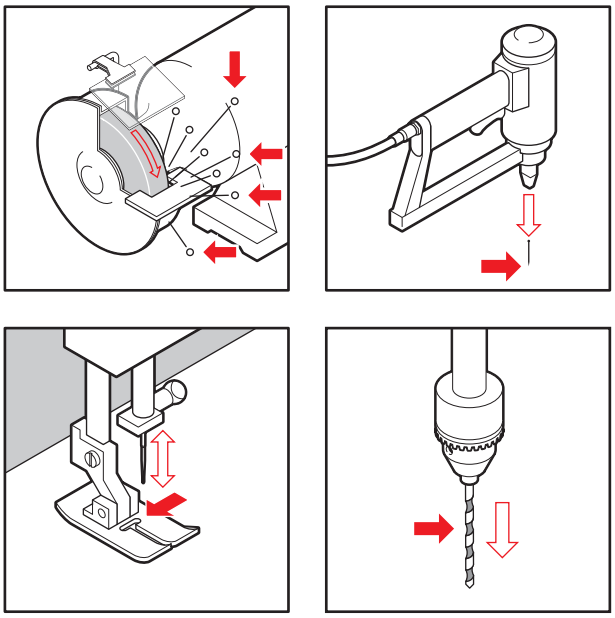

Illustration 13. Stabbing and puncture by flying objects or moving parts of machinery.
Solid red arrows = items that could penetrate the body. White arrows = movement of objects or machine part.

Friction and abrasion hazards

Friction burns can be caused by smooth parts operating at high speed. Other examples of friction or abrasion hazards include the sides of a grinding wheel, the belt of a belt sanding machine, material running onto a reel or shaft, a conveyor belt and its drums, and pulleys and fast-moving ropes or belts.

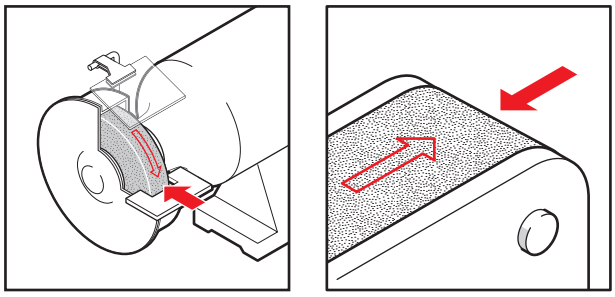

Illustration 14. Friction and abrasion hazards.
Solid red arrows = where a body part may be injured. White arrows = movement of machine part.

Hot or cold hazards

There are a range of hot or cold hazards that may need to be considered including:

- incidents that may occur if people are required to constantly work where the temperature is outside a comfortable range;
- extreme heat or extreme cold, which may affect machinery operations; and
- injuries that may occur if there is contact with hot or cold parts.

Concurrent hazards

Some of the hazards that may arise with machinery or plant may occur at the same time. This should be considered during hazard identification.

Use of physical barriers

Many of the types of hazards illustrated can be effectively managed by the installation of physical barriers. Examples of these are addressed in Section 3 (Guards and safety devices), Section 4 (Considerations for designers) and Section 5 (Guards for different machines) of this code.

Check for specific requirements

Before proceeding to Step 2: risk assessment, check to see if the hazards identified are subject to a specific regulation, code of practice or guidance material issued under either the OSH Act or MSI Act. If so, there may be specific requirements to be taken into account. Details of where to find information are given in Appendix 1 and Appendix 2.

2.2 Step 2: Risk assessment

The second step in the risk management process is assessing the risks of injury or harm arising from the hazards identified in the workplace.

In general, this involves looking at the chance or likelihood of a hazard occurring and, if it does, the extent of any injury or harm, that is the consequences. It is a way of deciding which hazards need to be addressed first, that is where there is the highest risk of injury or harm.

This step should provide information on:

- where, which and how many workers are likely to be at risk of incurring injury or harm;
- how often this is likely to occur; and
- the potential severity of any injuries.

With hazards from bits of moving, rotating or reciprocating machinery, the risk assessment is primarily concerned with assessing the likelihood of a worker getting caught, entangled or nipped and determining the severity of injuries.

Risk factors to consider during the risk assessment include:

- visibility — for example, how visible or noticeable is the hazard?;
- orientation — for example, a feed screw located low and oriented horizontally would be a risk for hair, tie and jewellery entanglement. One located and/or oriented differently would pose a different risk; and
- anticipated work practices, including less obvious ones. These can include:
  - reaching into machines to free blockages/jams or retrieve things. For example, the moving parts in a screw conveyor are behind closed panels, but when a jam occurs, a worker may open the panel and stick their hand in;
  - maintenance, inspection, repair and cleaning practices; and
  - infrequent or one-off tasks required on the plant.

Assessing the risk should therefore take into consideration whether the danger zone can be reached and the likelihood of a worker extending fingers, hands, arms, feet or legs into places where they do not go during normal machine operation.

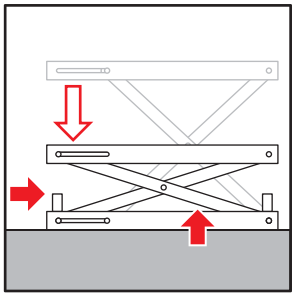

Illustration 15. An example of visibility risk factor. When the top part of the machine lowers, it comes to rest on supports on each corner, so only a small area on the underneath of the top may be a hazard.
Solid red arrows = where body part may be injured. White arrows = movement of machine part.

Adequate information, knowledge and experience

Risk assessment is not an absolute science — it is a 'best estimate' made on the basis of available information. Therefore, it is important that:

- the people undertaking a risk assessment have the necessary information, knowledge and experience of the work environment and work process, or such a person is involved; and
- workers and safety and health representatives are consulted as they may be able to advise on the particular hazards and risks associated with different machinery or plant.

This enables you to be systematic in determining the 'best estimate'.

If required, Australian Standards AS 4024.1301 and AS 4024.1501 in the Australian Standard, *AS 4024 Safety of machinery* series contain further information on risk assessment factors and methodology.

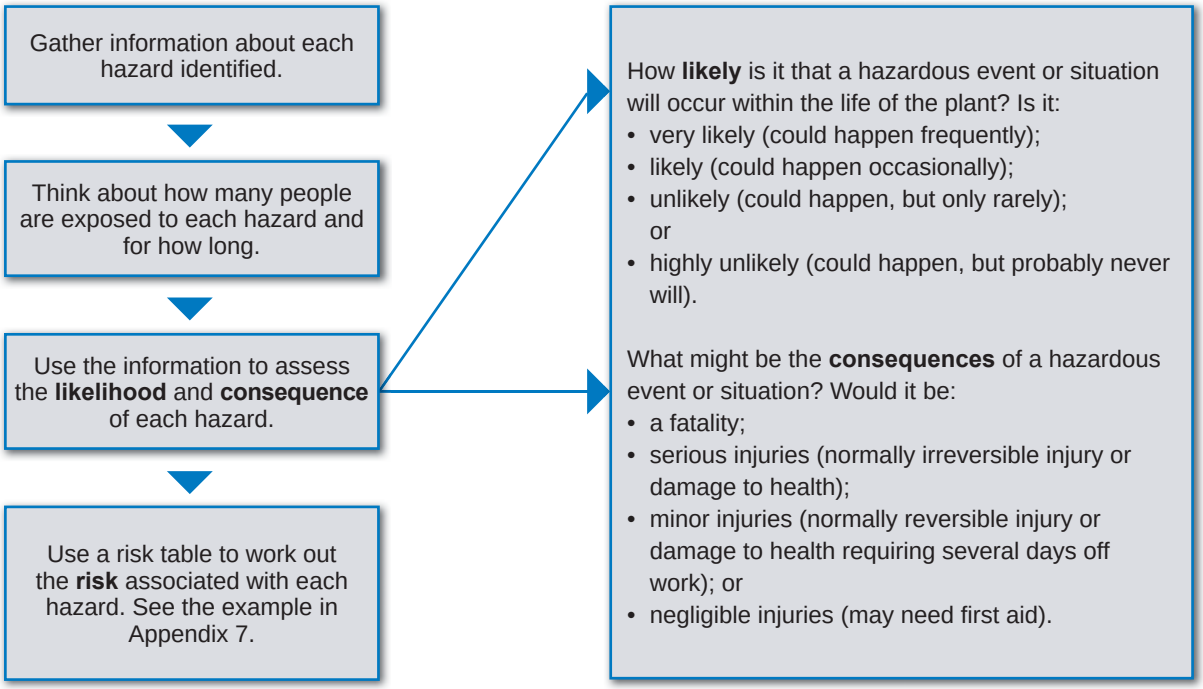

Illustration 16. Risk assessment.

Priorities

Once hazards have been rated, a prioritised list of workplace risks requiring action can be developed.

Risk assessment form

A risk assessment form is included in Appendix 7. This will help to assess the risks posed by machinery and plant.

It is suggested that one form be used per machine or part of a machine if there are several hazards. This form may be adapted for other activities relevant to machines in the workplace, such as purchase, installation, maintenance or work processes.

2.3 Step 3: Risk control

The third step is to implement control measures to eliminate or reduce the risks of a person being injured or harmed and ensure the measures are monitored and reviewed on an ongoing basis.

When considering risk control, there is a recommended order of control measures to implement, ranging from the most effective to the least effective, to eliminate or reduce the risks of injury of harm. This is also referred to as the ‘hierarchy of control’. It is:

- elimination;
- substitution;
- isolation;
- engineering controls;
- administrative controls (for example, work practices that reduce the risk such as providing procedures and instruction); and finally
- personal protective clothing and equipment — these should only be considered when other control measures are not practicable or to increase protection. While essential for some work procedures, these should be last in the list of priorities.

The above control measures may be used in combination.

See regulations 4.37 and 4.29 of the OSH Regulations or, for mining industry workplaces, regulations 6.17, 6.18 and 6.2 of the MSI Regulations.

Provision of secure fencing or guarding to control risks

With the control of risks that could arise from unguarded machinery or plant, there are specific requirements in the legislation for the implementation of control measures.

Employers, main contractors, self-employed people and people who have control of a workplace or its means of access must **ensure that every dangerous part of fixed, mobile or hand held plant is, as far as practicable, securely fenced or guarded** in accordance with regulation 4.29 of the OSH Regulations or, for mining industry workplaces, regulation 6.2 of the MSI Regulations (see below) unless the machinery or plant is positioned or constructed so it is as safe as it would be if securely fenced or guarded.

Hierarchy of guarding

Regulation 4.29 of the OSH regulations or, for mining industry workplaces, regulation 6.2 of the MSI regulations require that the above people must ensure that, where guarding should be provided for machinery or plant, it comprises:

- a permanently fixed physical barrier for cases in which, during normal operation, maintenance or cleaning of the plant, no person would need either complete or partial access to the dangerous area;
- an interlocked physical barrier for cases in which during normal operation, maintenance or cleaning of the plant, a person may require complete or partial access to the dangerous area;
- a physical barrier securely fixed in position by means of fasteners or other suitable devices sufficient to ensure that the guard cannot be altered or removed without the aid of a tool or key for cases where neither a permanently fixed physical barrier or an interlocked physical barrier is practicable; or
- if none of the above guards is practicable, a presence-sensing safeguard system; however,
- where guarding of any moving part of the machinery or plant does not eliminate the risk of entanglement or it is not practicable to guard it, the above people must ensure that workers or other people do not operate or pass close to the moving part unless **a safe system of work is in place** to reduce the risks as far as practicable.

Other guarding requirements

The above people must also ensure that:

- fences or guards provided are **constantly maintained** and of **substantial construction** taking into account their intended purpose; and
- as far as practicable, any fence or guard provided is **kept in position** while the machinery or plant is operated.

Note that Part 4, Division 4 of the OSH Regulations or, for mining industry workplaces, Part 6, Division 2 of the MSI Regulations contain additional requirements in relation to safety of plant.

Additional controls

Even when one or more control measures have been implemented, additional controls might also be required, such as administrative controls or personal protective clothing and equipment.

Administrative controls or use of personal protective clothing or equipment should not be relied upon as the primary means of risk control. They are dependent on human behaviour and require management, enforcement and commitment to work effectively.

Administrative controls may be used as an interim measure until higher level controls are implemented or used in tandem with more effective control measures.

Examples of administrative controls are managing the time and hours of work, who does the work and who has access to work areas, machinery or plant. Other examples include training workers in the proper procedures and processes for operating machinery or plant and limiting exposure or the amount of time spent doing hazardous work activities.

Personal protective clothing and equipment means clothing, equipment or substances that, when worn correctly, protect part or all of the body from risks of injury or disease at work or in the workplace, for example protective eyewear, protective hearing devices, sturdy gloves or mesh gloves to prevent cutting injuries.

2.4 Holistic approach

The risk management process of identifying hazards, assessing the risks and implementing controls should be holistic. For example:

- interaction between a combination of hazards and its effect on the level of risk should be assessed;
- in some instances it may be acceptable to have a higher risk rating for a hazard or hazards provided the implemented control measure(s) address the overall risk to a higher degree; and
- a potential hazard may not necessarily require a single matching control. A response could be to implement a control measure that addresses a number of potential hazards.

2.5 Implementing control measures

Activities necessary to allow the selected control measures to function or operate effectively include:

- developing work procedures — these should be developed in relation to chosen control measures to ensure their effectiveness. Management, supervision and worker responsibilities should be clearly defined. In relation to use of machine safeguarding, the procedures should, at a minimum, cover:
  - arrangements for ensuring the appropriate guarding is purchased and correctly installed;
  - arrangements for provision of instruction, supervision and training of workers to ensure the machinery is only operated with the guarding in place;
  - the requirement for workers to follow instructions;
  - arrangements for maintenance of the machine and safeguards; and
  - arrangements for workers to report malfunctions or problems with machinery;
- consultation and communication — workers and, where they exist, safety and health representatives must be consulted and informed about the control measures to be implemented and of any changes to these arrangements. Information may also need to be provided to others who may enter the workplace, including cleaners, visitors and contract staff;
- provision of training and instruction — training and instruction must be provided as necessary for workers, supervisors and others to enable them to use the control measure so they are not exposed to hazards. This information should be provided to workers in a manner that is readily understood, with special consideration given to language and literacy issues;
- supervision — adequate supervision must be provided as necessary to ensure that the control measures are being used correctly; and
- maintenance — work procedures should clearly identify maintenance requirements to ensure the ongoing effectiveness of the control measures. Looking at maintenance of control measures is an important part of the implementation process.

2.6 Monitoring and reviewing effectiveness of control measures

Having implemented control measures, it is important that they be regularly monitored and reviewed.

Questions to ask

In monitoring and reviewing control measures, it is useful to ask:

- have control measures been implemented as planned?
- if control measures have not been implemented, why not?
- are the control measures being used and, if so, are they being used correctly?
- are control measures working?
- have changes made to control exposure to the assessed risks resulted in what was intended?
- have implemented control measures resulted in the introduction of any new hazards?
- have implemented control measures resulted in the worsening of any existing hazards?

In order to answer these questions, there may be a need to:

- consult with workers, supervisors and, where they exist, safety and health representatives;
- measure levels of exposure, for instance take noise measurements in the case of isolation of a noise source;
- refer to manufacturers' instructions;
- monitor incident reports; and
- contact industry associations, unions, government bodies or safety and health consultants.

In determining the frequency of the monitoring and review processes, consider:

- the level of risk — high risk hazards need more frequent assessments;
- the type of work practices or plant involved;
- a regular review of the process for hazard identification, risk assessment and risk control to ensure the risks are effectively managed; and
- further review of control measures when new methods, tasks, equipment, hazards, operations, procedures, rosters or schedules are introduced, the environment changes or there is any indication risks are not being controlled.

2.7 Keeping documents and records

It is advisable to record the chosen control measures. If a preferred control measure cannot be implemented immediately, the controls intended as short-term and longer term solutions, along with the proposed implementation timeframe, should be recorded.

Keeping records helps track what has been done or what is planned and assists in maximising the effectiveness of the process.

Adequate recording of the risk management process undertaken in regard to machinery and plant helps demonstrate compliance with legal obligations. The level of documentation should be appropriate for the level of risk and control measures.

See regulation 4.34 of the OSH Regulations or, for mining industry workplaces, regulation 6.25 of the MSI Regulations.

The OSH Regulations and the MSI Regulations include **specific requirements to keep records** of any maintenance, inspection, commissioning, alteration or test results for **certain types of plant.** There are also requirements related to information provided by suppliers of plant and obligations for transfer of information upon sale of the plant. These obligations are mandatory.