

# Machine Guarding

MAJOR WORKPLACE HAZARDS



Government  
of South Australia

Poor machine guarding practices are one of the greatest contributors to workplace injuries. So many South Australians – either through their experiences in the workplace – or through the experiences of their families and friends – have seen the consequences of inadequate machine guarding.

Inadequate machine guarding practices can lead to anything from near misses – to the loss of fingers or hands – to workplace deaths. The memories of these accidents are indelibly etched in the minds of those who witness them, of the injured, of their workmates – both shop floor workers and managers - and of the families of the injured.

This issue cannot be taken lightly.

Inadequate machine guarding is one of six major occupational health and safety risks that have been identified through an analysis of workers' compensation data, and a survey of Workplace Services field staff.

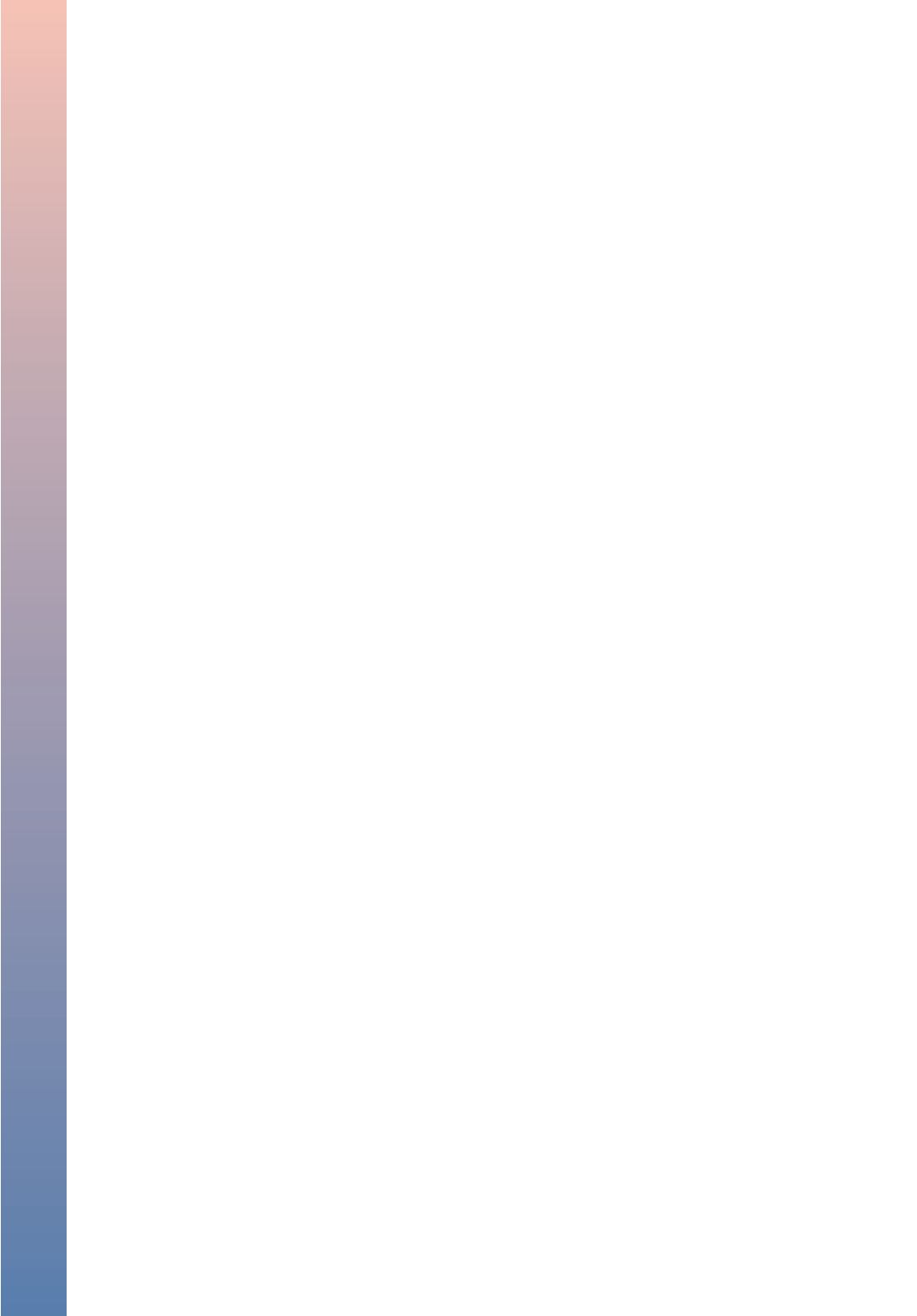
The Workplace Hazards Project aims to reduce injuries and increase awareness of health and safety obligations across industry. The Project puts a focus on the recurring injuries caused by six major occupational health and safety hazards. These major workplace hazards are:

- ◆ Working at Heights;
- ◆ Chemical Use;
- ◆ Manual Handling;
- ◆ Electrical;
- ◆ Machine Guarding; and
- ◆ Load-Shifting.

This booklet is designed to help managers and employees better understand and manage machine guarding issues in the workplace.

The information provided in this booklet will be a valuable source of practical guidance that will assist in achieving safer workplaces. We must work together to make sure that more South Australians return home from work safely .

*Michael Wright MP  
Minister for Industrial Relations  
2002*



## INTRODUCTION

Poor machine guarding practices are a major hazard confronted by people in the workplace everyday. Approximately 8 out of 10 workplace fatalities and 1 in 4 workplace injuries involve mechanical equipment. Many workplace injuries, caused through machinery are preventable.

Exposure to dangerous machine parts during operation, examination, lubrication, adjustment and/or maintenance, pose many risks. If the risk cannot be eliminated it must be minimised.

In order to reduce the risk, all machinery must be securely guarded to prevent access to dangerous parts. All guards should be correctly and securely fitted **before** operating machinery.

Machine guarding is vital to every workplace using machinery. It is an essential protection that employers must provide for their workers. Machine guards do not have to be complicated nor interfere with productivity.

**MAKE SURE YOUR  
MACHINE GUARDS  
ARE IN PLACE**

## THE HAZARD/RISK MANAGEMENT APPROACH

### WHAT DOES IT MEAN: HAZARD V RISK?

- ♦ A **Hazard** is something which has the potential to cause injury, illness or death. The term *hazard* can be applied to substances, methods or machines.
- ♦ A **Risk** is the possibility of injury, illness or death to a person due to hazard exposure. The *risk* will depend on factors such as the nature of the hazard, the degree of exposure and the individual characteristics of the person and/or hazard.

*For example, a piece of plant or machinery may be a potential hazard; however, it may not necessarily pose a risk unless it is incorrectly guarded or the operator is inadequately trained.*



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# MACHINE GUARDING

## IDENTIFYING THE HAZARDS

Hazard identification is the process of identifying all situations or events that could give rise to a potential for injury. It generally involves consideration of the possible type of injury or illness such as lacerations or crushed fingers caused through inadequate machine guarding. Situations and events which may impact on health and safety and result in injury include:

- ◆ machine use
- ◆ environmental conditions
- ◆ ergonomic needs
- ◆ machine failure

Machine guarding hazard identification is achieved through:

- ◆ Discussions with employees.
- ◆ Safety assessments conducted by engineers and designers in the early stages of a new product and/or process design.
- ◆ Prepurchase reviews of specifications for equipment and materials, conducted to ensure only the safest equipment comes into the workplace. Once equipment and materials arrive, check for hazards and introduce controls before use.
- ◆ Incident, accident and injury data analysis, to identify any patterns of injury or near misses which have occurred in the workplace, or in other similar workplaces.
- ◆ Work process reviews. Informal hazard assessments can easily be conducted by experienced tradespeople. This requires workers to carefully think through the task and try to anticipate where hazards might arise. Workers should consider:
  - activities they perform
  - where their face, hands and feet are placed
  - the body position they assume while they are performing a specific task
  - hazard exposure inherent in the equipment or generated by it
- ◆ Regular workplace inspections (using a checklist) to help uncover obvious workplace hazards.

*Occupational Health Safety and Welfare Regulation 3.3.1 requires the identification of all reasonably foreseeable hazards to health and safety arising from plant, or systems of work associated with plant.*

The following areas on machinery may be dangerous and are considered a risk. Consider them in your checklist when conducting a workplace inspection.

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# MACHINE GUARDING

Once you have **identified** the hazards (or danger areas), you should **assess** the risk (how likely it is to cause injury, and how severe the injury could be) and **control** these risks by guarding or by some other risk control method.

## RISK ASSESSMENT

Risk assessment is the process of prioritising identified hazards so that effort can be directed to eliminate, or control, those risks that have a high potential to cause harm. This is particularly important when an injury has occurred, or a new work practice or procedure is to be introduced. Risk assessments need to be undertaken on a regular basis and need to consider:

- ◆ **frequency** and level of exposure
- ◆ **pattern** of exposure (continuous or intermittent)
- ◆ **adequacy** of any existing risk control measures

Employers should conduct a separate risk assessment **for each machine** and any associated system of work used with that machine.

Identified hazards should be assessed to determine their potential to cause injury. The **likelihood** of the hazard causing an injury (**probability**) and the **severity** of the possible injury (**consequence**) need to be considered.

## THE RISK ASSESSMENT CALCULATOR

The Risk Assessment Calculator is a tool which helps you identify the level of risk.

### Using the Risk Assessment Calculator:

- ◆ select the appropriate point on the 'Probability' scale
- ◆ select the appropriate point on the 'Exposure' scale
- ◆ draw a line between the points chosen on the 'Probability' and 'Exposure' scale
- ◆ extend the line so that it intersects with the 'Tie Line'
- ◆ select the appropriate point on the 'Possible Consequence' scale
- ◆ draw a line from the point on the 'Tie Line' to the point on the 'Possible Consequences' line
- ◆ extend the line to the risk score scale

*Occupational Health Safety and Welfare Regulation 3.3.2 states the method used for risk assessment must adequately address the identified hazards.*



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## CONTROLLING THE RISK

The *Occupational Health Safety and Welfare (OHS&W) Regulations* require an employer to control the risk identified in any machine guarding task as far as 'reasonably practicable'. This means consider the following:

- ◆ severity of the hazard or risk in question
- ◆ knowledge of the hazard/risk and suitable ways of removing or reducing it
- ◆ availability and suitability of control measures
- ◆ cost of removing or reducing it

Appropriate control measures must be put in place to eliminate the risk, or where it is not reasonably practicable to do so, the risk must be minimised.

The ***hierarchy of control*** (listed in order of priority) is:

- 1 Elimination
- 2 Substitution
- 3 Engineering
- 4 Administration
- 5 Personal Protective Equipment (PPE)

Control measures must be chosen in order of priority, starting at level 1 and working to level 5 in the hierarchy of control. If control measures cannot be implemented, then the hazard management approach (as shown in the following page) should be applied. This approach shows the step-by-step process for identifying the hazard, assessing the risk and implementing appropriate risk control measures.

Consultation between employers and employees (or their health and safety representative) to evaluate the effectiveness of implementing control measures (eg, machine guarding) is essential.

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# MACHINE GUARDING

## 2. Substitution

'Substitution' involves replacing a hazardous piece of machinery or a work process with a non-hazardous one. For example:

- the operator using a tool to load a press with parts instead of placing them in by hand
- automating a process to prevent the operator from entering a danger area

## 3. Engineering

If a hazard cannot be eliminated or replaced with a less hazardous option, the next preferred measure is to use an engineering control. 'Engineering' controls may include:

- guarding machinery
- using enclosures (eg, enclosing a noisy piece of machinery)
- automating a process

## 4. Administration

Where 'Engineering' cannot fully control a health and safety risk, administration controls should be used. 'Administration' controls introduce work practices that reduce risk and limit employee exposure. They include:

- training employees in correct and safe operation
- developing Safe Operating Procedures (SOPs)
- reducing the number of employees exposed to the hazard
- reducing the period of employee exposure
- developing and implementing lock-out procedures
- displaying appropriate warning signs

## 5. Personal Protective Equipment

Personal Protective Equipment (PPE) should only be used when other higher order control measures are not possible, and only as a short term solution. Efforts to remove health and safety risks using 'Elimination', 'Engineering' and 'Administration' controls should be fully explored before PPE is implemented. Examples of PPE include:

- safety glasses
- gloves
- hearing protection

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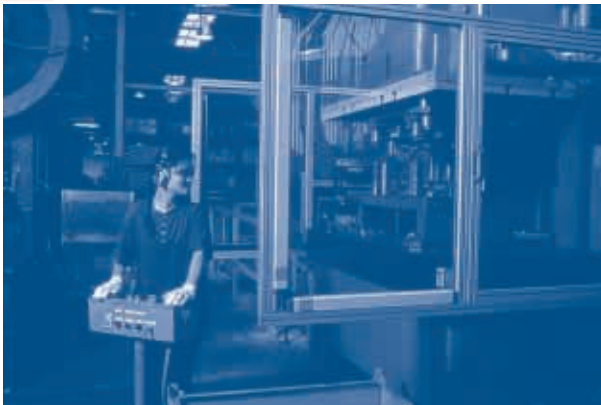
# MACHINE GUARDING

## ◆ Presence Sensing Devices

Presence Sensing Devices (PSD) detect entry into the 'dangerous work space' of a machine and stop all moving parts. Restart of the machine is possible only after a person, body part or obstacle has been removed. Examples of PSD include photoelectric light curtains, laser scanners and pressure mats.

The installation of these devices should comply with Australian Standard 4024 – Safeguarding of machinery – general principles.

*The correct application of various types of guards can be found in AS 4024.1 Safeguarding of machinery – general principles and AS 4024.2 Safeguarding of machinery – presence sensing systems.*



## ◆ Automatic Guards

Automatic Guards automatically move into position as the machine or cycle is started. They are also known as push away guards and are only suitable on slow moving machines.

## ◆ Adjustable Guards

Adjustable Guards can be adjusted to accommodate different sizes, shapes and materials. They also provide a barrier, that can be adjusted, to assist with a variety of production operations.

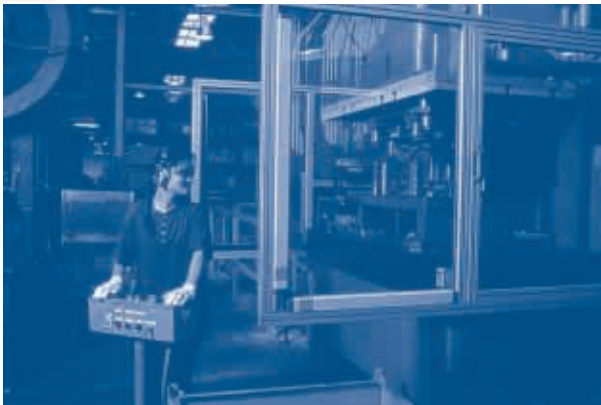
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## GUARDING COMMON MACHINE TYPES

### Exposed Rotating Cutting

Exposed Rotating Cutting machinery includes cut-off saws, planers, milling machines, friction cutters and boring equipment. Fixed, adjustable and self adjusting guards should be fitted where appropriate.

Note: An adjustable guard fitted to a planer allows material to be fed over the rotating cutters while protecting the operator.



### Pulleys and Drives

Fixed guards are preferred for Pulleys and Drives. All nip-points are to be guarded so as to be out of the operators reach.

### Rotating Shafts and Rollers

Fixed guards are preferred for Rotating Shafts and Rollers. It is important that guarding provides adequate protection against loose clothing and long hair becoming entwined within rotating shafts and rollers.

Examples of rotating shafts include:

- ◆ couplings
- ◆ spindles
- ◆ fan-shafts
- ◆ ironing rollers



*(Case study) A man had his hand severely crushed and the skin stripped away from the fingertips when it was drawn in between the inking rollers of a printing press. The man was attempting to remove a flake of paint off one roller while the press was running at high speed. A fixed guard was later installed.*



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# MACHINE GUARDING

## Power Presses

The two main categories of power presses are:

- ◆ power stamping presses
- ◆ brake presses

Suitable methods to control hazards associated with power presses may involve a **combination** of guard types. For example, fixed and interlocked guards may be appropriate for a power press during a production run, whereas, presence-sensing devices (ie, light curtains or light beams) may be used to guard a brake press.

Supplementary information on guarding power presses is provided in the Workplace Services brochure titled '*Machine Guarding – Metal Fabrication Industry*'.

The machine guarding method you choose for a power press depends upon the type of job and how it is to be carried out. Associated hazards must be identified, the level of risk assessed and adequate controls put in place to minimise or eliminate the risk.

Regular maintenance of machinery is extremely important. For maintenance to be effective, inspection records must be kept. Other safeguards (eg, two-handed controls, emergency stops, etc) must be considered when designing a machine guarding system.



*Guarding of power presses must (as a minimum) comply with AS 1219 Power presses – safety requirements and should be in accordance with AS 4024.1 Safeguarding of machinery – general principles and AS 4024.2 Safeguarding of machinery – presence sensing systems.*

## GUARD DESIGN

The primary function of a guard is to provide a physical barrier which prevents access to dangerous parts of a machine.

Poorly designed or inappropriate guarding often contributes to machine related injuries.

Guards should be designed to make tasks such as machine cleaning, adjustment or belt changes easier, particularly if these tasks need to be undertaken regularly. You should **be able to remove a guard only with the aid of a tool.**

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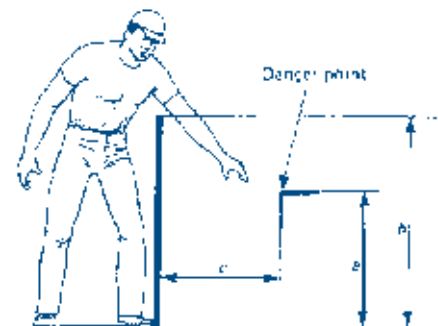
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## ERGONOMIC CONSIDERATIONS

The following illustrations and tables may help you assess what sort of guarding is required and where it should be located (in order to keep a danger point on a machine safely out of reach).

Where doubt exists in relation to the distances shown, measurements should be taken of the actual work place to ensure danger points are beyond reach.



### LEGEND

a = distance of danger point from floor

b = height of edge of barrier

c = horizontal distance from edge of barrier to danger point

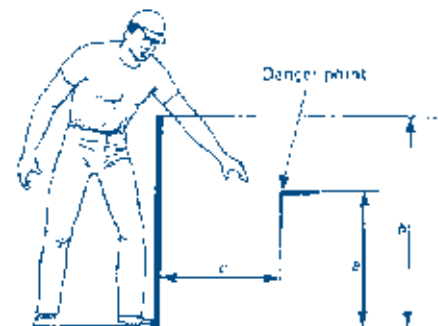
millimetres

Height of danger zone $a$	Horizontal distance to danger zone $c$								
	Height of protective structure $b$								
	1 000†	1 200†	1 400†	1 600†	1 800	2 000	2 200	2 400	2 500
2 500	—	—	—	—	—	—	—	—	—
2 400	100	100	100	130	100	100	100	100	—
2 200	600	600	500	500	400	350	250	—	—
2 000	1 130	900	700	600	500	350	—	—	—
1 800	1 130	1 000	900	900	800	—	—	—	—
1 600	1 330	1 000	900	900	500	—	—	—	—
1 400	1 300	1 000	900	800	100	—	—	—	—
1 200	1 400	1 000	900	500	—	—	—	—	—
1 000	1 400	1 000	900	300	—	—	—	—	—
800	1 300	900	600	—	—	—	—	—	—
600	1 200	500	—	—	—	—	—	—	—
400	1 200	300	—	—	—	—	—	—	—
200	1 100	200	—	—	—	—	—	—	—
0	1 100	200	—	—	—	—	—	—	—

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200	1 100	200	—	—	—	—	—	—	—
0	1 100	200	—	—	—	—	—	—	—

# MACHINE GUARDING

Part of body	Illustration	Opening	Safety distance $s_r$		
			Slot	Square	Round
Finger(s)		$e \leq 4$	$\geq 2$	$\geq 2$	$\geq 2$
		$4 < e \leq 6$	$\geq 10$	$\geq 6$	$\geq 5$
Finger up to knuckle joint or Hand		$6 < e \leq 8$	$\geq 20$	$\geq 15$	$\geq 5$
		$8 < e \leq 10$	$\geq 80$	$\geq 25$	$\geq 20$
		$10 < e \leq 12$	$\geq 100$	$\geq 80$	$\geq 80$
		$12 < e \leq 20$	$\geq 120$	$\geq 120$	$\geq 120$
Arm up to junction with shoulder*		$30 < e \leq 40$	$\geq 850$	$\geq 200$	$\geq 120$
		$40 < e \leq 120$	$\geq 850$	$\geq 850$	$\geq 850$

DIMENSIONS IN MILLIMETRES

## OTHER CONSIDERATIONS

### Work Organisation and Work Processes

Your work practices should incorporate the use of guards on machinery.

Sometimes guards are removed, or not used to make a task easier or quicker. Avoid work practices that may encourage workers to remove or bypass guards, eg, bonus or incentive payment systems may encourage guard removal and therefore should be used with caution.

When developing a machine guarding solution:

- ◆ talk to the employees who use the machinery
- ◆ take into account safety, job procedures and production rates
- ◆ you may need to modify existing work procedures to ensure guarding does not create new problems
- ◆ consider the movement of materials on site

In the long term, a carefully considered guarding solution will prove to be less costly and more efficient for your business and employees.

# MACHINE GUARDING

Part of body	Illustration	Opening	Safety distance $s_r$		
			Slot	Square	Round
Finger(s)		$e \leq 4$	$\geq 2$	$\geq 2$	$\geq 2$
		$4 < e \leq 6$	$\geq 10$	$\geq 6$	$\geq 5$
Finger up to knuckle joint or Hand		$6 < e \leq 8$	$\geq 20$	$\geq 15$	$\geq 5$
		$8 < e \leq 10$	$\geq 80$	$\geq 25$	$\geq 20$
		$10 < e \leq 12$	$\geq 100$	$\geq 80$	$\geq 80$
		$12 < e \leq 20$	$\geq 120$	$\geq 120$	$\geq 120$
Arm up to junction with shoulder*		$30 < e \leq 40$	$\geq 850$	$\geq 200$	$\geq 120$
		$40 < e \leq 120$	$\geq 850$	$\geq 850$	$\geq 850$

DIMENSIONS IN MILLIMETRES

## OTHER CONSIDERATIONS

### Work Organisation and Work Processes

Your work practices should incorporate the use of guards on machinery.

Sometimes guards are removed, or not used to make a task easier or quicker. Avoid work practices that may encourage workers to remove or bypass guards, eg, bonus or incentive payment systems may encourage guard removal and therefore should be used with caution.

When developing a machine guarding solution:

- ◆ talk to the employees who use the machinery
- ◆ take into account safety, job procedures and production rates
- ◆ you may need to modify existing work procedures to ensure guarding does not create new problems
- ◆ consider the movement of materials on site

In the long term, a carefully considered guarding solution will prove to be less costly and more efficient for your business and employees.

# MACHINE GUARDING

## Fatigue

The safe use of machinery requires more than attending to guarding. Long hours of work or long periods without adequate breaks can lead to loss of concentration and slow reflexes which enhance the risk for human error. Excessive heat, poor ventilation and poor operator comfort, ie, inappropriate seating position, location of controls can also contribute to a loss of concentration and error. Employers should take this into account when considering machine guarding.

## Lighting

Consider the following safety issues relating to the provision of adequate and appropriate lighting around machinery:

- ◆ direction and intensity of lighting
- ◆ contrast between background and local lighting
- ◆ colour of the light source
- ◆ reflection, glare and shadows
- ◆ stroboscopic effect of fluorescent lighting on moving machinery. It can make moving parts of machinery look as if they are stopped

## Noise

Noise, particularly excessive noise, interferes with concentration and can cause an operator stress which may lead to errors in judgement and prevent effective verbal communication.

Given this, it is essential to minimise noise in the workplace. Where noise levels remain high ensure operators wear appropriate and properly fitted hearing protection.

In many instances, carefully designed guarding of moving parts can aid noise reduction and help remove the stress associated with prolonged exposure to excessive noise.

## Ventilation

Some processes and machinery generate heat. Design guarding to allow air flow through areas of mesh so that equipment does not overheat.

*(Case study) A factory was fined \$75000 after a 16 year-old worker had two fingers severed by a power press in December 1999. The employer pleaded guilty for failing to maintain a safe work area.*

*Penalties in South Australia for non-compliance with the OHS&W legislation were significantly increased in January 2001.*





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# MACHINE GUARDING

Safe operating procedures are required to ensure machinery cannot be restarted when undergoing maintenance or other temporary operations. A lock-out (or tag-out) system may also be required. Conduct a hazard identification and risk assessment to determine the most suitable location of controls.

## Weight

Large or heavy sections of guards may need to be removed for maintenance access. Some sections may remain fixed; however, when possible ensure that the sections to be removed can be easily handled by one person. Put handles on moveable sections where appropriate.

## Colour Coding

It is good policy for all safety guards within a workplace to be painted the same colour, eg, 'sunflower' yellow, for high visibility (if different to the general machinery colour) to assist in easily identifying when a safety guard is not in its proper place.

## Interactions

Guards that move out of the way for each operation (automatic guards) need special consideration. Assess the potential for problems in the following interactions:

- ◆ between **guard and machine**
- ◆ between **guard and person**
- ◆ between **guard and workpiece**

## Dust

A dusty workplace can be dangerous. Dust and other airborne contaminants can have direct and severe long term effects on the health of workers. Respiratory problems, skin disorders and even cancer may be caused through dust. The discomfort caused by dust on the skin, clothing and protective equipment can also compromise safety.

Dust can also be a potential safety risk by clogging machinery parts, inducing sudden breakdowns, obscuring moving parts and other hazards.

Airborne dust also can create an explosive hazard in some industries.

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# MACHINE GUARDING

- ◆ Temporary or permanent loss of an experienced staff member through injury can be very costly, especially in terms of loss of expertise to the business.
- ◆ Injuries can retard your business. The legal, medical and other costs often go uncalculated. Even one incident involving litigation may bankrupt a small employer.
- ◆ Employers may face increased premiums.
- ◆ Adverse publicity resulting from death, severe injury, prosecution, or common law claims may impact on your workers as well as your customer group.

Have you factored these costs into your business?

## FURTHER ASSISTANCE

### Consulting Engineers

There are a number of consultants that can offer advice on machine guarding. If you decide to use a consultant, shop around and make sure that the consultant is fully conversant with South Australian legislative requirements. Ensure their approach is consistent with the principles identified in this guide. Ask for evidence of previous work in the area and check out their standard of work for yourself by talking with other clients.

You may consider reducing your costs and time by sharing the Consulting Engineers costs with other employers in your area.

### Your Workers

Workplace safety committees or health and safety representatives should also be involved in developing safety solutions. If you don't have these in your workplace you should still involve workers. In the end, your employees have a direct interest in safeguarding their own health.

Your workers can assist in developing solutions. They work with the machinery every day and can often help identify a problem and assist in devising the most effective and cost-efficient solutions.

A guard may look fine from an engineering viewpoint but should also consider worker comfort and ease of operation. Workers are usually in the best position to judge this.

### Section 21

An employee must take reasonable care to protect the employee's own health and safety at work.

### OHS&W Regulations 1995

#### Division 1.2.1 Employers

1.2.1 (1) Subject to any express provision in a particular regulation to the contrary, an employer must, in respect of the health, safety or welfare of his or her employees, and the health or safety of any other person who could be adversely affected by the performance of work, ensure compliance with any regulation that, pursuant to regulation 1.2.14 and schedule 1, applies to employers.

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# MACHINE GUARDING

## **AS 1473 – Wood-processing machinery - safety**

Specifies minimum requirements for the guarding and safe use of powered machines which cut or abrade wood, wood products and like materials, to be observed by employers, trainers, employees, designers, makers and suppliers of woodworking machinery and other persons having an interest in woodworking machine operations.

Chainsaws, and machinery used in the milling of raw sawlogs, together with debarkers and log peelers are not covered.

## **AS 1755 - Conveyors - safety requirements**

Specifies minimum safety requirements for the design, construction, installation and guarding of conveyors and conveyor systems, with specific requirements for unit and bulk handling conveyors. Provides recommendations for inspection, maintenance, marking and identification, and the training of operators.

## **AS 1788 - Abrasive wheels**

Specifies requirements for the design and construction of abrasive wheels and the manufacture, installation, application and operation of abrasive wheels and ancillary equipment. Particular requirements are given for the construction of guards for all equipment fitted with abrasive wheels and for the construction of flanges for use with abrasive wheels.

## **AS 1893 - Guarding & safe use of metal & paper cutting guillotines**

Outlines the general specifications of guarding requirements, with particular information on guarding different types of machines. Fixed, interlocked, automatic and electronic guards are included.

## **AS 2294 - Protective structures for earthmoving machines**

Specifies the requirements for roll-over protective structures and falling-object protective structures.

**Australian Standards** are available from:

Standards Australia  
63 Greenhill Rd, Wayville  
Tel: 1300 654 646  
[www.standards.com.au](http://www.standards.com.au)

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