
Occupational Health & Safety Practitioner

Reading

INTRODUCTION TO MACHINE HAZARDS

January 2009



Contents

OVERVIEW	1
SECTION 1: INTRODUCTION	2
SECTION 2: IDENTIFICATION OF HAZARDS.....	4
SECTION 3: CUTTING	6
SECTION 4: SHEARING.....	7
SECTION 5: STABBING AND PUNCTURING.....	8
SECTION 6: IMPACT	9
SECTION 7: ENTANGLEMENT	10
SECTION 8: FRICTION AND ABRASION	13
SECTION 9: CRUSHING	14
SECTION 10: SHEARING OR CRUSHING – NIP POINTS.....	15
SECTION 11: PROJECTILES AND ENERGY RELEASE	16
SECTION 12: RISK ASSESSMENT	17
SECTION 13: LEGAL REQUIREMENTS.....	19
REFERENCES AND FURTHER READING.....	20



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OVERVIEW

This reading identifies the hazards inherent with the use and maintenance of production machinery. It provides examples of the various types of hazards. Brief details of the risk assessment process and of the legal situation are also included.

Objectives

After reading this information you should be able to outline the hazards associated with common machinery.

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Section 1: INTRODUCTION

Glossary of terms

When they are first used, glossary terms are indicated with an asterisk (*). Make sure that you are familiar with the **Glossary of terms** before going any further.

Hazard Identification	is the process of identifying situations or events that could give rise to the potential of injury, or of harm to the health, of a person.
Hazard	in relation to a person, means anything with the potential to cause injury, or harm to the health of the person.
Leadscrew	threaded shaft used to drive a carriage on a machine, eg. shaft used to drive the toolpost carriage on a lathe.
Mandrel	spindle or bar of a lathe (for instance) that supports the material being turned. - <i>World Book Dictionary</i> .
Nip Point	in the context of machinery means a point in or around the machine with the potential to nip a body part.
Nip	to pinch; - to bite; - to snatch; - to take quickly - <i>World Book Dictionary</i> .
Reciprocate	Alternate backward and forward motions - <i>Oxford Dictionary</i> .
Risk Assessment	is the process of determining whether there is a risk associated with an identified hazard, that is whether there is any likelihood of injury or harm to health.
Risk	in relation to any injury or harm, means the likelihood of that injury or harm occurring.

1.1 Introduction

Since the beginning of the industrial revolution the number of machines being introduced to workplaces has been increasing exponentially. Initially machines were unguarded, probably because the hazards* associated with machinery were not fully appreciated and the expectations of the community in respect of safety were not as high as they are today.

You will no doubt have seen photographs of factories in the late 1800s and the early 1900s with line shafts running from one end to the other with numerous pulleys and unguarded flat belts driving a variety of machines. The accidents that occurred with such systems led to the realisation that action had to be taken to protect workers. Current occupational safety and health legislation places responsibilities to minimise hazards on everyone involved in the life cycle of the machinery, from designers to the person finally disposing of the machinery.

In comparison with States like New South Wales and Victoria, Western Australia's manufacturing industry is on a small scale, making it difficult to justify jiggling and tooling to automate manufacturing processes with the associated improvement in safety for machine operators.

This "economy of scale" problem also results in many old machines remaining in service long after their genuine "use by date" has expired, for those one or two jobs a year that can then be done "in house" rather than sent out to a competitor with a more appropriate / modern machine. As a result it is particularly necessary for those who work with and around these machines to be aware of the related hazards.

Section 2: IDENTIFICATION OF HAZARDS

The most readily available source of information pertaining to the safe operation of machinery is contained within the operator's manual for the machine. Occupational health and safety legislation requires (amongst other things) persons who supply machinery to, so far as is practicable, ensure that persons properly using the machinery are not exposed to hazards. As part of this obligation suppliers are required to provide adequate information in respect of any dangers associated with the machinery, the proper maintenance of the machinery and how to correctly use the machinery.

The reality, unfortunately, is that with older machinery and machinery that has changed ownership, operator's manuals are frequently not available. In such cases, the following generic information will be of assistance.

2.1 Hazard categories

There are many hazards associated with machinery. They fall into three principal categories:

- Hazards related to the machinery itself, such as shearing and abrasion and release of hazardous substances.
- Hazards related to the location of the machine, such as stability (could it roll or fall over) or its proximity to another structure.
- Hazards related to systems of work associated with the machine, such as manual handling injuries caused when putting material into the machine.

This reading will principally address hazards related to the machinery itself, but some examples given will relate to machinery location and systems of work.

2.2 Common injuries and related situations

The common injuries associated with machines are crushing, cutting, shearing, puncturing, abrasion (or burns), and tearing (or stretching) or a combination of two or more of these. However, electric shock, hearing loss, ill health from the release of hazardous substances or from lack of oxygen and broken bones from falls (slippery or wet surfaces) are also relatively common. Of course, some of these injuries or events cause amputation or death.

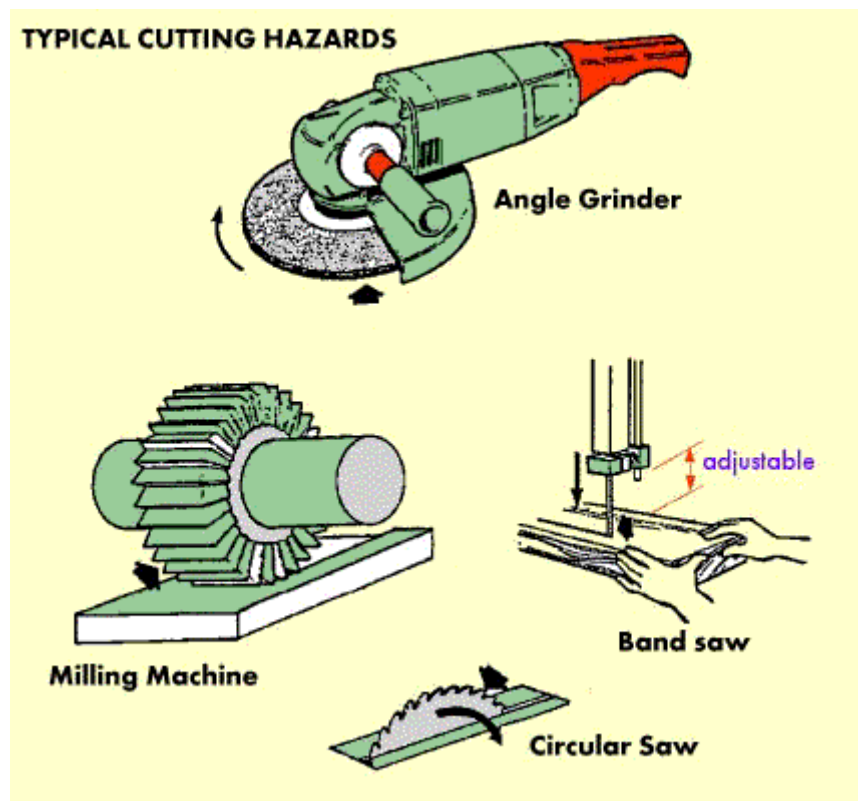
The movements of parts of machines consist basically of rotating, sliding or reciprocating motion or a combination of these motions.

The common situations which result in injury to persons are:

- Coming into contact or entanglement with a machine. This could include a person being drawn into a machine or being drawn into a position where they might sustain further injury.
- Being caught between a machine and material being used in the machine to manufacture a product.
- Coming into contact or entanglement with material being used in the machine to manufacture a product.
- Being caught between a machine or machine part and a fixed structure such as a wall, column or fixed machine.
- Being struck by parts of the machine during failure or break-up of the machine.
- Being struck by material ejected from the machine.
- Being struck as a result of a release of potential energy.

Section 3: CUTTING

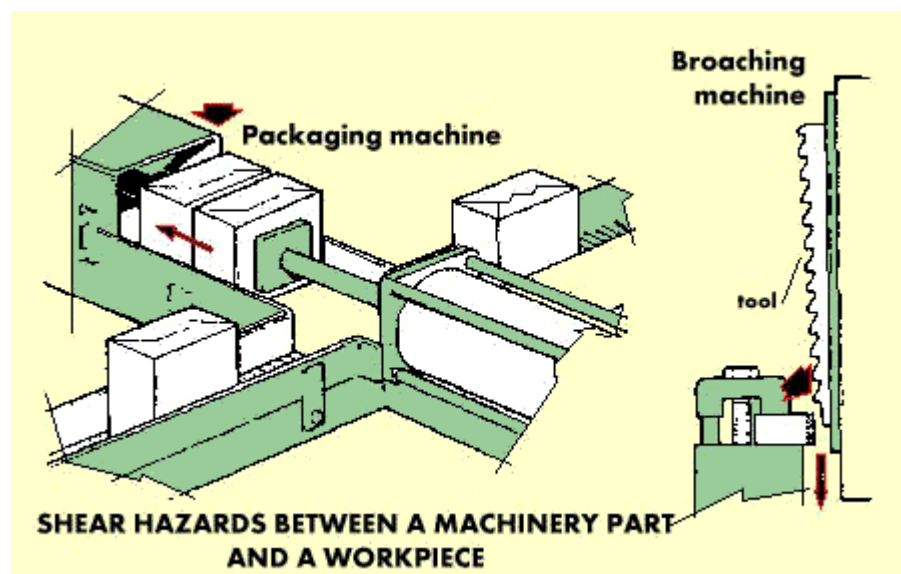
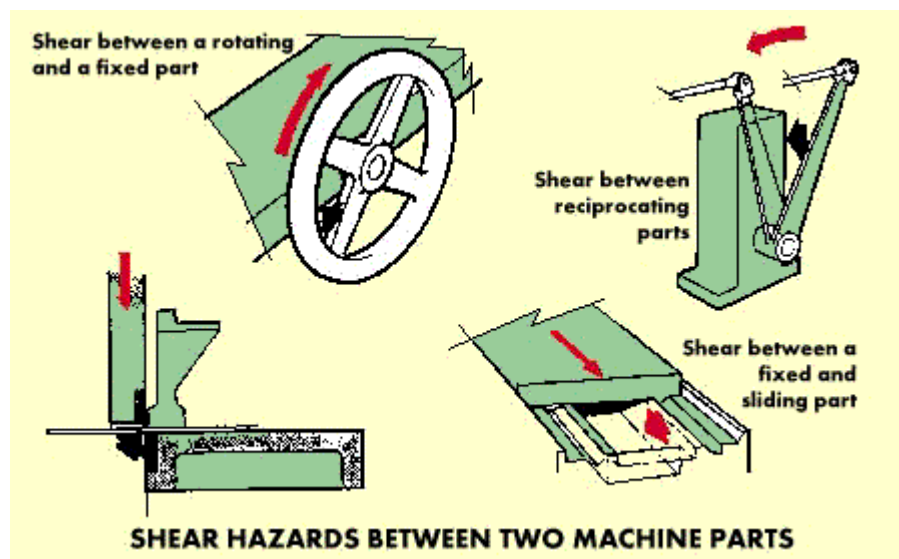
Examples of cutting hazards associated with machines include all kinds of obvious cutting tools such as jig saws, circular saws, milling machines, routers, spindle moulders, planing machines, band saws, rotary knives and angle grinders, as well as water jet cutting or sharp edges of moving sheet material in a machine.



Section 4: SHEARING

Parts of the human body may be sheared between:

- Machine parts, eg. the table of a metal planing machine (shaper) and its bed, the table and blade of a guillotine or power press, or between parts that oscillate such as in a wool scouring machine.
- A machinery part and a workpiece, eg. the tool of a broaching machine and the part being broached.



Section 5: STABBING AND PUNCTURING

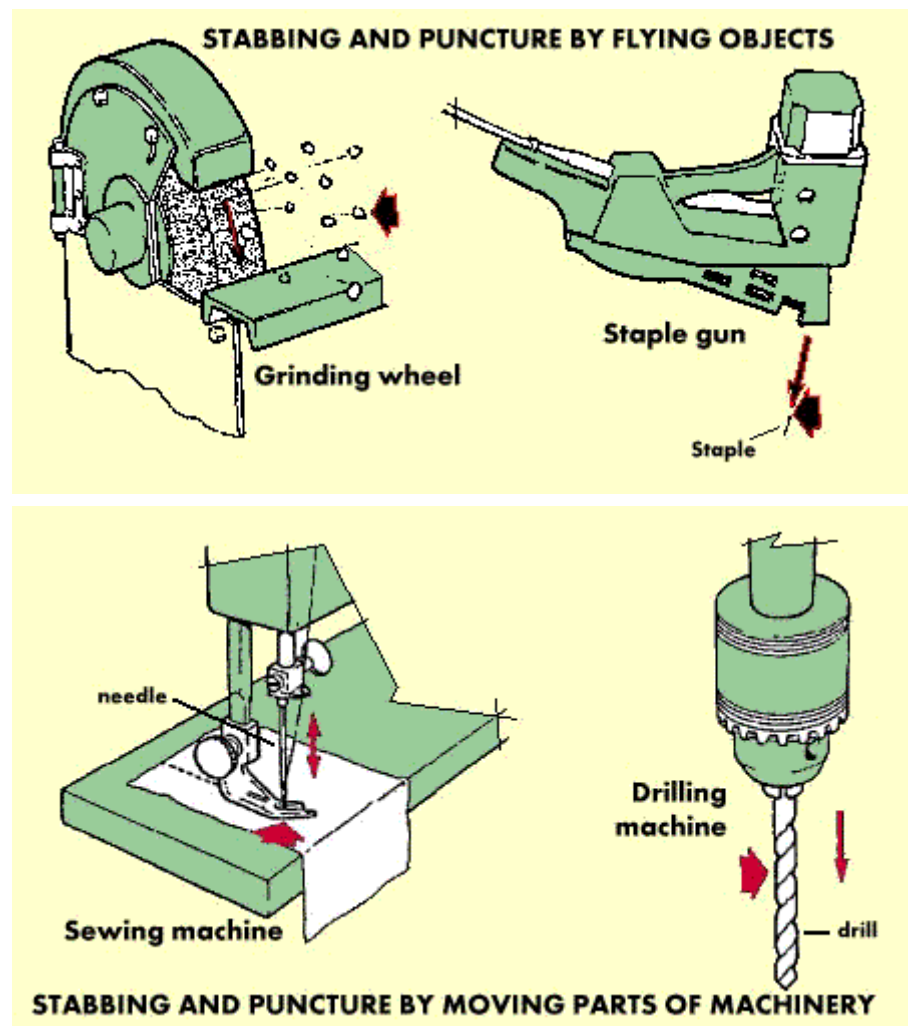
The human body may be penetrated by:

(1) Flying objects such as:

Parts of a machine, eg. the flying shuttle of a loom, a loose tool in a lathe, broken tooling on a press or the breaking-up of an abrasive wheel.

Material ejected from a machine, eg. swarf, ejection of a workpiece, molten metal ejected from a diecasting machine, sparks from a welding process, a bolt from an explosive-powered tool or debris thrown by rotary mowers and hedgecutters.

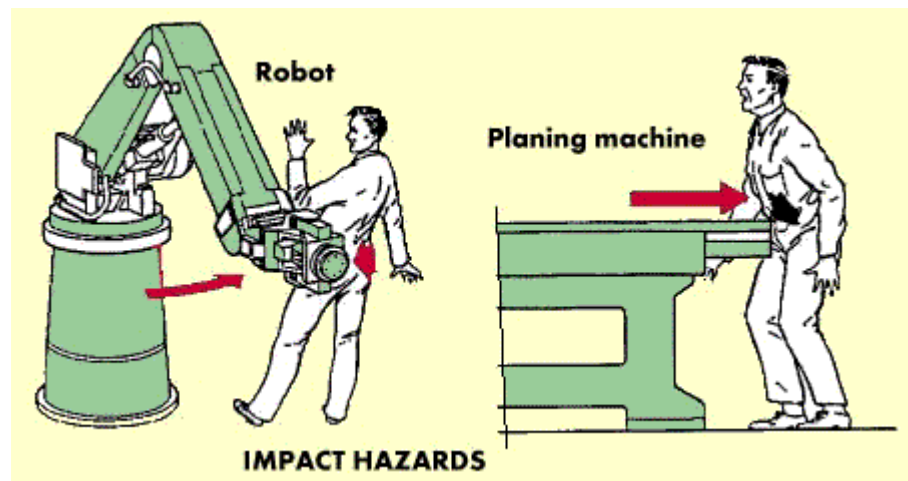
(2) Rapidly moving parts of machinery or pieces of material, eg. the needle of a sewing machine, the drill of a drilling machine or the arm of a robot.



Section 6: IMPACT

Impact hazards relate to objects which 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.

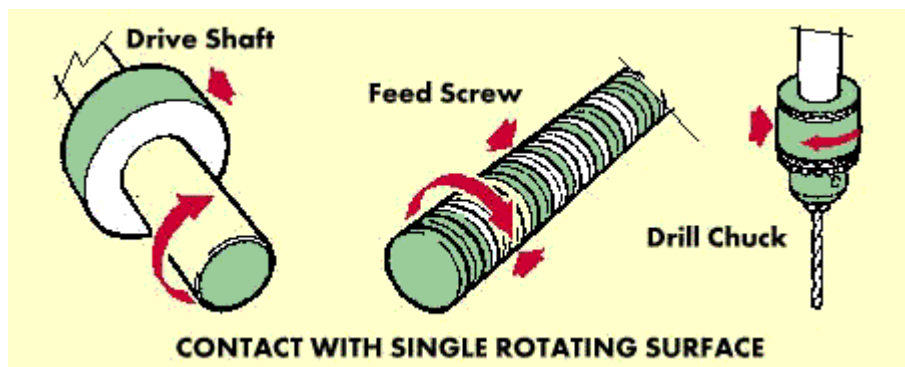


Section 7: ENTANGLEMENT

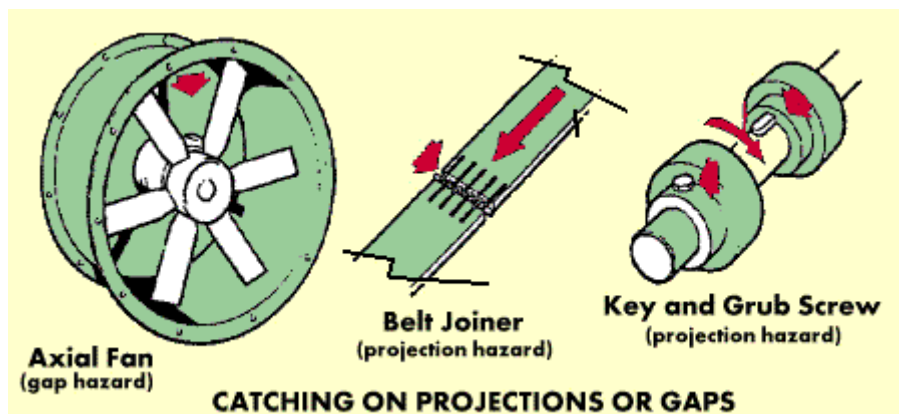
Entanglement involves being caught in a machine by loose clothing (such as gloves or neckties), jewellery, long hair, cleaning rags, bandages or rough material being fed into the machine.

Bodily contact of the following types may lead to entanglement:

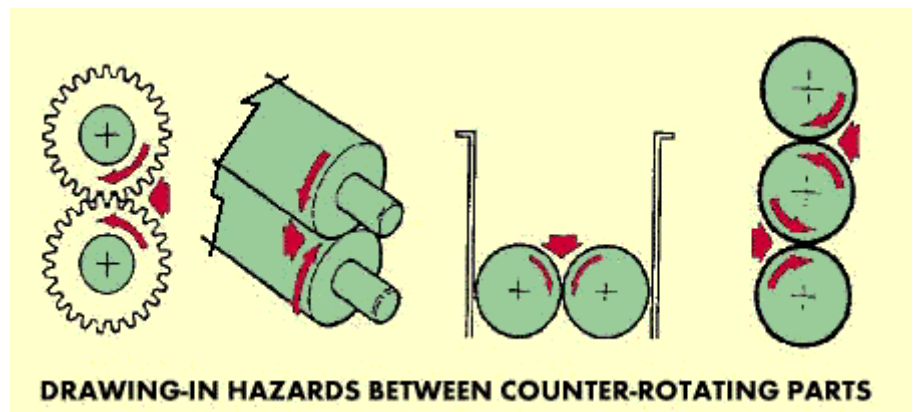
1. Contact with a rotating surface, eg. plain shafting, couplings, spindles, chucks, leadscrews*, mandrels* or rotating workpieces (including plain bar material).



2. 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 whilst fan blades, spoked wheels (such as pulleys, sprockets, gear wheels and flywheels), mixer and beater arms and spiked cylinders are gap related hazards.

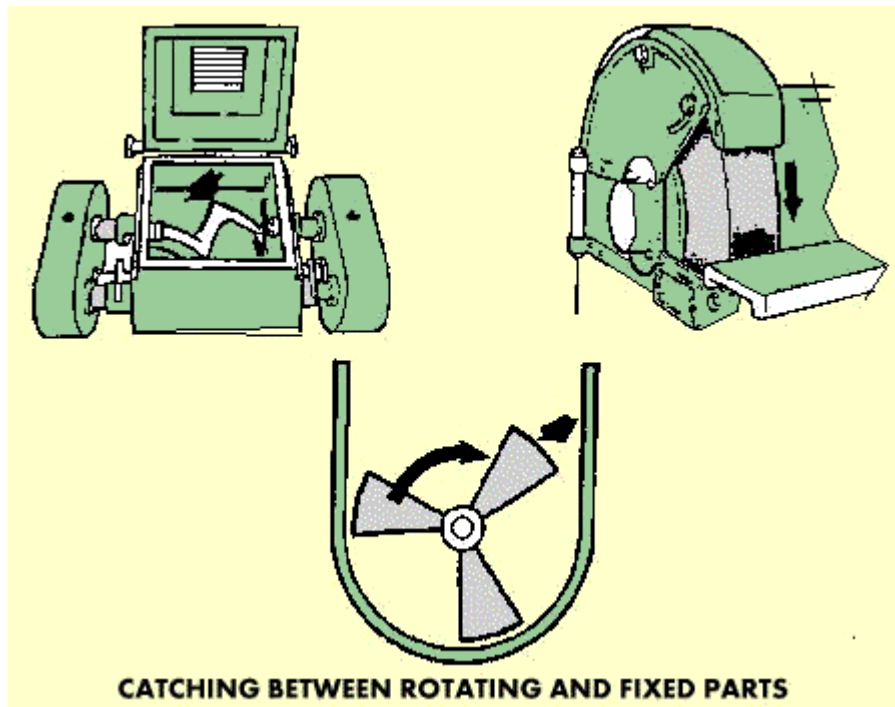


3. Contact with materials in motion, such as in centrifuges, tumble driers and dough mixers or swarf from machining operations.
4. Being caught in the nip-point:
 - Between counter-rotating parts, ie. cylindrical parts rotating in opposite directions such as gear wheels, rolling mills, mixing rolls and calenders or between material and a roll where material is being drawn between two rolls.



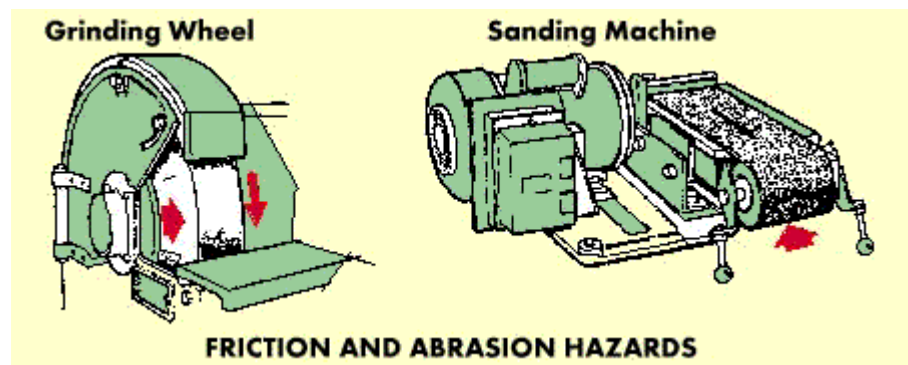
- Between rotating and tangentially moving parts, eg. a power transmission belt and its pulley, a chain and chain wheel, a rack and pinion, a conveyor belt and any of its pulleys and a rope and its storage reel.

- Between rotating and fixed parts, eg. 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.



Section 8: FRICTION AND ABRASION

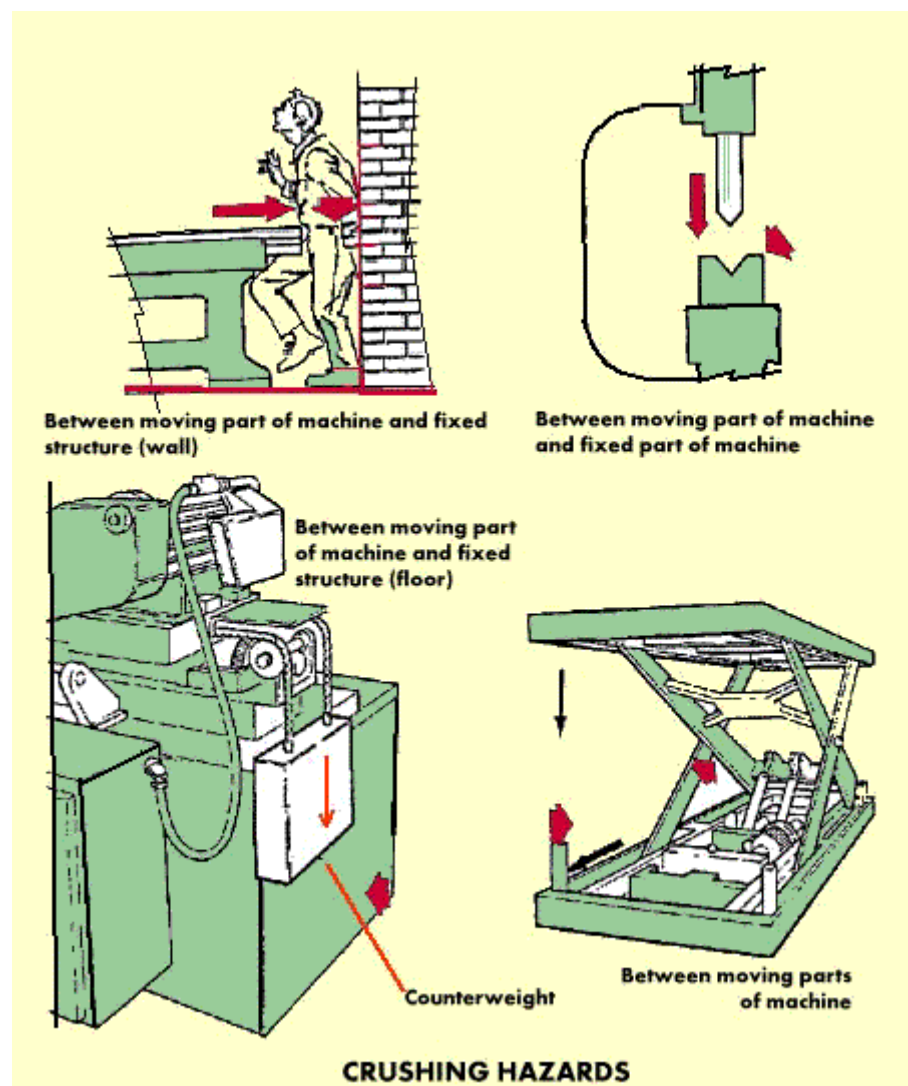
Friction burns can be caused by smooth parts operating at high speed, such as the rim of a centrifuge basket. Other examples of friction or abrasion hazards include the periphery of a grinding wheel, the belt of a belt sanding machine, material running onto a reel or shaft, a conveyor belt and its drums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



Section 9: CRUSHING

Crushing occurs when a part of the body is caught:

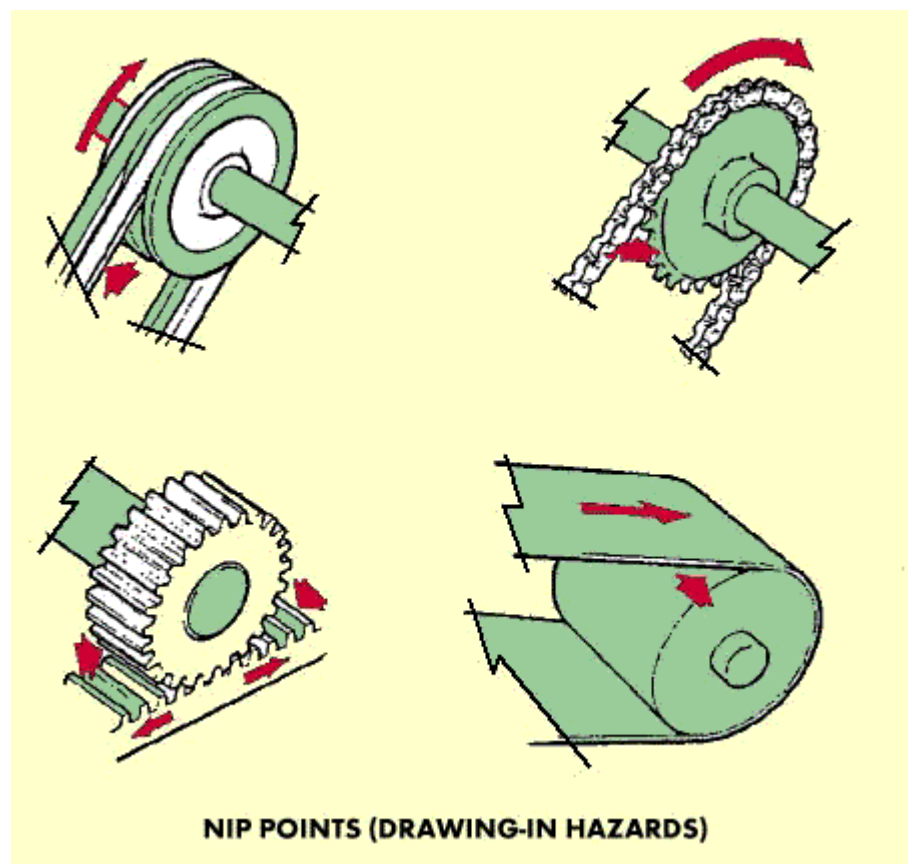
- between a fixed and moving part of a machine, such as the bed and tool of a power press;
- between two moving parts of a machine, such as the support arms of a scissor lift platform; and
- between a moving part of a machine and a fixed structure, such as a counterweight and the floor.



Section 10: SHEARING OR CRUSHING - NIP POINTS

Shearing or crushing injuries can be caused when a part of the body is drawn into a "nip-point*" formed in any of the following ways:

- In-running nips* between two counter-rotating parts, eg. meshing gears, rolling mills, mixing rolls, press rolls and calenders.
- In-running nips between a rotating surface and a tangentially moving surface, eg. 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 (eg. metal, paper, cable or rope) runs on to a reel, drum or shaft.



Section 11: PROJECTILES AND ENERGY RELEASE

11.1 Projectiles ejected from a machine

Failure of a machine, or seizing of component parts of a machine, can result in the expulsion of parts of the machine or material with the potential to cause serious injury. Similarly, failure of the machine control system can cause the release of material being processed. Examples are the disintegration of an abrasive wheel, the seizure of a brake or clutch, bursting of a high pressure hydraulic line, or the failure of work holding devices such as vices and clamps.

11.2 Release of potential energy

Unexpected release of potential energy may cause injury. Examples are the energy stored in flywheels and springs, the release of pressure and objects falling under the force of gravity.

Section 12: RISK ASSESSMENT

Risk*, in relation to any injury or harm, means the likelihood of that injury or harm occurring. The amount of risk depends upon the circumstances. These include the type and size of machine, what it is used for, the need for approach to it, ease of access and the quality of supervision present. Risk also depends upon the knowledge, skills and attitude of the person(s) present in those circumstances and an individual's awareness of the danger and the skill needed to avoid it. The ability to identify those at risk and to identify when the risk occurs is important and applies to operators as well as management.

Assessing the risks associated with each hazard is a way of identifying which hazards need to be controlled and which to tackle first.

To assess risk it is necessary to consider two factors:

1. The chance of each situation or event actually occurring (**the likelihood**).
2. The extent of the harm (injury or ill health) should it actually occur (**the consequence**).

This process may involve some subjective judgements. Make your "best estimate" and have another person, knowledgeable about the hazard and work practices, carry out a check assessment. This will ensure a somewhat systematic estimate.

Using research and observations about people's exposure to the hazard, determine "**likelihood**" using categories such as:

- very likely - could happen frequently
- likely - could happen occasionally
- unlikely - could happen rarely
- highly unlikely - could happen but probable never will; and

then determine "**consequence**" assuming such categories as:

- fatality
- major injuries - normally irreversible
- minor injuries - normally reversible
- negligible injuries - requiring no treatment or first aid only.

Having determined the "likelihood" and "consequence" of each hazard, rate the hazards according to how serious the risk is. A risk table such as that illustrated below may facilitate this process.

Consequence	Likelihood			
	Very likely	Likely	Unlikely	Highly unlikely
Fatality	HIGH	HIGH	HIGH	MEDIUM
Major injuries	HIGH	HIGH	MEDIUM	MEDIUM
Minor injuries	HIGH	MEDIUM	MEDIUM	LOW
Negligible injuries	MEDIUM	MEDIUM	LOW	LOW

Events or situations assessed as *very likely with fatal consequences* are the most serious (HIGH risk); those assessed as *highly unlikely with negligible injuries* are the least serious (LOW risk).

When developing risk control strategies, hazards with a HIGH rating should be tackled first.

Section 13: LEGAL REQUIREMENTS

In Australia, designers, manufacturers, importers and suppliers have a duty to ensure that their equipment is safe, so far as is reasonably practicable.

The *National Standard for Plant* (Safe Work Australia), on which most machinery related regulations in Australia are based, requires designers to consider the hazards associated with the machinery they design through its complete life cycle, ie. during manufacture, transport, erection/installation, commissioning, use, maintenance, storage and disposal, as well as the physical capacities and requirements of potential operators. Designers are required to assess the hazards identified and by the use of relevant Standards minimise the associated risks. Guarding of some sort will generally be required to control any residual hazards.

Manufacturers of machinery are required to identify hazards to potential operators that arise from the construction of the machinery. They must assess the related risks and where necessary either control the hazards or arrange with the designer to alter the design to minimise them.

Importers must assume the responsibilities of the designer and manufacturer.

Suppliers must ensure the responsibilities of the designer and manufacturer have been carried out. Where the supplier identifies a hazard he/she must make a risk assessment* and put the necessary controls in place before the machinery leaves his/her control.

Your feedback

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REFERENCES AND FURTHER READING

Australian Council of Trade Unions *Controlling Risks from Plant*.
Publicity Works, Melbourne.

Australian Standard AS 4024.1 *Safeguarding of Machinery -
General Principles*.

Australian Standard AS1893 *Code of Practice for the guarding
and safe use of paper cutting guillotines*.

Australian Standard AS 1219 *Power Press Safety Requirements*.

Safe Work Australia *National Standard for Plant*.

WorkSafe WA *Plant Design: Making it Safe*.

WorkSafe WA *Plant in the Workplace: Making it Safe*.