



Department of Consumer  
and Employment Protection  
Government of Western Australia



# MACHINERY AND EQUIPMENT SAFETY – AN INTRODUCTION

1ST EDITION



WA | QLD | NSW | SA | VIC

working  
across  
borders

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## Acknowledgement

WorkSafe Western Australia acknowledges WorkSafe Victoria for the original development of this publication.

## Disclaimer

Information in this publication is provided to assist people in meeting their occupational safety and health obligations. While information is correct at the time of printing, readers should check and verify any legislation referenced in this publication to ensure it is correct at the time of use.

Changes in law after this document is published may impact upon the accuracy of information. This information is provided as a service to the community. It is made available in good faith and is derived from sources believed to be reliable and accurate at the time of publication.

# INTRODUCTION

*Machinery and Equipment Safety: An Introduction* is provided in accordance with the *Occupational Safety and Health Act 1984* (OHS Act) to assist employers and employees comply with their duties and obligations.

This guide is an *introduction* to managing the risks associated with use of machinery and equipment in the workplace.

Employers can use this guide to:

- identify machinery and equipment hazards in the workplace
- eliminate or reduce the risk of those hazards causing harm.

The guide will also be useful to anyone else who is interested in machinery and equipment safety, such as employees and Safety and Health Representatives.

WorkSafe also has additional guidance supporting all topics introduced in this document. To find out more or to seek further technical information with regard to your machinery and equipment, refer to **Section 4** of this document.

## **CONSULTING EMPLOYEES AND SAFETY AND HEALTH REPRESENTATIVES**

Consultative processes allow people to provide input and raise potential safety concerns about the work they undertake. Although hazards associated with machinery and equipment are often easily identified, the ways in which people can gain access to, or may be exposed to, hazards require a detailed understanding of how they do their job.

# 1

## KEY PRINCIPLES OF MACHINERY AND EQUIPMENT SAFETY

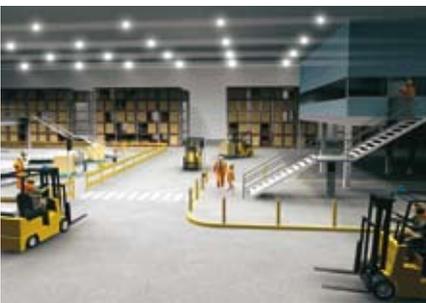
### RISKS ASSOCIATED WITH:

- 1.1 **Mechanical hazards**  
that cannot be eliminated must be controlled to prevent harm.
- 1.2 **Non-mechanical hazards**  
that cannot be eliminated must be controlled to prevent harmful exposure.
- 1.3 **Access hazards**  
that cannot be eliminated must be controlled to provide safe access (for operation, maintenance, repair, installation, service, cleaning or decommissioning).

# KEY PRINCIPLES OF MACHINERY AND EQUIPMENT SAFETY



*Robotic arms can reach over their base, move with remarkable speed and high force, and can cause injury if controls to separate people from moving plant are not implemented.*



*Mobile plant operated in areas where people work may cause injury through collision. Traffic control and segregation are forms of control.*

## 1.1 MECHANICAL HAZARDS

Machines have moving parts. The action of moving parts may have sufficient force in motion to cause injury to people.

When reviewing machinery and equipment for possible mechanical hazards, consider:

- machinery and equipment with moving parts that can be reached by people
- machinery and equipment that can eject objects (parts, components, products or waste items) that may strike a person with sufficient force to cause harm
- machinery and equipment with moving parts that can reach people such as booms or mechanical appendages (arms)
- mobile machinery and equipment, such as forklifts, pallet jacks, earth moving equipment, operated in areas where people may gain access.

Common mechanical hazards and associated risks for machinery and equipment are shown below.

HAZARD	RISK
Rotating shafts, pulleys, sprockets and gears	Entanglement
Hard surfaces moving together	Crushing
Scissor or shear action	Severing
Sharp edge – moving or stationary	Cutting or puncturing
Cable or hose connections	Slips, trips and falls (e.g. oil leaks)

## FURTHER INFORMATION

Commission for Occupational Safety and Health guidance notes:

- Plant in the workplace
- Powered mobile plant
- Safe movement of vehicles at workplaces
- Working safely with forklifts

# KEY PRINCIPLES OF MACHINERY AND EQUIPMENT SAFETY



Woodworking dust generated by a buzzer is removed via forced extraction and ventilation.



Welding fumes are extracted via flexible, locatable forced extraction and ventilation system.

## 1.2 NON-MECHANICAL HAZARDS

Non-mechanical hazards associated with machinery and equipment can include harmful emissions, contained fluids or gas under pressure, chemicals and chemical by-products, electricity and noise, all of which can cause serious injury if not adequately controlled. In some cases, people exposed to these hazards may not show signs of injury or illness for years. Where people are at risk of injury due to harmful emissions from machinery and equipment, the emissions should be controlled at their source.

When reviewing machinery and equipment for possible non-mechanical hazards, consider how machines and equipment can affect the area (environment) around them.

Common non-mechanical hazards are shown below.

NON-MECHANICAL HAZARDS	
Dust	Mist (vapours or fumes)
Explosive or flammable atmospheres	Noise
Heat (radiated or conducted)	Ignition sources (flame or spark)
High intensity light (laser, ultra-violet)	Molten materials
Heavy metals (lead, cadmium, mercury)	Chemicals
Steam	Pressurised fluids and gases
Ionising radiation (x-rays, microwaves)	Electrical

## FURTHER INFORMATION

Commission for Occupational Safety and Health codes of practice:

- Managing noise at workplaces
- Spray painting

Commission for Occupational Safety and Health guidance notes:

- Controlling wood dust hazards
- Controlling Isocyanate hazards at work
- Prevention of carbon monoxide poisoning from petrol and gas powered equipment
- Material safety data sheets

# KEY PRINCIPLES OF MACHINERY AND EQUIPMENT SAFETY



*Permanently fixed gantries, ladders and walkways are incorporated into this machinery and equipment to reduce the risk of a fall from height occurring during operation and maintenance.*

## 1.3 ACCESS HAZARDS

People must be provided with safe access that is suitable for the work they perform in, on and around machinery and equipment. A stable work platform suited to the nature of the work that allows for good posture relative to the work performed, sure footing, safe environment and fall prevention (if a fall may occur) is a basic requirement.

As an example, cooling towers on building roofs may have poor access, yet must be attended by a service person at predictable times for water treatment, chemical dosing or monitoring of automated dosing equipment. People performing these tasks must be provided with the means to get themselves and any equipment they require onto the roof with no risk or minimal risk of fall or injury.

When thinking about safe access to machinery and equipment, think about how, who, when and what:

- who will be working on or around the machinery and equipment?
- people required to work in enclosed areas where the atmosphere could be harmful, such as pits, tanks or storage vessels?
- what equipment or materials need to be carried to undertake the task?
- where and when is access required for operation, maintenance and cleaning?
- how will people gain safe access (walkway, gantry, elevated work platform or ladder)?
- what work will be carried out during access?
- will people be near or exposed to an unidentified mechanical or non-mechanical hazard at the time of access?
- has consultation occurred with employees or contractors regarding how they intend to gain access, and what equipment and work platform or structure is best suited for the intended task?

## Access

Access needs can be predicted and access planning must occur in advance.

People need access to machinery and equipment in the workplace (either continually or occasionally) for tasks such as operation, maintenance, repair, installation, service or cleaning. These tasks are examples of access that can be predicted.

Access may vary during each stage of machinery and equipment life cycle. For example:

- installation or removal
  - complete access from every area may be required, and involve disconnection or connection of services such as water, air, pipes, installation of electrical cable to switch board, etc.
- operation
  - access for set-up, operation and adjustment.
- maintenance, repair, cleaning, alteration or adaptation
  - access to remote areas may be required.

## FURTHER INFORMATION

Commission for Occupational Safety and Health code of practice:

- Prevention of falls at workplaces

Commission for Occupational Safety and Health guidance note:

- Working alone

# KEY PRINCIPLES OF MACHINERY AND EQUIPMENT SAFETY

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## EXAMPLES OF COMMON HAZARDS BY TYPE OF WORKPLACE ACTIVITY

### PEOPLE WHO INSTALL OR DISMANTLE MACHINES AND EQUIPMENT COULD:

- work in isolation
- work on machines and equipment at height or over machinery or equipment to connect services (such as electricity, air or water)
- work in low light or with bright directional light
- access machinery and equipment from the top, sides or underneath
- work with/near cranes, forklift or rigging to lift machinery and equipment
- work in confined spaces
- use power tools, welders, extension leads, which present electrical hazards if damaged or wet.

### PEOPLE OPERATING MACHINES AND EQUIPMENT COULD:

- be required to place their hands close to the mechanism of the machinery or equipment that does the work, and may be injured if caught or trapped by moving parts
- be exposed to constant harmful noise, radiated energy or fumes being emitted from the machinery and equipment they are operating or are close to
- inadvertently bump or knock poorly placed control levers or buttons
- be required to make adjustments to the mechanism of machinery and equipment while the machine is in motion
- be required to clear away scrap
- make minor adjustments or reach into the moving mechanism of the machine they are operating.

### PEOPLE PROVIDING MAINTENANCE OR REPAIR SERVICES COULD:

- work alone
- work on machines and equipment at height, or over machines and equipment to connect services (such as electricity, air or water)
- access machines and equipment from the rear or sides
- need to enter confined spaces of larger machinery and equipment
- be trapped by mechanism of the machinery and equipment through poor isolation of energy sources or stored energy, such as spring-loaded or counter-balance mechanisms, compressed air or fluids, or parts held in position by hydraulics or pneumatic (air) rams
- move heavy parts when changing the set-up of machinery and equipment, or repairing failed parts such as electric motors or gear box assemblies
- disable or remove normal safety systems to access machines and equipment mechanism.

### PEOPLE PROVIDING CLEANING SERVICES COULD:

- work alone
- access machines and equipment from the rear or sides or in unexpected ways
- climb on machines and equipment
- enter confined spaces of larger machines and equipment
- become trapped by mechanism of the machinery and equipment through poor isolation of energy sources or stored energy, such as spring-loaded or counter-balance mechanisms, compressed air or fluids, or parts held in position by hydraulics or pneumatic (air) rams
- work with chemicals
- operate electrical equipment in wet areas.

# 2

## RISK CONTROL OF MACHINERY AND EQUIPMENT HAZARDS

- 2.1 Risk control of machinery and equipment hazards (general)
- 2.2 Risk control of mechanical hazards
- 2.3 Risk control of non-mechanical hazards
- 2.4 Risk control of access hazards

# RISK CONTROL OF MACHINERY AND EQUIPMENT HAZARDS



Centre lathe: The exposed rotating chuck of a centre lathe can eject parts or tools with great force, cutting fluid fumes are difficult to contain and the machinery requires manual set-up.



CNC Lathe: Substituting a centre lathe with a CNC lathe (Computer Numeric Control) is an example of improved risk control of machinery and equipment through improvement in design.

## 2.1 RISK CONTROL OF MACHINERY AND EQUIPMENT HAZARDS (GENERAL)

Where exposure to machinery and equipment hazards cannot be *eliminated* or *substituted* for machinery and equipment of improved design, *risk control(s)* must be applied to the hazards that prevents or reduces the risk (chance) of injury or harm. Health and safety laws require the *highest order* control be applied so far as is reasonably practicable.

**Higher order** machinery and equipment risk controls are *preventative* by nature, are effective and durable for the environment it is used in, and **deal directly with the hazard at its source**.

**Lower order** machinery and equipment risk controls, such as personal protective equipment (PPE), can prevent injuries, but are generally not as effective as higher order controls, as they rely more on employee behaviour, maintenance programs and supervision.

**Administrative controls** use systems of work to reduce risk by providing a framework of expected behaviours. Examples are rotation of staff to reduce exposure to a hazard, or a documented safe system of work, such as 'lock out-tag out'. These types of controls rely on extensive instruction, information, training and supervision. In terms of time and ongoing administration by managers and employers to ensure the desired behaviour occurs, administrative controls can be the most expensive and least effective form of hazard control.

**Note:** The use of PPE and administrative controls are low or last order controls used to deal with any residual risk associated with the hazard.

As such, these last resort controls can be used in support of higher order controls that deal with a hazard at its source and should not be considered as the sole means of control. These types of risk controls require constant monitoring and reinforcement.

Effective machinery and equipment risk controls reflect some or all of the following characteristics:

- the hazard is controlled at its source
- contact or access to the hazard is prevented
- sturdy construction (correct materials with few points of potential failure)
- fail-safe (failure of the control system to be effective will result in machinery shut-down)
- tamper-proof design (as difficult as possible to bypass)
- presents minimum impediment to machinery and equipment operator
- easy to inspect and maintain
- does not introduce further hazards through action of the risk control.

# RISK CONTROL OF MACHINERY AND EQUIPMENT HAZARDS



Fences, barriers, guards and interlocked gates separate people from the hazardous action of machinery and equipment.



An old style power press incorporating a manual interlock and adjustable guarding. If the guard slides up, a connected metal bar separates the clutch mechanism and the press will not activate.

The guard can be adjusted to provide an opening by releasing retaining bolts on the guard face to allow individual panels to move. Adjustment must be performed by an experienced person to ensure the resulting opening only provides room necessary to incorporate the material being fed in and prevents hands or fingers intruding into the danger area.

## 2.2 RISK CONTROL OF MECHANICAL HAZARDS

Separation is a simple and effective machinery and equipment risk control.

Separation may be achieved by distance, barrier or time.

- Distance separation means a person cannot reach the hazard due to distance.
- Barrier separation means an effective barrier or guard denies access and controls ejection of parts, products or waste.
- Time separation means at the time of access, the machinery or equipment is disabled.

Examples include:

- physical barriers and guards such as fences, screens or fixed panels of various materials
- various forms of guarding and interlocking (as described in Australian Standard AS 4024, part 1601 and part 1602, Safety of Machinery)
- making the hazard inaccessible by reach (where the distance between a person and the hazard forms an effective barrier).

**Note:** When considering the suitability of distance guarding, also consider the safe access requirements of maintenance people who gain access by ladder, scaffold or elevated work platform.

### Guarding

A guard can perform several functions: it can deny bodily access, contain ejected parts, tools, off-cuts or swath, prevent emissions escaping or form part of a safe working platform.

Guarding is commonly used with machinery and equipment to prevent access to:

- rotating end drums of belt conveyors
- moving augers of auger conveyors
- rotating shafts
- moving parts that do not require regular adjustment
- machine transmissions, such as pulley and belt drives, chain drives, exposed drive gears
- any dangerous moving parts, machines or equipment.

Where access is not anticipated, a **fixed guard** can be permanently applied by bonding agent, welding or secured with one-way screws. If access is generally not required, a permanently fixed barrier is the preferred option.

Where access to the hazard is infrequent, the installation of a **fitted guard** that can be removed by use of a tool may be an acceptable control, where the tool to remove the barrier or guard is not normally available to the operator.

**Adjustable guarding** incorporates movable sections or panels of the guard and allows for material or parts to be fed into the guarded area while still preventing bodily contact.

# RISK CONTROL OF MACHINERY AND EQUIPMENT HAZARDS



The narrow throat of the mincer prevents a person's hand from accessing the hazard.



An old style press refurbished with an interlocked safety cage and gate.

The control mechanism uses a combination of pneumatics and electrical interlocking to ensure the danger area of the press cannot be accessed unless the press downstroke action is disabled.

Improved design and technology can be fitted to older machinery and equipment to meet current standards and reflect the latest knowledge regarding ways to control hazards and risks in the workplace.



Captive key systems: The key cannot be removed unless it is in the off position. The same key is used to unlock the access gate. Only one key per system is retained by the locking mechanism.

**Tunnel guards** provide a tunnel, aperture or chute in which material can be inserted into the machinery and equipment, but due to the restrictive design and depth of the opening, fingers, hands, arms or the entire person is prevented from intruding into the danger area.

Where frequent cleaning is required, the guard may be constructed of mesh that prevents intrusion of body parts but allows for hosing. Food production workplaces that use conveyors in areas where hygiene or food safety is an integral part of the operation use fixed mesh guarding of conveyor end rollers.

**Interlock guarding** occurs when the act of moving the guard (opening, sliding or removing) to allow access stops the action of the hazardous mechanism.

Interlock guarding works by:

- mechanically disconnecting the drive mechanism (applies a brake or disengages a clutch or geared mechanism)
- isolating the power source of the drive mechanism (stops the motor)
- a combination of mechanical and power disconnection.

Interlock guarding is generally achieved via mechanical or electrical means, but may also include hydraulic or pneumatic control systems.

The energy stored in moving parts (momentum) can cause the mechanism of the machine or equipment to run on for some time after the source of driving energy has been removed.

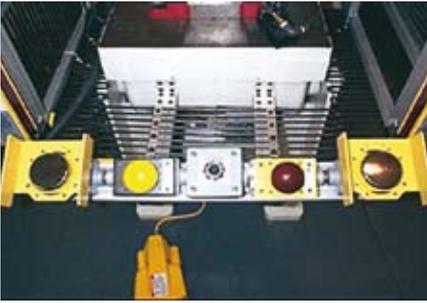
For access panels or doors supporting an interlocking device that allows access to mechanical parts that move for periods after the energy source is removed, a separate mechanism to delay release of the retaining or locking mechanism may be incorporated.

**Captive key systems** rely upon a single key that is shared between the control panel ('on' switch) and the access gate lock of the physical barrier to the danger area. Removal of the key from the control panel can only occur when the switch is in the off position, and the gate will only release the key when in the locked position.

Captive key systems do not provide full isolation of the power source, but may provide limited temporary access under controlled conditions.

Effective supervision, instruction and training are required as administrative controls to ensure that only one key is available for the system, and the key is not removed from the access gate or guard by a second operator while a person is exposed to the danger area of the plant. Operations such as maintenance, repair, installation service or cleaning may require all energy sources to be isolated and locked out to avoid accidental start-up.

# RISK CONTROL OF MACHINERY AND EQUIPMENT HAZARDS



*A two-handed control option may be suitable to ensure that a machine cannot operate until both hands of the operator are clear of the hazard area.*

## Other mechanical hazard risk control options

### **Simultaneous two-handed operation**

Where a machine has only one operator, the use of simultaneous two-handed operation buttons can serve as a risk control. This ensures that operation of the hazardous mechanism cannot occur until both hands are clear of the danger area.

The two buttons must be pushed at the same time and are located at a distance from each other that prevents simultaneous operation by one hand.

The operation should be designed so that if either or both of the buttons are released, the hazardous action of the machine or equipment cannot be reached, or if it can be reached, the mechanism returns to a safe state.

### **Presence sensing systems**

If physical guards are not reasonably practicable, then a presence sensing system can be used as a control to reduce risk. Presence sensing systems can be used where people enter areas shared by moving production equipment.

Presence sensing systems are capable of providing a high degree of flexibility with regard to access.

Presence sensing systems detect when a person is in the identified danger area, and stops or reduces the power or speed of the mechanism at the time of entry to provide for safe access.

Presence sensing systems can rely on foot pressure pads, infra-red sensing, light beams or laser scanning. The most appropriate type of sensing device will depend on the operating environment and access requirements.

Australian Standard AS 4024.2 provides guidance on design specification, ratings on integrity and reaction times. Manufacturers' specifications for installation and maintenance must also be observed.

Specialist assistance may be required by experienced professionals to ensure correct selection and installation of presence sensing systems. Companies who manufacture or supply these systems also provide technical support and installation assistance.



*A light curtain used to disable the hazardous mechanism of a machine must resist failure and fault.*

# RISK CONTROL OF MACHINERY AND EQUIPMENT HAZARDS

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*Components relied on to protect people from harm are designed and built to a high standard, and display compliance ratings relative to their reliability. They must also be correctly installed to ensure their effective operation.*

## **Critical safety systems**

A safety control system responsible for ensuring the safety of a person when approaching or accessing a hazard is called a critical safety system.

Failure of the critical safety system will leave a person exposed to the hazard, and in danger.

Critical safety systems may include barriers or guards fitted to prevent access, or integrated complex interlocking and presence sensing systems. Failure to replace guards, damaged perimeter fences that allow access and bypassed or disabled interlocking systems are examples of critical safety systems failures that require immediate attention to ensure the safety of people.

## **High integrity/fail-safe control**

All safety control systems should be designed and built to prevent failure or, in the event of failure, de-activate the operation of the machinery and equipment.

The extent to which a safety control system should tolerate faults is a function of risk (likelihood and consequence), and is described fully in Australian Standard *AS 4024.1501 Safety Related Parts of Control Systems*, which explains the categories of control required as a function of increasing risk.

Many different types of machinery and equipment use high integrity safety systems that disable a mechanism at the time of access. Some examples include:

- brake press
- power press
- robotic machine (automated machines)
- injection moulders
- powered guillotines
- programmable lathe and milling equipment
- industrial mixers
- mincing equipment
- plasma cutting tables
- laser cutting tables.

## **Redundant and self-monitoring fault detection systems**

Redundant or dual systems (doubling up) and self-monitoring fault detection systems are also effective methods to prevent failure of critical safety systems.

Selection and installation of these types of complex interactive control measures may require expert or specialist assistance.

The Australian Standards provide information on plant safety systems and reflect current state of knowledge and best practice. The *AS 4024 Safety of Machinery* series of publications provides specific information for commonly used machine types in industry such as woodworking or metal working machinery.

# RISK CONTROL OF MACHINERY AND EQUIPMENT HAZARDS

## 2.3 RISK CONTROL OF NON-MECHANICAL HAZARDS

The first step in selecting suitable and effective controls for non-mechanical hazards is to understand the nature of emissions that can be released by machinery and equipment in the workplace, where those emissions collect and the way they may cause harm.

- Separating people from non-mechanical hazards is necessary where the emission cannot be controlled at the source through elimination or substitution. Hazardous machinery and equipment emission controls rely largely on isolation of people from the hazardous emission.  
Hoods, lids, covers or impervious guards (solid barriers that prevent escape of the emission) can serve to contain a number of different types of emissions within machinery or equipment.  
For potentially harmful substance exposures from machinery and equipment, such as mist, fumes, vapour or dust, and where it is not reasonably practicable to control the emission at its source, ventilation and extraction systems are used to remove the hazardous atmosphere from the work environment.
- For noise, guarding may also serve to mute noise emissions through application of sound absorbing materials. Other emissions such as lasers, ultra-violet light, bright light or welding flash can also be safely screened to prevent potential harmful exposure.
- Oil leaks from machinery or equipment may present a serious slip hazard. By preventing oil leaks through routine maintenance, or containing leaking oil with a drip tray or through spill containment strategies, the risk the hazard presents is controlled.

### Personal protective equipment

Where it is not reasonably practicable for emissions to be controlled at their source or removed or reduced through effective ventilation, extraction or diversion, the use of personal protective equipment (PPE) as a final measure must be considered to ensure safety.

PPE is a lower order control and can only be used where higher order controls are not reasonably practicable or are not totally effective.

Selection and use of PPE requires careful consideration, as there are many different types that reduce the risk of injury of contact or exposure to a hazard.

Incorrect use of PPE or purchasing inappropriate PPE can contribute to serious workplace incidents.

PPE that is uncomfortable, restrictive or heavy may create secondary hazards, and, as a result, constant supervision may be necessary to ensure it is used effectively.



Ear muffs.



Gloves.



Particle half face respirator.



Welding mask.



Safety glasses.

# RISK CONTROL OF MACHINERY AND EQUIPMENT HAZARDS



Fixed access platform.



Mobile work platform with fall arrest harness.



Temporary mobile platform.

## 2.4 RISK CONTROL OF ACCESS HAZARDS

### Confined space

Larger machinery and equipment may contain internal areas where a hazardous atmosphere may occur by design or as a result of the work being done.

A confined space may exist where people require access to a mostly closed area that presents difficult or restricted path of access, where oxygen levels may be depleted or displaced, or where harmful levels of contaminate, such as gas, vapour or dust, exist.

Training in confined space entry and having another person present in the immediate vicinity during the work is a legal requirement that must be observed prior to allowing people to enter a confined space.

### Working at height

Providing people with a suitable work platform for the task being undertaken reduces the risk of injury from falling from machinery and equipment.

Often 'safe access' equipment made available during installation of machinery or equipment is removed after commissioning. Workplace managers may not have considered or recognised the need to provide similar means to gain safe access to parts of machinery and equipment at height or in awkward locations for maintenance, repair, service or cleaning activities.

Safe access at height can be broken into three categories. Each category has in common the need to provide a stable, safe platform suitable for the work to be undertaken, and to be equipped to support and retain a person within the confines of the platform.

#### 1. Fixed or permanently installed access platforms:

- gantries
- mezzanine floors
- fixed platforms
- stairways.

#### 2. Mobile elevated work platforms (EWPs):

- scissor lifts
- knuckle booms.

**Note:** Safe work practices must take into account the risk of trapping an operator between the EWP and a fixed structure, e.g. overhead beams, electrical cables, pipes.

#### 3. Temporary platforms:

- scaffolding
- ladders.

Where safe working platforms are used and the risk of a fall remains, **travel restraint** and **fall arrest harnesses** can be used where a suitable point of attachment exists. Harness systems, anchor points and shock absorbing lanyards must be compatible at each point of attachment from the anchor point to the harness, with approved and rated latching devices to ensure the integrity of the system.

When using fall arrest systems, specialist assistance may be necessary to select appropriate equipment, provide effective training in use and inspection, and develop an emergency retrieval plan to recover a person suspended in a fall arrest harness. People suspended by a harness for short periods of time may suffer serious health effects or may have incurred injury during the fall prior to the fall arrest device deploying. Emergency retrieval plans should allow for immediate local response in safely retrieving people to avoid fatalities.

**Note:** Occupational Safety and Health Regulations 1996 prescribe specific requirements that must be taken into account when determining risk controls for both *confined spaces* and *working at heights*.

## FURTHER INFORMATION

Commission for Occupational Safety and Health code of practice:

- Prevention of falls in the workplace

# RISK CONTROL OF MACHINERY AND EQUIPMENT HAZARDS

## Lock out–tag out: Removing and controlling energy sources during access

People performing tasks such as maintenance, repair, installation, service and cleaning are highly vulnerable, and have a higher risk of being killed or maimed through inadvertent operation of machinery and equipment they are working in, on or around.

Accidental start-up or movement of a machine mechanism can occur if control levers or buttons are bumped or knocked, if a short circuit of the control system occurs, when hydraulic or air pressure is released, or when undoing retaining bolts.

It is essential that people who work in, on or around machinery and equipment are not exposed to hazards due to accidental start-up or movement of the mechanism. (Reference: Australian Standard *AS 4024.1603 Safety of Machinery.*)

The following is an overview of the lock out–tag out process:

- **shut-down** the machinery and equipment
- **identify** all energy sources and other hazards
- **identify** all isolation points
- **isolate** all energy sources
- **de-energise** all stored energies
- **lock out all isolation points**
- **tag** machinery controls, energy sources and other hazards
- **test** by ‘trying’ to reactivate the plant without exposing the tester or others to risk (failure to reactivate ensures that isolation procedures are effective and all stored energies have been dissipated).

## Identifying energy sources

All energy sources likely to activate the machinery and equipment and expose people to hazards should be identified prior to work beginning.

Such energy sources include:

- electricity (mains)
- battery or capacitor banks
- fuels
- heat
- steam
- fluids or gases under pressure (water, air steam or hydraulic oil)
- stored energy
- gravity
- radiation.

If original designer and installer ‘as built’ diagrams of machinery and equipment installations are not available, new diagrams and photographs showing location and details of various isolation points of machinery and equipment should be developed as part of the isolation procedures. Isolation points may include switches, valves, energy lines, pipes, power sources.

These diagrams and photographs can then be used, along with written procedures, for information and training.

# RISK CONTROL OF MACHINERY AND EQUIPMENT HAZARDS

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## ***De-energise stored energies***

Any or all of the following steps are necessary to guard against energy left in the machinery and equipment after it has been isolated from its energy sources:

- inspect the machinery and equipment to make sure all parts have stopped moving
- install ground wires
- release the tension on springs or block the movement of spring-loaded parts
- block or brace parts that could fall
- block parts in hydraulic and pneumatic systems that could move from pressure loss
- bleed the lines and leave vent valves open
- drain process piping systems and close valves to prevent the flow of hazardous material
- if a line must be blocked where there is no valve, use a blank flange
- purge reactor tanks and process lines
- dissipate extreme cold or heat, or provide protective clothing
- if stored energy can accumulate, it must be monitored to ensure it stays below hazardous levels.

## ***Isolation procedures***

Isolation procedures in each workplace vary in detail because of differences in machinery and equipment, power sources, hazards and processes. However, if adequate interlocking is not possible, or the maintenance, repair, installation, service or cleaning requires the method of guarding or interlocking to be bypassed or removed, an isolation procedure should be implemented.

**Note:** Activating operational stop buttons, emergency stop devices or interlock devices is not equivalent to the isolation of power sources or the release of stored energy.

## ***Lock out***

### **Isolation devices**

A wide range of devices is available for locking out energy sources and other hazards that could pose a risk to people working on machinery and equipment. These devices include switches with a built-in lock, and lock outs for circuit breakers, fuses and all types of valves.

Also readily available are chains, safety lock out jaws (sometimes called hasps), which accommodate a number of padlocks, and sets of robust safety padlocks. Only devices that incorporate a lock or accommodate one or more padlocks are suitable lock out devices.

# RISK CONTROL OF MACHINERY AND EQUIPMENT HAZARDS



Tag and lock.

## One person – one lock

If more than one person is working on the same item of machinery and equipment, each person should attach their own lock to prevent the isolator being opened while their specific task is in progress.

The isolation procedure should identify common lock out points to ensure energy cannot be restored while someone is still working on the machinery and equipment.

If two or more people are working on machinery and equipment that is isolated through several lock out points, each person should attach a lock and tag to each lock out point.

To avoid the need for multiple locks on each lock out point, a lock box may be used. Under this system, each lock out point is locked by only one lock, and the keys to the locks of the machinery's lock out points are placed inside a box that is locked by all the individual locks of people working on the same plant.



Multiple locks.

## One lock – one key

Each person working on the machinery and equipment should have their own lock, key and tag. There should be no duplicate key available for any lock, except a master or duplicate key for use in an emergency that is secured and not readily available.

During inspection, repair, maintenance, cleaning or adjustment of the machinery and equipment, the one key to each person's lock should be held only by that person, who is responsible for both locking and unlocking the lock out device.

## Multiple energy sources

If more than one energy source or hazard has to be locked out to enable safe shut-down of the machinery and equipment, the single key to each lock out device should be held by the same person.

## Tag out

A tag on its own is not an effective isolation device. A tag acts only as a means of providing information to others at the workplace. A lock should be used as an isolation device, and can be accompanied by a tag.



Valve lock and tag.

## FURTHER INFORMATION

Commission for Occupational Safety and Health guidance note:

- Isolation of plant

# 3

## PURCHASING MACHINERY AND EQUIPMENT LIST

The following list provides topics for consideration and consultation when purchasing machinery and equipment. It is important to also note that under Section 23 of the OSH Act 1984, manufacturers and suppliers of plant have specific duties to ensure plant is safe.

### PEOPLE

- who will come into contact with the machinery and equipment?
- what are people required to do?
- how will work be carried out and completed?
- based on the knowledge of existing machinery and equipment, what improvements should the purchaser specify when buying new machinery and equipment?

### DOCUMENTATION AND TRAINING

- what supporting documentation will accompany the new machinery and equipment?
- to what standards has the machinery and equipment been manufactured (Australian, European, Japanese, American)?
- what support is offered by machinery and equipment suppliers (service, training, maintenance)?
- what operating and maintenance information is supplied with the new machinery and equipment?
- is the supplied information sufficient to provide the basis of a workplace training package?
- if the machinery and equipment is refurbished or second-hand, how do the risk controls compare with like new machinery and equipment?
- have you allowed extra resources to upgrade existing risk controls to reflect current state of knowledge?

# PURCHASING MACHINERY AND EQUIPMENT LIST

## LOCATION

- where is the machinery and equipment to be located, and how much space does it require?
- is there enough room to access your machinery and equipment for servicing, maintenance, repair or cleaning?
- do people walk past or work in close proximity to the proposed machinery and equipment location?
- is there enough light?
- is there sufficient ventilation?

## OPERATION AND MAINTENANCE

- will the machinery and equipment introduce more noise to the workplace?
- will your machinery and equipment perform a task other than what it was designed for?
- what types of emissions does the machinery and equipment produce when operated or cleaned, such as noise, fumes, light and heat?
- what are the expected hours of machinery and equipment operation?
- how will material arrive, and how is product going to be removed after the process is complete?
- are there environmental factors, such as hazardous atmospheres of flammable vapours or dust or water, that may affect the machinery and equipment, the operators or maintenance workers?
- does the machinery and equipment have confined spaces?
- does the machinery and equipment have valves or isolation points located at height?

## VARIOUS

- will the machinery and equipment fit through the door?
- is the floor of your workplace strong enough to support the machinery and equipment?
- do you understand that if you purchase machinery and equipment outside Victoria, then you also take on the duties of the importer?
- do you understand the duties of an importer?
- do you understand that if you alter or adapt machinery and equipment to perform an alternate function, then you also take on the duties of the designer for those alterations?
- do you understand the duties of a designer?
- if the machinery and equipment is mobile, where will it operate and who may be in the area?
- in what terrain will the mobile machinery and equipment operate?

Refer to Section 4 for more information.

# 4

## INFORMATION AND GUIDANCE

### NOT SURE WHERE TO GO FROM HERE?

#### WorkSafe

Telephone: **1300 307 877**

Website: **[www.worksafe.wa.gov.au](http://www.worksafe.wa.gov.au)**

Email: **[safety@docep.wa.gov.au](mailto:safety@docep.wa.gov.au)**

#### General:

- employees can contact their union
- employers can contact their industry association

#### Legislation:

- *Occupational Safety and Health Act 1984*
- Occupational Safety and Health Regulations 1996

For copies of the above Acts and Regulations, go to [www.slp.wa.gov.au](http://www.slp.wa.gov.au)

#### Technical Standards:

- Standards Australia [www.saiglobal.com](http://www.saiglobal.com)
- AS 4024 Safety of Machinery