Queensland Government
Workplace Health and Safety

A Guide to Practical Machine Guarding

This Guide has been produced by the members the Metals Manufacturing and Minerals Processing Industry Committee. The committee consists of representatives of Employers, Employees and Health and Safety Experts from the Metal Manufacturing Industry

Contents

Practical Machine Guarding

Machinery is a major hazard at work. About 8 out of 10 workplace fatalities and 1 in 4 of workplace injuries involve mechanical equipment. Many workplaces with machinery have unnecessary injuries.

Where there is a risk of exposure to dangerous parts during operation, examination, lubrication, adjustment or maintenance, that risk must be eliminated, or, where it cannot be eliminated, minimised.

All machinery must be securely guarded to prevent access to dangerous parts.

Make sure machine guards are in place. All guards should be correctly and securely fitted BEFORE operating a machine.

Machine guarding is vital to every workshop using machinery. It is an essential protection you can and need to provide for your workers. Guards need not be complicated nor interfere with productivity.

Identify the Hazards

A ***hazard*** is something which could cause injury.

A ***risk*** is the likelihood of the hazard causing an injury, and how severe the injury could be

What parts of a machine do you look at to find the danger areas? Typically, the following areas on machinery are dangerous, and can be a risk to anyone near the machine:

Parts which move or transmit power

- belts & pulleys
- flywheels & gear wheels
- shafts & spindles
- slides & cams
- chain & sprocket gears

Parts that do the work

- tools & dies
- guillotine blades
- milling cutters
- circular saws
- drills & chucks

To help identify dangerous machine parts, look for:

- 'drawing in' points
- shear points
- impact and crushing areas
- cutting areas
- entanglement areas
- stabbing points
- abrasion areas
- flying particles
- any protrusions which could cause injury

Machine Hazards which may be controlled by Guarding:

- Contact or entanglement with machinery
- Trapped between machine and material or fixed structure
- Contact with material in motion
- Being struck by ejected parts of machinery
- Being struck by material ejected from machine
- Release of potential energy

Once you have identified the 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 in some other effective way.

Assess the Risks

Where a hazard is identified, an assessment of risks associated with the hazard must be made. Employers should conduct a separate risk assessment for each machine and any associated system of work used with that machine.

Risk assessment seeks to prioritise identified hazards so that effort can be directed to eliminate or control risks that have a high potential to cause harm.

Identified hazards are assessed to determine their real potential to cause injury. Consider the likelihood of the hazard causing an injury (probability), and how severe the injury could be (consequence).

Probability	**How likely could it happen?**
Very likely	could happen frequently
Likely	could happen occasionally
Unlikely	could happen but rare
Very unlikely	could happen but probably never will

Consequence	**How severely could it hurt someone**
Catastrophic	kills, disables, permanent injury
Major	maiming, significant injury, NOT permanent
Minor	first aid only, no lost time

The two categories of the assessed risk are then plotted on the risk chart to determine its priority for action.

Priority 1 urgent action is required to control this risk; down to

Priority 6 deal with other priorities first

RISK PRIORITY CHART

PROBABILITY **How likely COULD it happen**	**CONSEQUENCE: How severely could it hurt someone?** CATASTROPHIC kills, disables permanent injury	MAJOR significant injury, NOT permanent	MINOR first aid only, no lost time
VERY LIKELY could happen	**1**	**2**	**3**
LIKELY could happen occasionally	**2**	**3**	**4**
UNLIKELY could happen but rare	**3**	**4**	**5**
VERY UNLIKELY could happen, probably never will	**4**	**5**	**6**

Once you have ***assessed*** the risk (how likely it is to cause injury, and how severe the injury could be), you will need to **control** these dangers by guarding or in some other effective way.

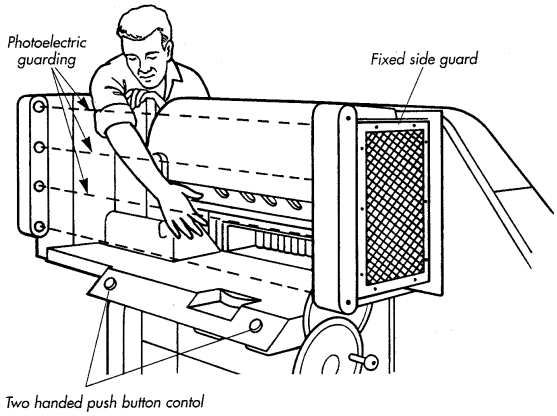
A blank *Risk Assessment Form* is included on page 4 to help you assess the risks on your machinery. This can be photocopied as many times as you need. It is suggested that you use one page per machine, or part of a machine if it has several hazards.

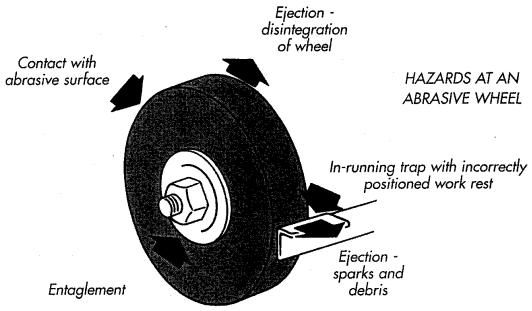
Control the Risks

Where an assessment identifies a requirement to control a risk to health and safety, that risk must be eliminated or, where it cannot be eliminated, minimised.

Appropriate control measures must be put in place to eliminate the risk or where it is not practical to do so, the identified risk must be minimised. Control measures must be chosen from the highest possible level in the following hierarchy:

LEVEL 1:	**Eliminate the risk**
LEVEL 2:	**Minimise the risk** by one or a combination of:
	substitution of a less hazardous machine
	modify the design of the machine
	isolation of the machinery
LEVEL 3:	**Where risk not minimised:**
	introduction of **administrative controls**
	appropriate **personal protective equipment**





Control measures adopted should be monitored, on a regular basis, to ensure their effectiveness.

Write your chosen method of controlling the risk on a copy of the *Risk Assessment Form* which can be found on page 4 of this document. If the control measure cannot be instituted now, you can use the form to note the controls to use now, and what you intend to do later.

Risk Assessment Form

(May be photocopied and used)

Type of Machine:.....

Identification: .....

Hazard: …….....

On the following chart, circle the most likely harm to a person if the risk happens (along the top)
Next, circle how often it COULD happen (down the left hand side)
The risk priority (score)is the number where the two intersect.

RISK PRIORITY CHART

PROBABILITY **How likely COULD it happen**	**CONSEQUENCE: How severely could it hurt someone?** CATASTROPHIC kills, disables permanent injury	 MAJOR significant injury, NOT permanent	 MINOR first aid only, no lost time
VERY LIKELY could happen	**1**	**2**	**3**
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VERY UNLIKELY could happen, probably never will	**4**	**5**	**6**

What is the risk priority? (score 1 - 6 from the above chart)

- If you score a 1 or 2, do something NOW.
- If you score 3 or 4, do something soon.

Chose control measures from the highest possible level in the following list:

LEVEL 1: Eliminate the risk

LEVEL 2: Minimise the risk
substitution of a less hazardous plant
modification of the design of the plant work
isolation of the plant
engineering controls such as guarding.

LEVEL 3: Where risk not minimised:
use **administrative controls,** and
appropriate **personal protective equipment**

CONTROL MEASURES - action to take:

NOW: .....

.....

LATER (Date: / /).....

.....

In many cases, GUARDING is the best form of control for the health and safety risks of a machine, particularly in most smaller businesses.

This *Risk Assessment Form* can be used to prioritise the risks found in a workplace.

Select the Guard

Types Of Guard

There are a number of different types of guards, all suited to particular purposes. You must consider which type of guard is best suited for your needs. The different types include:

- **fixed guards** - have no moving parts and prevent contact between moving machinery part and any part of the body. They offer protection only when properly fixed in position. Fixed guards should be easy to remove and replace, *but only be able to be opened or removed with a tool*.

- **interlocking guards** - are moveable, with the moving part interconnected with the control system. Interconnections are usually either electrical, mechanical, hydraulic or pneumatic. The interlock prevents the machinery from operating unless the guard is closed.

- **automatic guards** - automatically move into position as the machine, or cycle, is started. They are also known as push away guards. These are only suitable on slow machines.

- **distance guards** - prevent access to dangerous area through a barrier or fence.

- **trip guards (presence sensing devices) -** these stop the machine when **a** person gets into in a position where they are liable to be injured. A photo-electric curtain is an example of this type of guard.

Design the Guard

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

Some Basic Rules For Guard Design

Having a guard is not enough. Poorly designed or inappropriate guarding has often contributed to machinery injuries.

Guards should be designed for easy removal and replacement. This will make tasks such as cleaning, machine adjustment or belt changes easier, particularly if this needs to be done regularly. However, guards shall only be able to be removed with the aid of a tool.

Hinged guards may be used, however, their use should be restricted to instances where guard weight or restricted access for removal is a consideration. An interlock device may need to be used in conjunction with hinged guarding.

Avoid second best when designing a guard. If you use a guard from another machine, ensure it is not defective and it is appropriate for the machine.

When making your own guards ensure the materials used are of good quality.

Guarding can play a useful role in both dust and noise reduction. In many cases, issues of wear, heat and ventilation affect operating efficiency, health and safety. Careful attention to design and layout at the outset can avoid problems later on.

Technical assistance may be found in Australian Standards. The standards with particular relevance to machine guarding are listed on page 17, together with a brief description of their contents.

Ergonomic Considerations

The illustrations and table below will help you assess where and what sort of guarding is needed to keep a danger point on a machine safely out of reach.

Reach Measurements

The design and positioning of guards should provide at least the following clearance:

Reach	Minimum distance assumed
Arm reach	≥850mm from under arm to fingertip
Elbow reach	≥550mm from the inside elbow to fingertip
Wrist reach	≥230mm from wrist to tip of middle finger
Finger reach	≥130mm
Vertical reach	2500mm maximum when standing on toes

These dimensions include and allowance for clearance form danger points.

Guard Placement

The size of mesh or other openings in the guard and the distance of the guard from the danger point shall be:

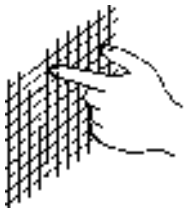
Mesh size openings up to and including 9mm	Distance of guard from danger point virtually the same as sheet metal, working clearance only required
Over 9mm but less than 40mm	Guard at least 200mm from danger point
All types of guards	Distance between bottom opening and floor not to exceed 250mm

Simple Gap / Distance Formula

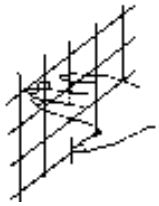
The following formula provides an easy method for determining gap or mesh openings, and the distance the guard should be from the danger point.

$$\text{Gap} = \frac{\text{Distance}}{10} + 6\text{mm}$$

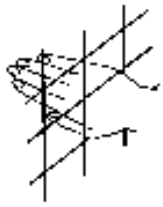
no admittance



reach restricted to root of finger



reach restricted to root of thumb



reach restricted to hand thickness

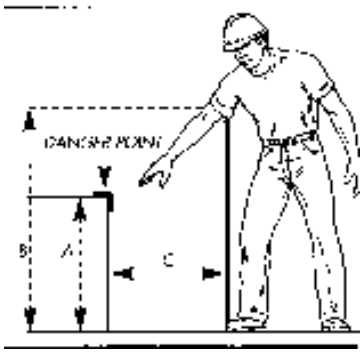
Reaching Down and Over

In the following diagram and table:

a = distance of danger point from the floor or working surface

b = height of the barrier

c = horizontal distance between edge of barrier and danger point



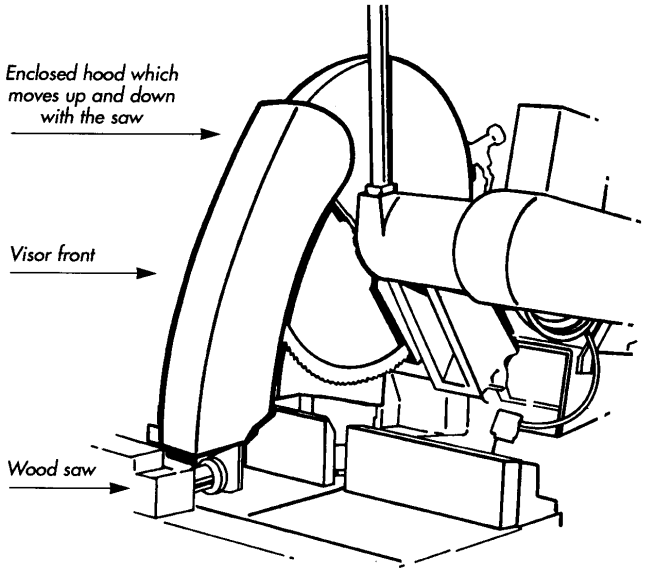
NOTE: Barriers must not be able to be stepped over.

a - distance of danger point from floor (mm)	**b** - height of the barrier (mm)							
	2400	2200	2000	1800	1600	1400	1200	1000
	c - horizontal distance between barrier and danger point (mm)							
2400	-	100	100	100	100	100	100	100
2200	-	250	350	400	500	500	600	600
2000	-	-	350	500	600	700	900	1100
1800	-	-	-	600	900	900	1000	1100
1600	-	-	-	500	900	900	1000	1300
1400	-	-	-	100	800	900	1000	1300
1200	-	-	-	-	500	900	1000	1400
1000	-	-	-	-	300	900	1000	1400
800	-	-	-	-	-	600	900	1300
600	-	-	-	-	-	-	500	1200
400	-	-	-	-	-	-	300	1200
200		-	-	-	-	-	200	1100

Guards for Different Machine Types

Exposed Rotating Cutting

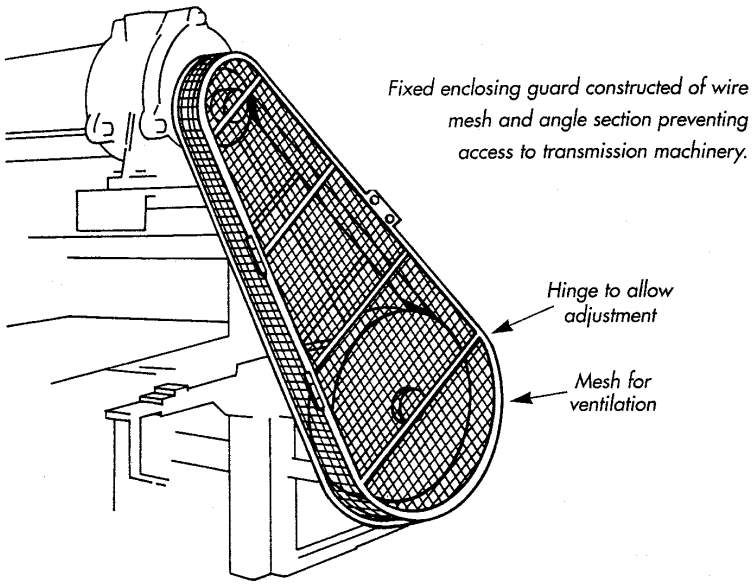
Exposed rotating cuffing machinery includes *Cut-off Saws, Milling Machines, friction Cutting and Boring* equipment. Fixed and moving guards should be fitted where appropriate.

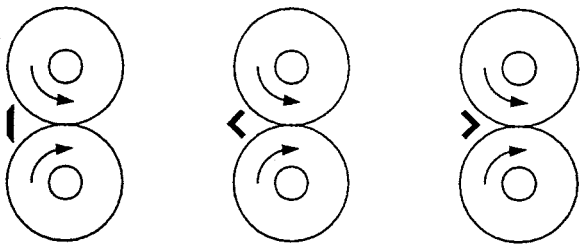


Self-adjusting guarding arrangement for a cut-off saw.

Pulleys and Drives

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



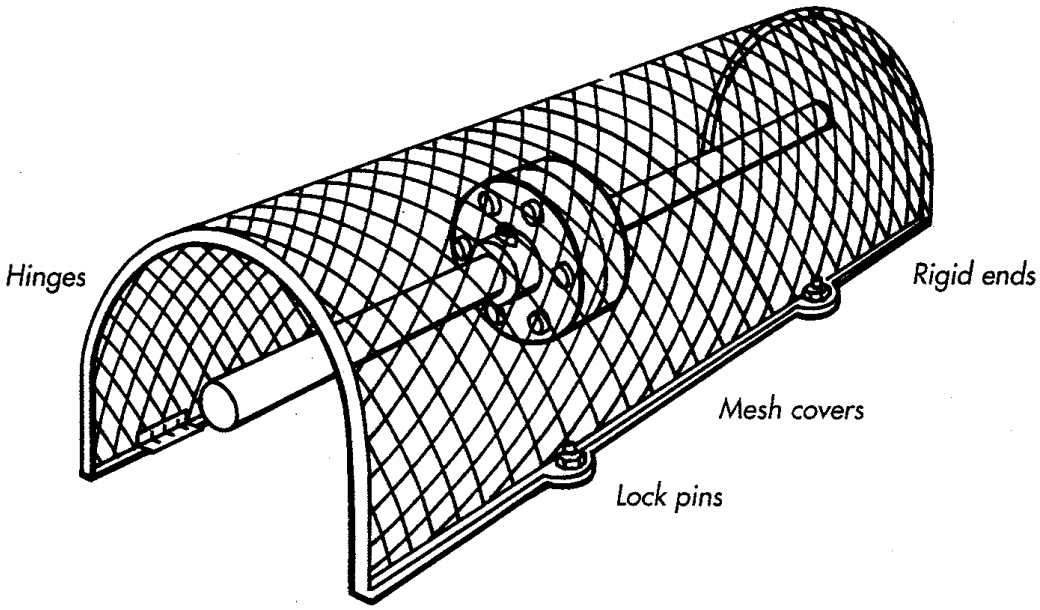


Use of flat plate or angle section to prevent access to in-running nips.

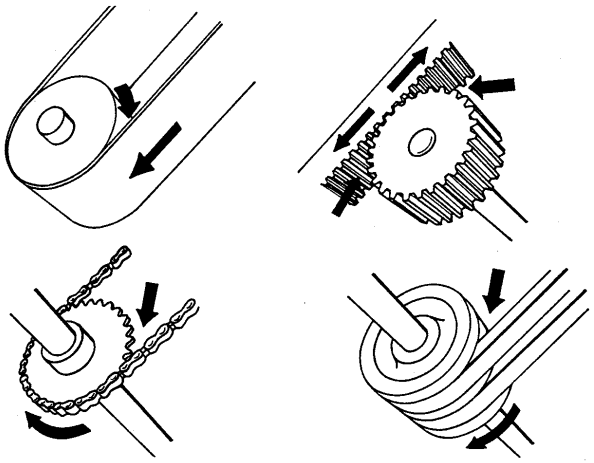
Rotating Shafts and Rollers

Fixed guards are preferred for Rotating Shafts and Rollers. Examples of rotating shafts include couplings, spindles, fan-shafts and ironing rollers.

Provide protection against loose clothing and long hair getting entwined with rotating shafts.



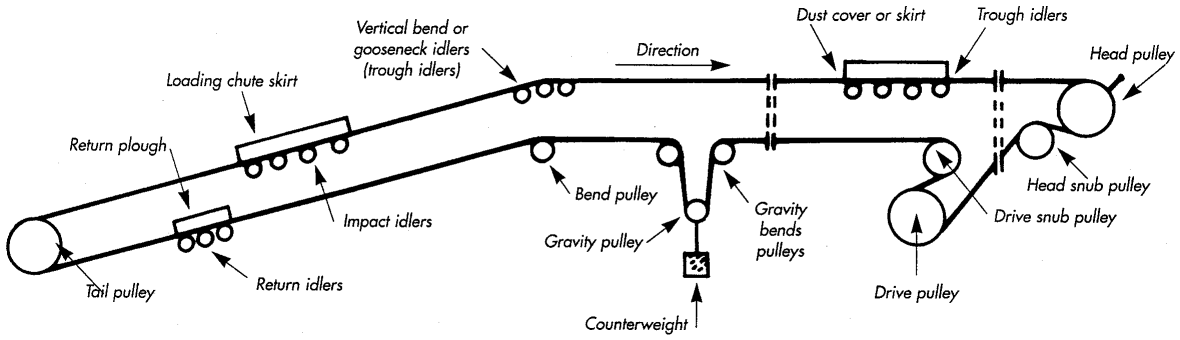
ROTATING SHAFTS/COUPLINGS



DRAWING-IN HAZARDS BETWEEN ROTATING AND TANGENTIALLY MOVING SURFACES

Conveyors (bulk handling)

Belt Conveyors, Screw Conveyors and Bucket Conveyors typically require guarding - usually with fixed guards.

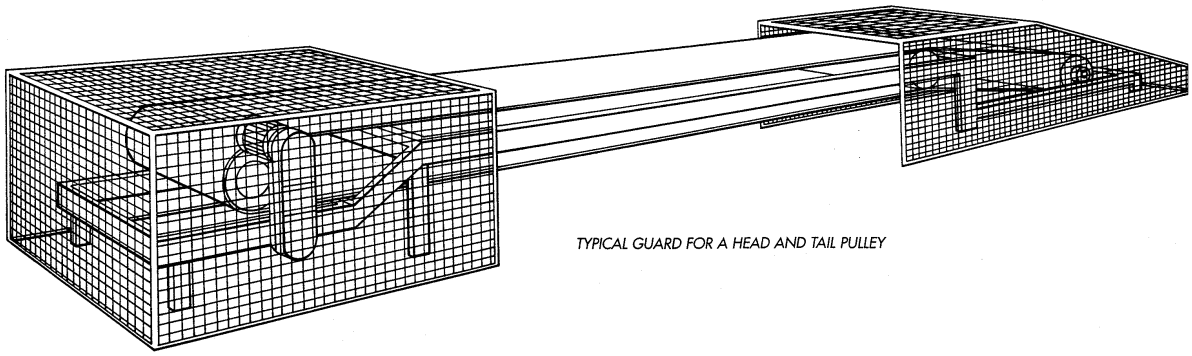


THIS ILLUSTRATION SHOWS THE NUMEROUS DANGER POINTS ON A STANDARD CONVEYOR.

The following examples show ways to guard the head and tail sections of conveyors. All guards should be designed for easy removal and should require the use of a tool for this removal.

It is important to note that physical guarding is not the only safety aspect of conveyor systems Other safeguards are:

- **Electrical isolation** - (lock-out/tag-out)Although safeguards are provided which prevent access during most phases of machine life, they may not be effective at all times because of the need to gain access to hazardous areas during maintenance, set-up, etc. Isolation procedures should be developed by the employer which are appropriate for the particular machine. These procedures could include various types of locks, keys and danger tags. A typical lock-out/tag-out system for conveyor drives would be to apply a lock to the isolation switch, as well as a danger tag with the maintenance person's name on it.
- **Start and stop controls** - Conveyors should be provided with appropriate drive power isolation, whether electrical, hydraulic, pneumatic or mechanical. Isolation should be secured by means of a lock-out/tag-out system. At each conveyor start location, a clearly labelled Stop control should be provided. Where the Start control is in a position from which the whole of the conveyor operation cannot be viewed, a visible or audible signal should be provided to warn persons in the vicinity.
- **Emergency stop controls** - All conveyors should be fitted with emergency Stop controls. Where conveyors are readily accessible, these controls should be located at intervals not exceeding 30m. A lanyard type pull-wire is considered appropriate. These controls must be manually reset before the conveyor can be started.
- **Access provisions** - Machinery design should allow all routine adjustment, lubrication and maintenance to be carried out without removing guards or extensive dismantling of components. Lubrication and routine maintenance facilities should be incorporated outside the danger area wherever practical. However, when persons require access to the danger area, for example for machine setting, safe isolation procedures should be used.
- **Lighting** - Provide local lighting on the machine for lighting the work area when the machine or guards render normal lighting inadequate for safe operation. Local lighting should also be provided in areas of regular maintenance which are poorly lit, for example inside certain electrical compartments where electrical isolation is necessary for access.



TYPICAL GUARD FOR A HEAD AND TAIL PULLEY

Power Presses

Power presses can be divided into two categories **1**. Power stamping presses **2**. Press Brakes

1. Stamping Presses (Key Clutch And Hydraulic)

Depending on the type of job to be carried out, there ore various ways of guarding these presses:

a. Fixed Guarding

A fixed guard has no moving parts and offers protection only while the guard is in its correct position.

Operator access to the hazardous area is prevented, however with the aid of a tool, slides can be adjusted to allow work to be fed through the guard into the stamping area.

b. Interlocked Guarding

An interlocking guard is a guard which has a moveable part, that is interconnected with the power or control system of the machine so that until the guard is closed, the interlock prevents the machine from operating.

With the key-clutch type of press fitted with interlocked guarding, it is also necessary to fit an anti-repeat device to prevent a power stroke in the event of a clutch failure.

c. Presence Sensing Devices (Photoelectronics)

Hydraulic Machine only. This device detects the presence of a person, or part of a person, in a defined area and prevents the dangerous parts of machinery from moving while anyone is in that area.

The installation of these devices should comply with AS 4024 parts 2 and 3.

d. Two-Handed Controls

Hydraulic machines only. This is a device which requires both hands to operate the machine controls and should be installed in accordance with the following:

- The controls shall be separated and protected to prevent spanning with one hand only
- It shall not be possible to set the dangerous parts in motion unless the controls are operated within .5 sec of each other
- If one or both controls are released, movement of the dangerous parts shall be arrested immediately
- The controls should be positioned at such a distance from the danger point that, on releasing the controls, it is not possible for the operator to reach the danger point before the motion of the dangerous parts has been arrested.

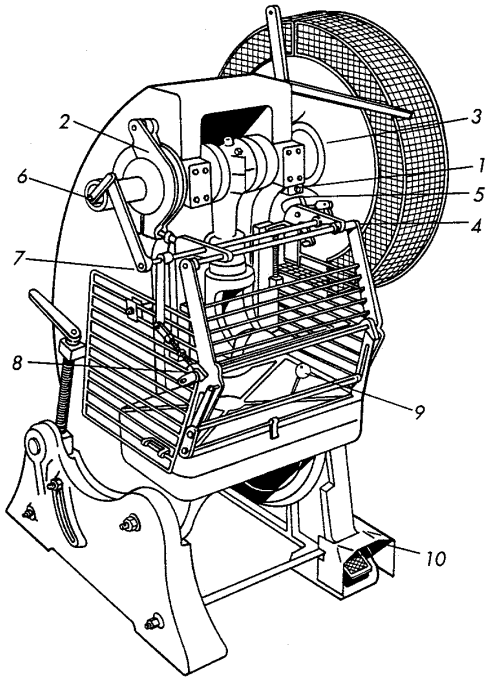
- Rear and side guarding of the machine is required.

Regular maintenance of 'key-clutch' presses is extremely important. For maintenance to be effective, inspection records should be kept.

Safety inspections should include the condition and operation of the following:

- Flywheel bearing and shaft
- Extractor cam and key
- Anti- repeat device
- Brakes
- Guards

Flywheel seizure. *The flywheel journal bearings must be kept well-lubricated and clean the majority of presses have ball or roller-bearings but some imported machines do have rolling keys. The design of rolling key clutches is such that plain bronze bearings are a necessity. any metallic fragment entering the bearing, or a simple lack of lubrication, could cause the bearing to seize on the journal of the crankshaft and an uninitiated stroke to occur.*



MAINTENANCE PROBLEM AREAS

1. *Clutch mechanism*
2. *Brake*
3. *Flywheel bearing*
4. *Pitman screw*
5. *Clutch interlock*
6. *Guard control*
7. *Linkage and attachments*
8. *Toolsetter's disconnection*
9. *Distortion and deterioration of guard gates*
10. *Guard over foot pedal*

2. Press Brakes (Mechanical & Hydraulic)

A Press-Brake is a machine generally limited to linear bending and forming of material eg. sheet metal and heavy gauge material.

If Press-brakes are being used for specific repetitive jobs, fixed guards may be fitted. However, for general use, these machines would require presence sensing devices, ie. light curtains or light beams fitted. These light beams and light curtains would enable employers to fully utilise their presses. To ensure the safety and integrity of these presence sensing devices, their design, manufacture and installation should comply with the relevant standard.

Presence Sensing Systems - Light Curtains

Light curtains consist of several pairs of light box units and a control box. Each light box pair has a transmitted and receiver. The transmitter generates a curtain of high intensity, micro-second infra-red light pulses across the machine operators work area approximately 600mm from the hazardous area. Any intrusion into this light curtain produces a signal for the control box to stop the machine.

In order to assist the operator these light curtain systems have a variety of operating modes for example:

Continuous Stroking: In this mode, when the control pedal is depressed, the machine will move from the top of the stroke and continue to stroke while the pedal is depressed. If the light curtain is penetrated while the machine is downstroking, the machine will stop.

Top-to-Top: In this mode the machine operates as in the continuous mode, except that regardless of whether the operator releases the foot pedal, the machine will stop at the top after one cycle.

Bottom Stop: In this mode the machine starts from the top of the stroke when the pedal is depressed, and stops leaving a daylight gap of 6mm between the top and bottom beam. At this point the light curtain is muted or bypassed. Depressing the pedal again moves the machine to the bottom of the stroke and returns it to the top where it stops. At this point the light curtain is reactivated.

Bottom Stop-to-Bottom Stop: This mode is similar to the bottom stop mode except that the machine does not stop at the top of the stroke. It stops at the 6mm gap mute position or when the light curtain is obstructed on the down stroke.

Pulsing: In this mode the light curtain is muted or bypassed and the machine can be moved down in 10mm increments with each depression of the pedal. This mode allows the operator to stand inside the curtain for close work.

Link: This mode is used for mechanical presses and is similar to the bottom-stop mode, except that the initial down stroke is controlled by an electric foot-switch and at the 6mm mute point, the pedal controlling the mechanical friction clutch is operated to finalise the stroke of the machine.

Presence Sensing Beams - Light Beams

This type of guarding system consists of three infra-red light beams mounted on the Press-brake blade.

The front beam protects the operator, while allowing work to be performed close to the blade.

The centre beam sets the mute bypass point.

The rear beam protects persons at the rear of the machine, eliminating the need for mechanical guarding.

For work with an unusual profile where the beam may be obstructed, the machine can be operated in the pulse mode. This mode mutes the guard and permits the blade to descend in 10mm increments.

This type of system cannot be used on mechanical presses.

Your Obligations

Your obligation in relation to guarding is not only personal and financial, there are also important legal requirements to adequately guard dangerous machinery.

Why should you treat machine guarding seriously?

- You have a "common law" *duty of care* to the people who come into contact with your business.
- 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. You will, however, suddenly discover all the little things you relied on them for in the past. Getting back to where you were is often a lengthy process.
- Injuries are bad for business. The legal, medical and other costs often go uncalculated. Even one incident involving litigation may bankrupt a small employer. Larger employers face increased premiums. You also need to be aware of the costs of adverse publicity (including worker morale) that often is associated with death, severe injury and subsequent prosecution for breaches of workplace health and safety laws- as well as the potential common law claims. Have you factored these costs into your business?

Employers are responsible for providing all necessary machine guarding and safety equipment throughout a factory, workshop, or other workplace.

Workers are responsible for using the guards and other safety measures as required by the employer.

Workplace Health and Safety Obligations

1. The Queensland *Workplace Health and Safety Act 1995* obliges all employers to ensure the health and safety of workers and other persons at work. A key element in a safe system of work is safe and properly maintained machinery- this includes the provision of adequate guarding.

2. As well as the employers obligations under the *Workplace Health and Safety Act 1995,* the *Advisory Standard for Plant* deals with machine guarding. It advises you how to comply with the law (it used to be called the *Code of Practice for Plant).*

3. Failure to properly guard machinery can lead to prosecution under the *Workplace Health and Safety Act 1995.* An improvement or prohibition notice may be placed on an employer who has a machine or work process which is unsafe. Unsafe machinery is one of the most frequent sources of workplace health and safety prosecution. Because it is so fundamental and the risks of severe injury so high, this is an area treated very seriously.

4. As an employer, you are obliged to provide a safe workplace. If a worker or a visitor is injured because of inadequate machine guarding, then you could face a common law damages claim. A breach of the *Workplace Health and Safely Act 1995* can also form the basis for a common law action. This form of legal action is becoming increasingly common - and expensive.

Other Issues around Machinery

Getting Started

What is the risk? This document gives a few ideas and concepts for guarding. After reading it encourage your staff to walk through the work areas and look for those items where moving components or exposed items could cause injury. It is usually not possible get everything fixed at once, so draw up a plan to rectify everything that has been listed, in order of priority. In prioritising items for attention consider not only the likelihood of injury but also the severity of injury (see risk assessment on page 2).

It is sometimes a good idea to arrange inspections by someone who is not familiar with your plant but is familiar with your industry.

In some cases you may want to look to longer term as well as immediate solutions. For example, guarding a particular machine may be the best solution now but look for a better machine or better solution when you come to replace that machine. Look at the safety characteristics of machines when purchasing new equipment, try to get suppliers and manufacturers to fit guards to your specifications. Where you see a problem is widespread see if your industry association can put some pressure on suppliers.

Work Organisation and Work Processes

In order to guard machinery effectively you need to know what are the movement of materials on site and what are the job procedures appropriate to the machinery. In many cases where injury arises from machinery or inadequate machine guarding it becomes clear that production rates and job procedures have not been assessed, monitored or systematised.

You may need to modify existing work procedures and processes to ensure the guarding does not create new problems. The desire for extra speed, less work and making tasks easier are the leading reasons why guards are bypassed or removed. Your machine guarding solutions must take this into account. This is another reason to get those using the machine involved in your solutions. In the long term a carefully considered solution will almost always prove to be less costly and more efficient.

Avoid practices that encourage workers to remove or bypass guards. Bonus or incentive payment systems can encourage these problems and therefore need to be used with caution. You need a system to ensure guards are used.

Human Error

Human error is not always the result of carelessness or negligence, but follows from normal human characteristics. People naturally become bored and distracted with repetitious work. This causes the loss of concentration, and this human error syndrome should be anticipated by designers, manufacturers and employers.

Machinery should be adequately guarded, taking into account the possibilities of human error.

The following factors are known to affect human error:

- Short Term Memory
- Information Handling Capacity

- Habit
- Fatigue
- Layout
- Lighting
- Noise
- Heat & Cold
- Housekeeping
- Ventilation
- Training

Short-term Memory

After first observing a hazard, a person can soon forget about it, especially if they are distracted. Vital controls have to be interlocked to ensure they can only be operated in the correct order or at appropriate times.

Information Handling Capacity

Vital information can be overlooked if it comes too quickly, or if it comes together with other information (information overload). If a person has to monitor more than one "channel" of information at any one time, they should have a clear order of priority.

Habit

People can continue a habitual activity despite indications of danger. Clear labelling of controls, and clear, simple warning notices can help. People also get used to a particular arrangement of controls. Use standardised controls as much as possible, and ensure that location of the controls is appropriate. The action used to operate a control should also be compatible with the effect on the machinery, for example, switching a control towards the left moves material into the machine in the same direction.

Fatigue

The safe use of machinery is more than attending to guarding. Long hours of work or long periods without adequate breaks can lead to loss of concentration, slow reflexes and enhanced risk of error. Excessive heat, poor ventilation and poor operator comfort (no attention to the location of stools, buttons etc) also contribute to losses of concentration and error. You should take this into account when looking at machine guarding.

Layout

Machine guarding will only be effective if it used in conjunction with proper attention to layout. Machines which are poorly located or too close together cannot be safe even if guarded. There are a number of basic points to consider in relation to layout.

- Avoid congestions or worker movements near machinery which are likely to cause problems.
- Make sure the layout doesn't encourage hazardous movements in relation to operation, cleaning or maintenance (eg blockage)
- Keep vicinity of machinery clear from rubbish, clutter etc.
- Try to have a layout which minimises unnecessary movements by trucks, people and materials. Simple and well understood flow lines will reduce the likelihood of persons coming near dangerous machinery or being "in the wrong place at the wrong time"

Lighting

The following issues should be considered in relation to providing adequate appropriate lighting for the safety of people around machinery:

direction and intensity of lighting

contrast between background and local lighting

colour of the light source

reflection, glare and shadows

the 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 operator stress (itself a source of errors). It can lead to mistakes and it can also prevent a verbal warning being communicated. Make sure efforts have been made to minimise noise in the workplace and where noise is still high, that operators wear appropriate properly fitted hearing protection.

You can make guarding part of the solution. In many instances carefully designed guarding of moving parts can aid noise reduction and help remove the stress associated with prolonged exposure.

Heat & Cold

A comfortable temperature is safer to work in. Accidents are more likely to happen if it is too hot or too cold. Personal protective equipment for heat or cold can also restrict movement and reduce the manual dexterity of workers, as well as increasing the risk of being caught in machinery.

Housekeeping

Untidiness can cause trips and falls. Work areas, walkways and other access paths should be clearly marked, kept clear and clean. Spills can easily cause falls, particularly if they are of an oily liquid. Design machinery to minimise lubrication oil loss or spillage. Clean up spills as soon as possible after they occur, and avoid any oily residues on the floor. Provide a rough anti-slip floor where this is not practical.

Ventilation

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

Training

All persons who supervise, manage or operate machinery should receive appropriate training and instruction for health and safety. Training should include safe operating procedures, and any precautions which may be needed to control the hazards of the machines they operate.

Do not assume that people already know or can informally learn about machine safety. Include training on any required personal protective equipment.

Simple Rules

Isolation

with the exception of those circuits required for safety systems, all machinery should be fitted with a means of isolation from all energy sources. Such isolators should be clearly identified and be capable of being locked if reconnection could place persons at risk.

An appropriate isolation method is a lock-out/tag-out system, in which one or more padlocks are fitted to the isolation switch, as well as danger tags with the exposed persons' names on them.

Safety Switches

Safety/stop switches must be located where they can easily be reached by an operator. Poorly located switches may encourage dangerous practices such as reaching across moving parts, a failure to shut down machinery when a problem occurs or situations where a machine can be started by one worker while another is in a dangerous location (for example, cleaning a bin).

You need to consider the number of switches. If the machine is large, several switches may be necessary. On the other hand, when there are multiple switches you must ensure safe operating practices are adopted so that machinery is not restarted when it is undergoing maintenance or other temporary operations. You should have a lock-out/tag-out system.

Inspection, Cleaning & Maintenance

To safeguard your operators and other staff you must have a regular inspection, cleaning and maintenance procedure which is well understood throughout the workplace. Special precautions need to be taken where workers undertaking these tasks are obscured or where there are multiple operating switches.

Apply isolation procedures whenever maintenance or repair requires people to enter the danger area around machinery.

Opening & Removing Guards

Guards must only be able to be opened or removed with the aid of a tool.

Hinged Guards

For ease of maintenance, hinged guards may be used. However, this type of guard may require the use of an interlock system.

Weight

Big guards may need to be removed for maintenance access. Some sections may remain fixed but try to ensure that the sections to be removed can be handled easily by one person. Put handles on moveable sections where appropriate.

Interactions

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

between **guard** and **machine**

between **guard** and **person**

between **guard** and **workpiece**

Colour coding.

It is good policy for all safety guards within a workplace to be painted the same colour. For example, high visibility yellow, (but different to the general machinery colour) so that it can be clearly seen when a safety guard is not in its proper place.

Dust

A dusty workplace could be dangerous. Dust and other airborne contaminants can have direct and severe long term effects on your workers health, which could include respiratory problems, skin disorders and even cancer. Dust can cause injury by clogging machinery, inducing sudden breakdowns and obscuring moving parts and other hazards. The discomfort caused by dust on the skin, clothing and protective equipment can also compromise safety.

A dust collection system can save clean up time and make your workplace much easier to work in. Furthermore, a little thought can lead to solutions which solve the health and machinery hazards associated with dust. A simple lid, cover or shield on saws, augers and other machinery can reduce the level of dust. Such guarding may also reduce the level of noise and improve worker comfort and productivity.

Further Assistance

FURTHER ASSISTANCE - DIVISION OF WORKPLACE HEALTH AND SAFETY

When considering your guarding needs or if you are unsure abut how to handle a problem you can get information from Workplace Health and Safety for advice. Such contact can be made over the phone and it doesn't mean you'll have an inspector or adviser at your workshop the next day unless you request it. Assistance can be found through:

1300 369 915

FURTHER ASSISTANCE - OTHERS

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 consultant is fully conversant with Queensland legislative requirements and that they take an approach to the problem which is consistent with the principles identified in this guide. Ask them for evidence of previous work in the area and check out the work for yourself, talking if possible with other employers. As a small employer you can pool with other employers in your area in order to spread the costs. This sort of co-operation makes sense as it saves time and money.

Your Workers

Don't forget your own workforce when it comes to getting solutions. They work with the machinery every day and they can often not only help better identify a problem but also help with devising the most effective and cost-efficient solutions. Workplace safety committees or health and safety representatives should be involved but even if you don't have these in your workplace you should still involve workers. In the end they have a direct interest in safeguarding their own health.

Even if you bring in experts or consultants you will need to ensure that workers are informed and involved. A guard may look fine from an engineering viewpoint but if it also needs to take account of worker comfort and ease of operation. Workers are in the best position to judge this.

FURTHER ASSISTANCE - AUSTRALIAN STANDARDS

Standards Australia is responsible for the development, publication and distribution of *Australian Standards*- the accepted standard for machine guarding and other issues in Australia. Some of the most useful standards available from Standards Australia relating to machine guarding are:

TITLE	DESCRIPTION
AS4024.1 - ***Safeguarding of machinery*** ***- General principles***	Sets out the general underlying principles for machine guarding and provides means for identifying hazards and risks arising from the use of machinery during all phases of machine life. Methods for eliminating or reducing these hazards and risks, for safeguarding machines, and for safe working practices are described. Guidelines for assessing the safety measures needed in particular circumstances are provided. It does not provide guidance for safeguarding any particular machine.

AS 4024.2 - ***Safeguarding of machinery*** ***- Presence sensing systems***	This draft standard sets out the requirements for presence sensing systems such as light beams and pressure sensitive devices for use in machine guarding applications. It includes the means for determining the separation distance between persons and machinery, as well as detailing the test requirements for the system.
AS 1219 ***- Power presses*** ***- Safety requirements***	Specifies safety requirements for the design, construction, operation and maintenance of power stamping presses and brake presses. Incorporates details for safeguarding power presses, die design and die setting. Provides recommendations for operation, maintenance and inspection of presses, and the training and supervision of operators.
AS 1473 ***- Guarding and safe use of woodworking machinery***	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*** ***- Design, construction installation and operation*** ***- 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 1788.1 ***- Abrasive wheels*** ***- Design, construction and safeguarding***	Specifies requirements for the design and construction of abrasive wheels and the manufacture and installation 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. Includes sections covering standard (normal) maximum operating speeds for all types of wheels. Extensively illustrated.
AS 1788.2 ***- Abrasive wheels*** ***- Selection, care and use***	Specifies requirements for the application and operation of abrasive wheels. Includes sections on the storage, handling and mounting of abrasive wheels, as well as conditions for using special operating speeds. Illustrations of suitable guards and guarding details are included.
AS 1893 - ***Code of practice for the guarding & safe use of metal & paper cutting guillotines***	Outlines the general requirements of guarding requirements, with specific requirements for the guarding of different types of machine. Fixed, interlocked, automatic and electronic guards are included.

Australian Standards are available from:

Standards Australia, 67 St Pauls Terrace, SPRING HILL 4000

P.O. Box 290, SPRING HILL 4004

Phone (07)3831 8605 Fax (07) 3832 2140