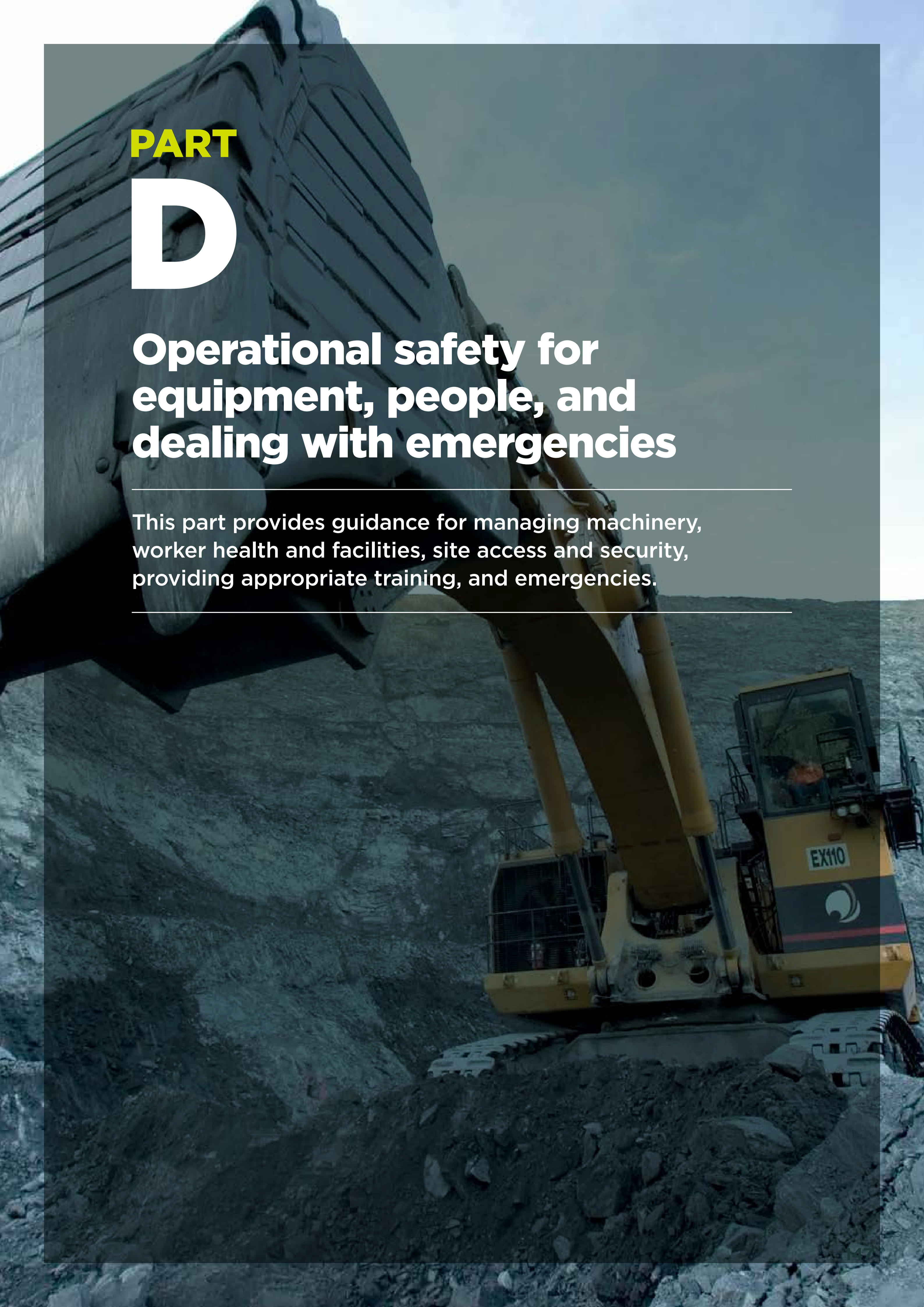
PART

D

Operational safety for equipment, people, and dealing with emergencies

This part provides guidance for managing machinery, worker health and facilities, site access and security, providing appropriate training, and emergencies.



PART D

12/

MACHINERY AND EQUIPMENT

IN THIS SECTION:

All sites use machinery and equipment in their day to day workplace activities. If the hazards associated with machinery are not safely managed, then serious injury and death can occur.

The overall message is – **safety by design**.

This section describes how to:

> identify and manage equipment hazards (for new and existing equipment)
> position and guard equipment
> use prestart warning systems and emergency stop systems effectively
> prevent, detect and deal with fires and explosions
> manage electrical hazards
> manage specific hazards around lifting equipment and floating equipment.

12.1 SCOPE

The scope of 'machinery' and 'plant' as defined in the *HSE Act* is extremely wide. It covers almost any equipment used at work including:

> hand tools such as hammers, handsaws
> individual machines such as circular saws, photocopiers, trucks
> apparatus such as laboratory apparatus (eg Bunsen burners)
> lifting equipment such as hoists, forklifts, elevating work platforms, lifting slings
> other equipment such as ladders, pressure water cleaners
> an installation (a series of machines connected together), for example a crushing plant and associated conveyor systems.

This section covers machinery and equipment commonly used at extractives sites where the information in the following documents, or other WorkSafe guidelines, may not be sufficient to provide industry specific guidance. This section does not cover vehicles including mobile plant (for information on vehicles see section 10).

The *WorkSafe Best Practice Guidelines for the Safe Use of Machinery* and *Ergonomics of Machine Guarding Guide* have information for managing hazards associated with machinery which may not be covered in these guidelines including:

> undertaking risk assessments
> choosing, buying, installing, modifying and decommissioning machinery
> eliminating hazards in the design process
> specific machinery hazards
> guarding types
> use, inspection and maintenance of machinery
> safe systems of work.

The *WorkSafe Approved Code of Practice for Managing Hazards to Prevent Major Industrial Accidents* outlines information for processes employed after crushing and screening (eg bitumen production or ore processing) that is not included in these guidelines. Appendix 2 of the code lists activities the code may apply to.

12.2 APPRAISAL OF MACHINERY AND EQUIPMENT PRINCIPAL HAZARDS

66 Site senior executive responsible for identifying principal hazards and having principal hazard management plans

(a) The site senior executive must-

- (a) carry out an appraisal of the mining operation to identify principal hazards at the mining operation; and
- (b) ensure there is a principal hazard management plan for each principal hazard identified.

To determine if activities associated with machinery and equipment are principal hazards, it is necessary to consider the following:

> how plant, equipment or installations might feasibly fail and the likely consequences of any such failure (ie structural support collapse)

> the type of fuel or energy used to power plant, equipment or installations used at the site (ie electricity, gas, petroleum)

> what the possible consequence of a loss control situation would be (ie mechanical failure leading to uncontrolled release of hazardous substances or energy sources)

> the hazards relating to moving parts (ie draw-in hazards, nip points, entanglement hazards)

> the hazards relating to suspended parts

> the hazards relating to surfaces (that is very hot or very cold).

If the degree of hazard is not clear the advice of a specialist mechanic, designer, engineer or the machinery or equipment's original manufacturer should be sought.

A risk assessment must be completed when developing the mechanical engineering PCP. The risk assessment must include the matters prescribed in regulation 97 of the Regulations.

12.3 MECHANICAL ENGINEERING OR ELECTRICAL ENGINEERING CONTROL PLAN

PART 4

PRINCIPAL CONTROL PLANS

92 Site senior executive responsible for having principal control plans

If a subpart of this Part applies to a mining operation, the site senior executive must ensure that there is a principal control plan for the mining operation that complies with that subpart.

Subpart 1 – Mechanical engineering

96 Application

This subpart applies to any mining operation where 1 or more principal hazards have been identified that may involve hazards or controls of a mechanical type.

Subpart 2 – Electrical engineering

99 Application

This subpart applies to-

(1) Any mining operation where 1 or more principal hazards have been identified that may involve hazards or controls of an electrical type.

Where one or more principal hazards have been identified that may involve hazards or controls of a mechanical type, the SSE must ensure there is a mechanical engineering control plan.

Where one or more principal hazards have been identified that may involve hazards or controls of an electrical type, the SSE must ensure there is an electrical engineering control plan.

The mechanical engineering control plan must contain information detailed in regulation 98 of the Regulations.

In summary, regulation 98 includes:

> the standards of engineering practice to be followed throughout the life cycle of the mechanical plant and installations
> the safe operation of conveyors, winding systems mobile plant and dredges
> the safety of plant and installations
> fitting appropriate fire suppression and shut-down systems
> fitting appropriate heat detection and automatic trip sensors
> rollover and falling object protection
> seatbelts and other restraints
> protective canopies
> safe storage and use of pressurised fluids
> means for the prevention, detection and suppression of fires on mobile plant and conveyors.

The electrical engineering control must contain information detailed in regulation 100 of the Regulations. In summary, regulation 100 includes:

> prevention of harm from electricity sources
> prevention of fires being started by electricity
> prevention of unintentional starting of electrical plant
> fitting electrical safeguards
> competencies required for workers carrying out electrical work
> the reliability of plant and installations used in monitoring hazard controls and communication systems
> a maintenance management system
> safe work practices for working on high voltage installations
> any other requirements of the *Regulations* in relation to the safety management of electrical plant and installations and electrical engineering practices
> the requirements of regulations made under the *Electricity Act 1992.*

Develop the mechanical engineering and electrical engineering control plans in the context of the whole health and safety management system. It should not be developed in isolation from other plans, processes and procedures that rely on the control plans as a control. This will ensure gaps and overlaps in information and procedures are identified and used in the implementation of suitable controls to minimise the likelihood of potential risks and impacts.

Machinery and equipment may also constitute a fire or explosion principal hazard. Therefore, a PHMP for Fire or Explosion may also be required (refer to regulation 85 of the Regulations).

For more detailed information on the content of principal control plans, and their interdependencies with other management and controls plans, processes and procedures see WorkSafe's *Guidance for a Hazard Management System for Mines*.

12.4 CHOOSING AND BUYING MACHINERY AND EQUIPMENT

The greatest opportunity to ensure machinery and equipment is safe is when new machinery or equipment is being scoped, designed and purchased. All operators should specify their expectations for achieving safety standards.

The designer, manufacturer, supplier and employer have obligations under the *HSE Act* and the *Health and Safety in Employment Regulations 1995* and should work together to manage issues such as:

> how the machine or equipment is used in the workplace
> risk levels and standards required
> type of guarding based on work patterns
> who will provide, install and commission the machinery or equipment
> integration with other machinery or equipment
> the working environment in which the machinery or equipment will operate

> any hazardous exposures arising from use of the plant or equipment such as noise or fumes
> who will train and supervise the operators
> operations and maintenance procedures
> intrusive maintenance and internal inspections required
> potential blockages or out of the ordinary situations
> how isolation from hazardous energy can be achieved.

Where the machinery or equipment is being designed and manufactured in-house, you take on the responsibilities set out in regulations 66 and 67 of the *Health and Safety in Employment Regulations 1995*. You (the designer) must have health and safety, including relevant standards, in mind when developing design concepts and throughout the design process.

If newly purchased machinery or equipment is not safe because of the way it has been designed, constructed, supplied or installed, you must stop using it until this has been fixed. Contact the manufacturer or supplier (or installer if relating to the installation) to resolve the issue.

12.5 EXISTING MACHINERY OR EQUIPMENT

With changes in technology and cost of solutions over time, measures to eliminate or isolate a hazard may become practicable. You should continue to assess significant hazards in order to determine whether there are other methods to control them. For example, replace a machine with a newer machine that eliminates the hazard. You should also routinely review systems, procedures and standards to reflect changes in technology and best practice.

You need to know what the hazards are with your machinery and equipment in order to do something about them. The first step in the hazard management process is to identify hazards – anything that can injure or harm someone.

Do a workplace inspection to identity all machinery and equipment used. Include common items that may not normally be thought of as ‘machines’. Also consider how other workplace items such as steps or platforms can affect the use of machinery and equipment.

Once you’ve identified all machinery and equipment, you can identify their hazards. You can identify hazards using physical inspection, task analysis, process analysis, guidance and standards, hazard and operability analysis (HAZOP) and accident investigation analysis.

For more detailed information on identifying, assessing and controlling hazards see the WorkSafe *Safe Use of Machinery Best Practice Guidelines*.

12.6 SITING OF MACHINERY

As a general rule, activities such as crushing and screening are noisy and dusty, so are sited away from boundaries to lessen the nuisance value of the activities. Some noisy and dusty processes may need to be housed to control these effects.

The safety of workers in the processing area is paramount. Traffic should be routed around the machinery wherever possible and machinery should be sited away from hazards (ie rock falls, overhead power lines).

Services, including electricity, air and water should be included in a site layout plan, particularly when placed underground.

12.7 ACCESS ROUTES

Machinery, including mobile crushers, often have areas where access at height is required to carry out routine operations, undertake maintenance or access control rooms.

This section deals with permanent (or fixed) access requirements (ie access to control rooms). For temporary access see section 16.1.

Where a structure is a building under the *Building Act 2004*, you must provide reasonable and adequate access to enable safe and easy movement of people[64]. Access routes must, among other things:

> have adequate activity space

> be free from dangerous obstructions and from any projections likely to cause an obstruction

> have a safe cross fall, and safe slope in the direction of travel

> have adequate slip-resistant walking surfaces under all conditions of normal use

> include stairs to allow access to upper floors

> not have isolated steps (ie single steps).

Have landings of appropriate dimensions where a door opens from or onto a stair, ramp or ladder so that the door does not create a hazard[64].

Access routes must also have stair treads and ladders which:

> provide adequate footing

> have uniform rise within each flight and for consecutive flights

> have stair treads with a leading edge that can be easily seen.

Access routes must also have handrails which:

> are smooth, reachable and graspable to provide support and to assist with movement along a stair or ladder

> be of adequate strength and rigidity as required by Clause B1 "Structure" of the *Building Code.*

Even if your machinery may not be classified a building under the *Building Act*, WorkSafe recommends you follow the requirements of the *Building Act*.

For more detailed information on access routes, including detailed diagrams of dimensions and construction requirements for stairs, ladders, ramps, barriers and access ways, see the MBIE Building Programme *Compliance Document for New Zealand Building Code Clause D1 – Access Routes* and *Compliance Document for New Zealand Building Code Clause F4 Safety from Falling.*

Refer to NZS/AS 1657 for more information.

12.8 GUARDING

The fundamental principles of guarding machinery are covered in the WorkSafe *Safe Use of Machinery Best Practice Guidelines,* and *Ergonomics of Machine Guarding Guide*. More information is available on the machinery fact sheets on WorkSafe's *Safe Use of Machinery* page at worksafe.govt.nz.

Where elimination of a hazard is not practicable, guarding is an effective isolation control provided the guards are the correct ones, and they remain in place.

This section provides additional guidance on effective guarding on fixed and mobile processing plant typically found in quarries and mines. It is not intended to be a comprehensive list and you may determine other types of guarding are more suited to the particular circumstances at your site.

Perimeter fencing (or area guards), although commonly used at extractive sites, does not meet the minimum requirements of *AS 4024.1 Series* where workers require access within the perimeter while the machinery is running. In these situations fixed guards should be used to guard individual nip points and entanglement hazards.

64 Building Code

Examples of fixed guards include:

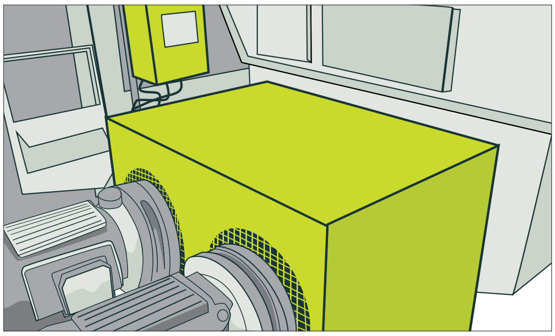


Figure 64: Example of fixed close-fitted guard enclosure on direct drive electric motors

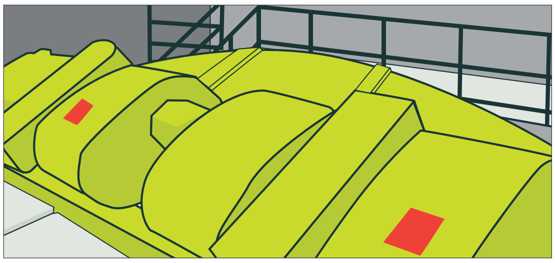


Figure 65: Example of totally enclosing sheet metal guard which are suitable for vibrating units with additional guards over the associated shafts and couplings

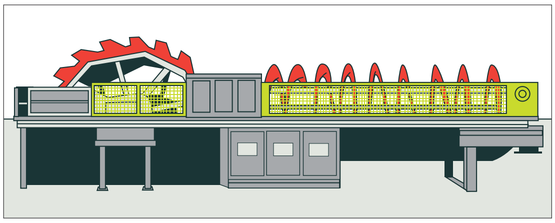


Figure 66: Example of panel mesh guards on fines dewaterer

Fines dewaterers use slowly rotating scraper blades to extract the finer particles. In addition to a sheet metal guard on the main dewatering section, a mesh guard should be provided around the trough of the scraper blade section. This should be fitted high enough to avoid workers falling into the trough or being able to reach the scraper blades and be at least 2.7 metres above ground level.

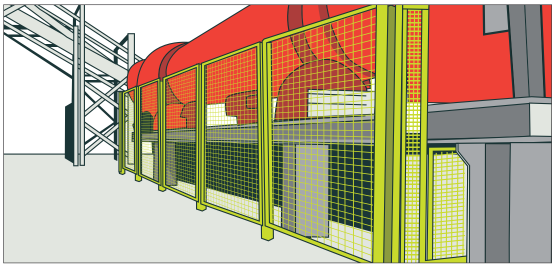


Figure 67: Example of panel type guards on dryer

Panel type guards secured to fixed uprights may be suitable for large rotating cylinders such as screens, dryers and trommels. The minimum height of the guard should be 2700 mm. Access gates should be interlocked unless access is required less than once per shift, in which case a locked gate can be used (must require a tool to open).

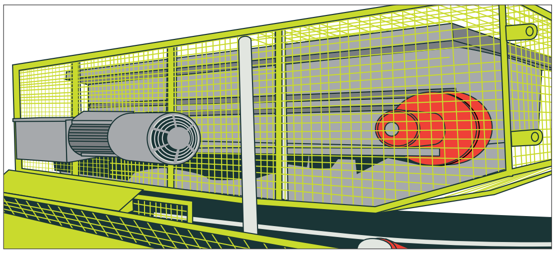


Figure 68: Example of close fitted guards on batch feeder belts

Batch feeder belts (while generally slower) have the same hazards as a normal conveyor. The feeder and all associated nip points should be enclosed within suitable guards fitted along the full length of the feeder. Guards should be provided on the underside to prevent access to tail and head drums.

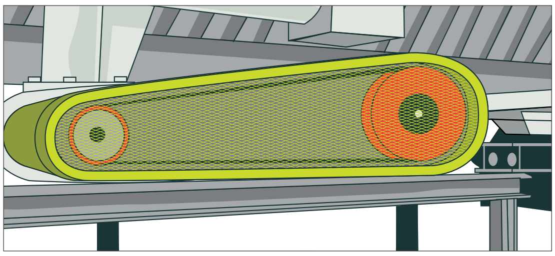


Figure 69: Example of close fitted guards on vee-belt drive

Vee-belt drives are commonly used on various items of plant. Open mesh guards help with efficient cooling of the vee-belts and pulleys and allow vee-belt tension to be visually checked without removal of the guard. The guard should fully enclose the front and back as required to prevent access.

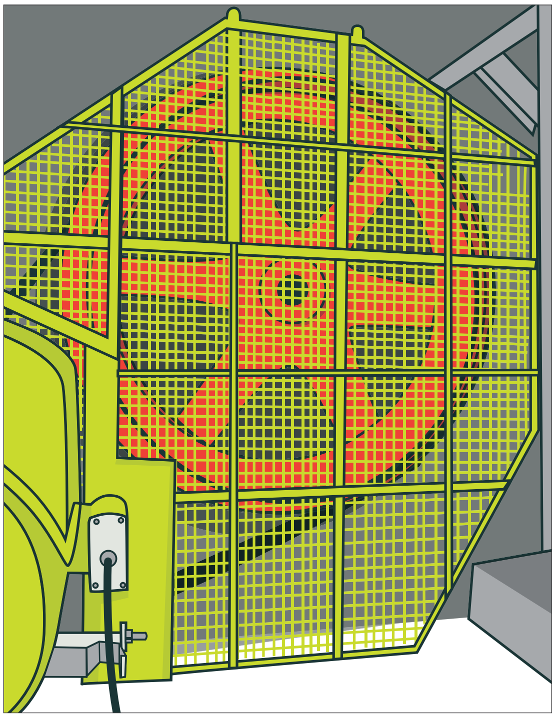


Figure 70: As with vee belt drives, a fixed guard totally enclosing the drive is suitable for primary jaw crusher drives. Alternatively guarding fitted around existing structures may be suitable

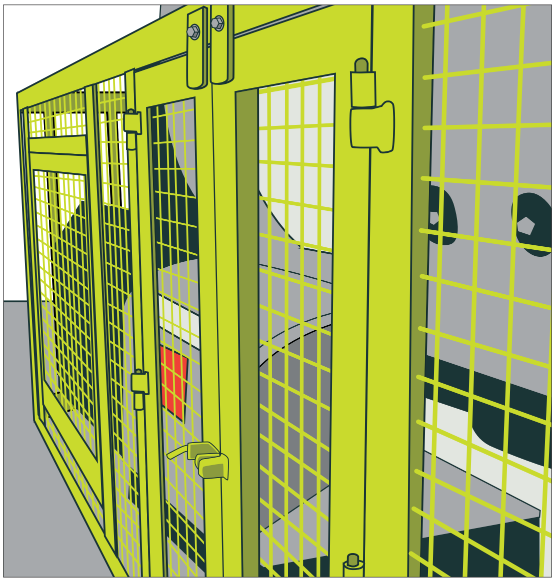


Figure 71: Example of hinged access panel guard bolted shut

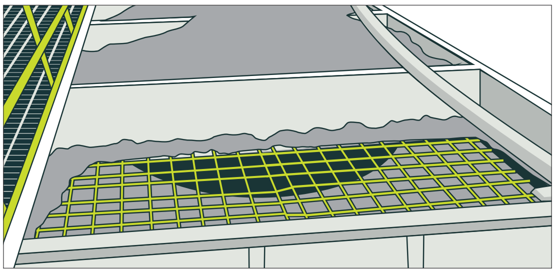


Figure 72: Example of steel man-grid on elevated feed hopper

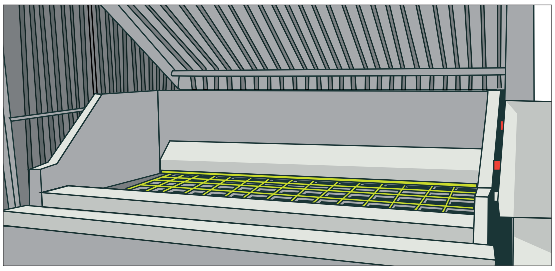


Figure 73: Example of steel man-grid on ground feed hopper

Steel grids, with sufficient strength to withstand any anticipated loads, should be provided in the top of all ground feed hoppers and easily accessible elevated feed hoppers. This is to prevent unauthorised or inadvertent entry. The exception is with primary hoppers or where products of a large dimension are being processed which may obstruct the grid.

Fitting grids on elevated hoppers may encourage people to walk on them next to an unprotected edge. Appropriate access prevention measures should be incorporated in the design (eg barriers).

Provision should be made to enable drivers at ground feed hoppers to release tail gate latches from a position of safety.

12.8.1 CONVEYOR GUARDING

Most serious accidents and fatalities with conveyors result from the machinery, and associated in-running nip-points, not being adequately guarded.

A wide variety of mechanical motions and actions on a conveyor system will present hazards to the worker. These can include the movement of rotating parts, moving belts, meshing gears, and any parts that impact or shear. These different types of hazardous mechanical motions and actions are basic in varying combinations to nearly all machines, and recognising them is the first step toward protecting workers from the hazards they present.

On a conveyor, in-running nip points are dangerous trapping points at the line of contact between the rotating drum or pulley (cylinders) and the moving conveyor belt on the in-running side of the cylinder. A similar point on the out-running side of the cylinder where the conveyor belt exits is not the dangerous location unless the conveyor can be reversed.

Even smooth, slowly rotating cylinders can grip clothing, and through skin contact alone force an arm, hand or body into a dangerous position. Frequently the machine is running too fast, or is too powerful to allow the person to stop the machine or pull the body part out. This can result in severe friction burns, amputation or significant (including fatal) crushing injuries.

Where a moving part cannot be eliminated, and workers are exposed to potential contact, fitting fixed barrier guards and additional in-running nip guards are practicable isolation controls.

Hazardous trap points may occur at the following locations:

> power transmission moving parts
> head and tail end pulleys
> bend, snub and take-up pulleys
> carrying and return idlers beneath feed hoppers, skirt plates and where the lift of the belt has been restricted as well as at convex curves (brow position)
> roller assemblies for conveyor belt tracking
> idlers accessible to people such as from crossovers or underpasses, maintenance or storage areas or cleaning areas and transition idlers adjacent to pulleys
> drive drums.

The following pages outline possible guarding for conveyor belt parts in operation, including:

> power transmission moving parts
> belts
> upper and lower strands in a straight run
> curved zone (brow positions)
> head and tail drums and transition zones
> gravity take up units
> fixed obstacles
> skirt boards.

It also provides general information on the use of nip guards.

POWER TRANSMISSION MOVING PARTS

Hazards associated with power transmission moving parts include the drive shaft, shaft end, sprocket, pulley, chain, drive belt and gear coupling. Possible consequences include drawing-in and crushing and entanglement of a loose piece of clothing in a protruding moving part.

If a hazard is less than 2700 mm from the ground or working platform fixed barrier guards should be fitted.

BELT

If the belt is in good condition possible consequences of contact (depending on the speed and belt characteristics) include friction burns or abrasion and impact with the belt. Install hazard controls in accordance with risk assessment results.

If the belt is not in good condition or there is evidence of a damaged belt splice, drawing-in, burns, and lacerations may be possible. Change the belt splice design or manufacturer if this is an ongoing problem. Otherwise maintain the belt and belt splice according to the manufacturer's specifications.

UPPER AND LOWER STRANDS IN A STRAIGHT RUN

An in-running nip will be present between:

> the upper strand and the pulleys under the hopper
> the upper strand and the pulleys under the skirt-board or skirt
> the upper strand and support rollers
> the upper strand and return rollers
> the lower strand and scrapers.

The following diagrams show suggested guarding in these areas.

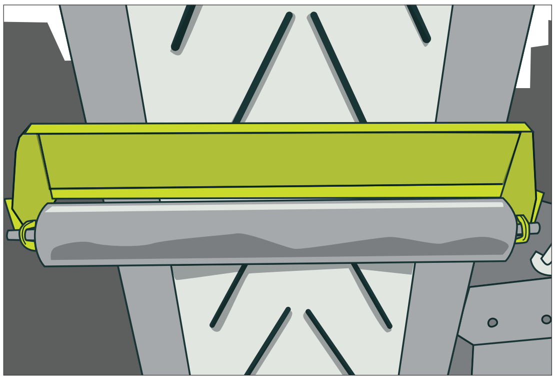


Figure 74: Plate type guard

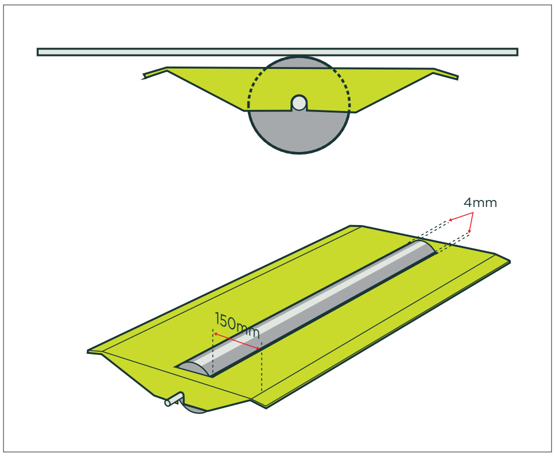


Figure 75: Bottom idler nip guard

CURVED ZONE (BROW POSITIONS)

In-running nips will be present between the belt and rollers in the curved zone with a possible drawing-in consequence. Fit a fixed barrier guard and, where required, additional nip-point guards.

HEAD AND TAIL DRUMS AND TRANSITION ZONE

In-running nips with a possible drawing-in hazard are present:

> between the belt and drums
> at the junction between two conveyors
> between the drum and fixed support brackets
> between the upper strand and the load carrying rollers in the transition zone.

Entanglement hazards also exist where the shaft is exposed. A fixed barrier guard and additional nip-point guards should be fitted.

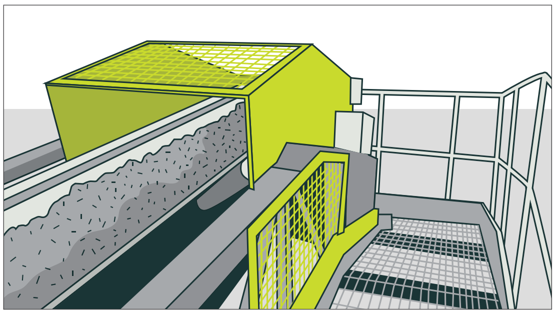


Figure 76: Example of head drum guards

Head drums which may become accessible by climbing stockpiles should be guarded. Alternatively stockpile heights should be strictly maintained to below 2700 mm in accordance with *AS 4024.1 Series* reach distances.

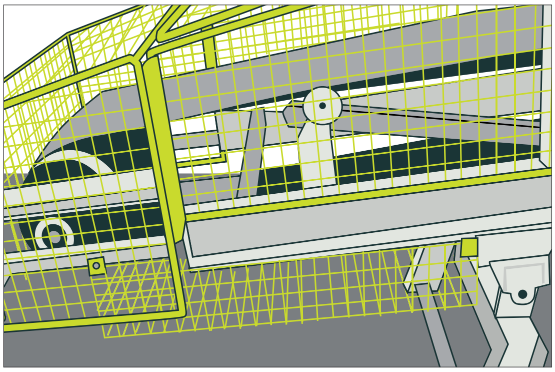


Figure 77: Example of tail drum guard

GRAVITY TAKE-UP UNITS

Conveyor gravity take-up units should be enclosed with mesh panels which prevent access to moving parts within the structure. This prevents the risk of the gravity take-up weight falling to ground level in the event of the belt, chains or ropes breaking. All panels should be secured so they require a tool for removal, or be interlocked.

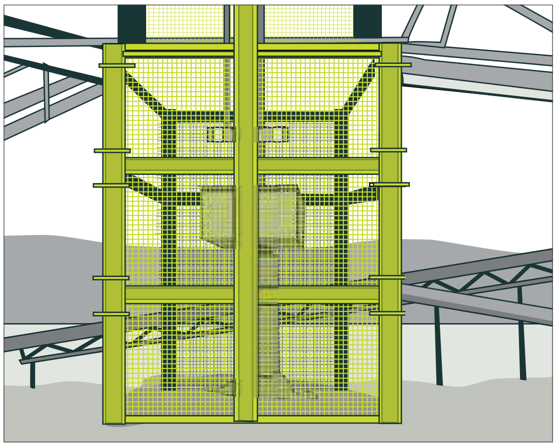


Figure 78: Example of perimeter guarding on gravity take-up points

FIXED OBSTACLES

Fixed obstacles which are not part of the conveyor can result in a person being trapped between the load and the fixed object. Examples of fixed objects are:

> posts
> walls
> tunnel entrances
> associated fixed equipment (ie metal detectors)
> large bulk loads (ie boulders).

In accordance with risk assessment results, consider fixed guards and deterrent devices. The objective is to keep the body, arms and legs away from the crushing area. The type of guard and its dimensions will depend on the body part at risk of being trapped and the weight of the load. The guard itself must not create a drawing-in or trapping area.

SKIRT BOARDS

You must ensure conveyors are designed, installed and used in such a way that no one is struck by falling objects[65]. The use of skirt boards can limit the amount of material that falls from conveyors (refer Figure 79).

[65] The Regulations, regulation 124 (1) (c)

Install skirt boards or other protective devices at:

> Loading and transfer areas. It is recommended that the skirt boards be at least two and a half times longer than the belt is wide, to allow the material to 'settle down'.

> Areas that have unusual features, such as magnets, crushers, and grizzlies.

> Places where people pass under the belt.

> Areas where maintenance, clean-up, or inspection activities are frequently performed.

In situations where fixed skirts are fitted above conveyor idlers, a trap point exists between the idler and the belt. Panels of guards should be fitted to prevent access to the trap points associated with the skirts of the conveyor (refer Figure 79).

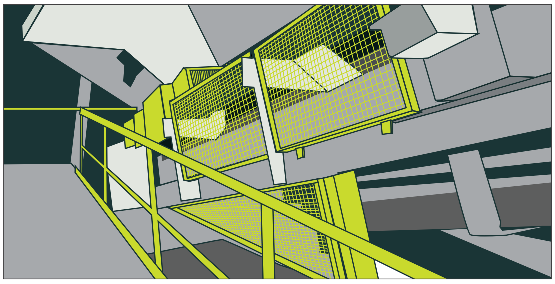


Figure 79: Example of skirting guards

GENERAL INFORMATION ON THE USE OF NIP GUARDS

Nip guards prevent access to the in-running nip's drawing-in zone. Where practicable, the nip guards should fill the drawing-in zone as much as possible and should be sufficiently rigid not to increase the clearance between the guard and the cylinders or the belt.

However, nip guards do not protect against the risk of pinching between the guard and the cylinder or belt, and residual risks of abrasion or burns may remain. In addition, they do not provide appropriate protection against the risks of hair or clothing being drawn in. Therefore, the risk assessment should take into account that the drawing-in effect increases with the diameter of the rollers, their roughness, their rotational velocity and the clothing or PPE worn (ie gloves).

To limit the risks of pinching, abrasion and burns, the clearance between the nip guard and the cylinder or belt should be as small as possible (maximum 4 mm). The angle between the guard and the tangent to the cylinder or between the guard and the belt should be 90° or slightly larger.

Nip guards are particularly suitable for cylinders, drums and rollers with a smooth and full end disc. They can be used with a smooth, flat or troughed belt, if they follow the profile of the belt, and the belt is tight and does not vibrate.

Where there are other machine hazards that require guarding (eg head drums with exposed rotating shafts), nip guards should be used in addition to fixed or inter-locked barrier guards.

DRAWING-IN ZONES

All in-running nips create hazardous zones (also called drawing-in zones) whose depth (p) varies with the diameter of the drums or pulleys (cylinders). The safety distance (sd) should be measured in relation to the accessible end of this drawing-in zone (called the "perimeter of the drawing-in zone") and not in relation to the axis of the cylinder.

In the case of two cylinders in contact the shape of the drawing-in zone is the angle that becomes even more acute when the cylinder radii is large. The hazardous zone is the angle between the two cylinders and is 12 mm in height.

The perimeter of drawing-in zone (p1 or p2) is determined by the 12 mm distance and the diameter of the cylinders.

In the case of a cylinder in contact with a belt, the drawing-in zone has the shape of a triangle that becomes even more acute when the cylinder radius is large. The danger zone consists of the triangle between the cylinder and the belt and is 12 mm in height.

In the case of two cylinders not in contact, or a cylinder close to a stationary object, the depth of the drawing-in zone varies in relation to:

> the diameter of the cylinders, and
> the gap between the cylinders, or
> the gap between the cylinder and the stationary object.

The depth of the drawing-in zone can then be zero (“p” = 0). The perimeter of the drawing-in zone can be confused with the axis of the cylinders if the gap is greater than 12 mm.

IDLER ROLLER NIP HAZARDS ON HEAVY DUTY BELT CONVEYORS

There is also a significant risk of injury posed by nip-point force on heavy-duty conveyor top and bottom idler rollers and the generally increased accessibility of nip-points due to greater width of idler rollers (particularly bottom idler rollers).

The two main factors to consider when undertaking a risk assessment are:

> Degree of hazard (likely severity of injury): Determined largely by the pressure between the belt and the idler roller. For example, if the stationary conveyor belt cannot be lifted off the idler by a person using one hand, it is likely nip guards will need to be installed.
> Likelihood of access to the nip-point: Determined by the height of the nip in relation to the activities that could be performed at that location and the separating distance between the nip-point and the likely position of workers that might make contact with it.

ADDITIONAL IN-RUNNING NIP GUARDS

From time to time access is required behind barrier guards or fixed guards, for the purpose of maintenance and cleaning of conveyor systems.

This results in potential exposure of workers to nip points. In addition guards are often left off at positions where they have to be frequently removed.

Previous initiatives have involved emergency stop cables interlinked with guards.

However, as these are not as effective as nip guards fitting directly at nip points (in addition to any other guards required) WorkSafe holds the view that these should be fitted, where practicable.

MAINTAINING NIP GUARDS

Nip guards are essential safety devices and they must be maintained in effective working order. They should be subjected to a suitable scheme of inspection, examination and maintenance. Each nip guard should be individually identified in such a scheme to ensure its location is known, and each has its own record of inspection, examination and maintenance.

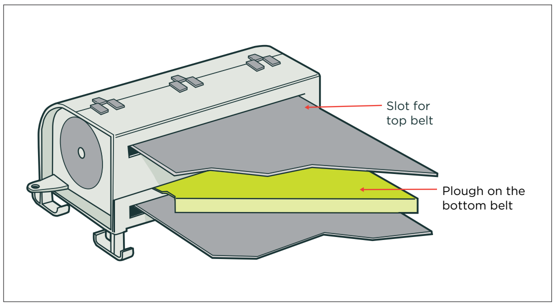


Figure 80: Tail drum return nip guard

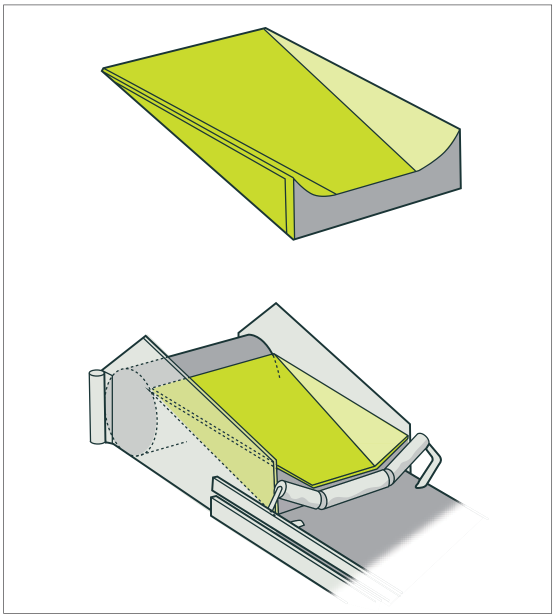


Figure 81: Head drum nip guard

12.8.2 STONE GUILLOTINE GUARDING

Stone guillotines (or stone cutters) with unguarded cutting knives can cause amputations and other serious injuries.

Examples of machine guarding methods include barrier guards, two-handed starting devices, remote-operator controls and electronic safety devices (eg light curtains). More detailed information is available from the WorkSafe *Safe Use of Machinery Fact Sheets* on the WorkSafe website.

Using machine-guarding methods that eliminate worker access to the cutting knife (called the "point of operation") is the preferred method of hazard control (refer Figure 82).

Two-handed starting devices are a cycle-initiation method that requires constant, simultaneous pressure from each hand on two separate controls to move the cutting knife. If the operator removes either hand from either of the controls, the blades will stop immediately. Two-handed starting devices are essential where fixed guards are not practicable (eg where the operator needs to feed blocks of stone into the cutting area) and operating controls are close to the knife. A suitable guard should be fitted to the side of the guillotine opposite to the controls where workers may reach into the hazardous area. Guillotines which rely on someone picking or pushing the stone after being cut should be fitted with a drop side or conveyor. This is so the stone is fed away from the hazardous area. Alternatively a suitable tool should be provided (refer Figure 83).

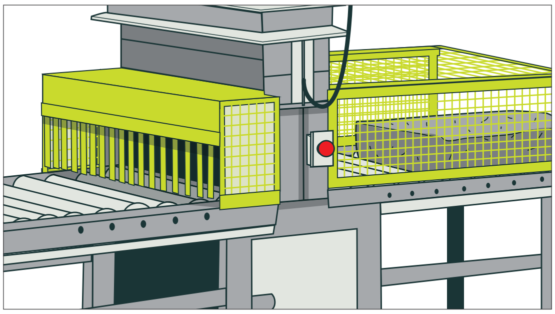


Figure 82: Stone guillotine with fixed guards

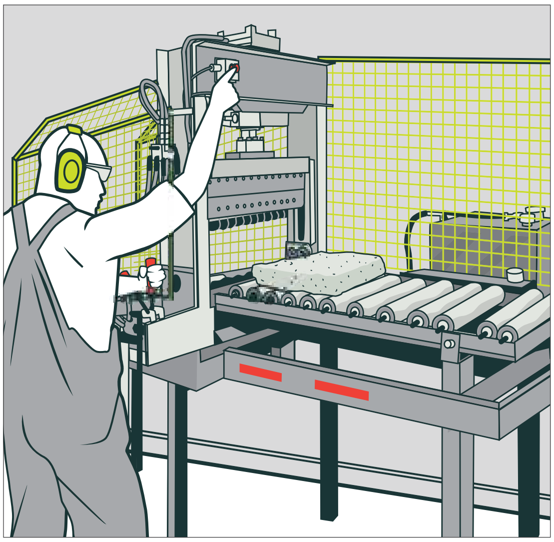


Figure 83: Example of two-handed starting device and drop side extraction

12.8.3 STONE SAW GUARDING

Stone saws range from sophisticated equipment capable of cutting large slabs of stone and intricate designs to smaller machines capable of simple cuts. Regardless of the size of the saw an operator may be in close proximity to the hazardous area when operating and suitable guarding or controls should be in place.

For larger saws the use of perimeter fences and interlocked gates would prevent inadvertent access and the operator from working in close proximity to the equipment.

Fixed guards alone might not be feasible as access is required for loading and unloading the stone. The following would all offer a high standard of protection:

> A perimeter fence and interlocked guards, such as manually-actuated sliding access gates (refer Figure 84). The interlocked guards should be fitted with a locking device so the guard remains closed and locked until any risk of injury from the hazardous machine has passed. This should allow for the rundown time of the saw blade.

> Electro-sensitive protective equipment such as light curtains at the front of the enclosure. When used in conjunction with a braking system to stop the movement before access to dangerous parts occurs. Alternatively the saw head could immediately return to a home position with a local guarding enclosure (refer Figure 85).

> Local retracting guards around the circular saw blade and pressure sensitive edges on the saw head and traversing table. This would have to be in conjunction with fast stopping times of the head and saw blade.

Guards may be extended to serve as noise enclosures. Local exhaust ventilation systems may be integral with the guard where appropriate.

Fixed guards or two-handed operator controls such as those outlined for stone guillotines may be suitable for smaller saws.

Remote-operator controls force the operator to remain at a safe distance from the hazard point (refer Figure 86). Hold-to run controls should be used for remote-operator controls. The machine should run down in the time it would take someone to reach the hazardous area when the operator removes their finger or hand from the control. Suitable controls must be in place to stop anyone else entering the hazardous area.

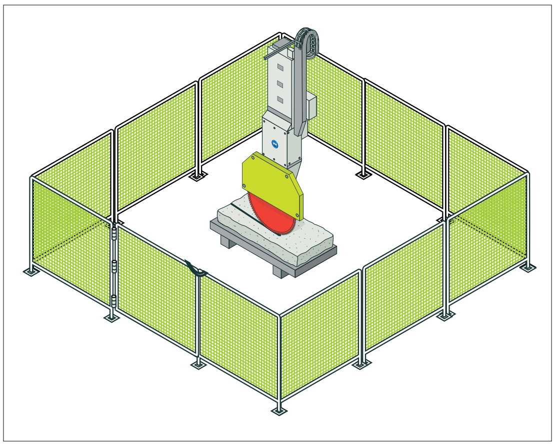


Figure 84: Stone saw with gate at access points

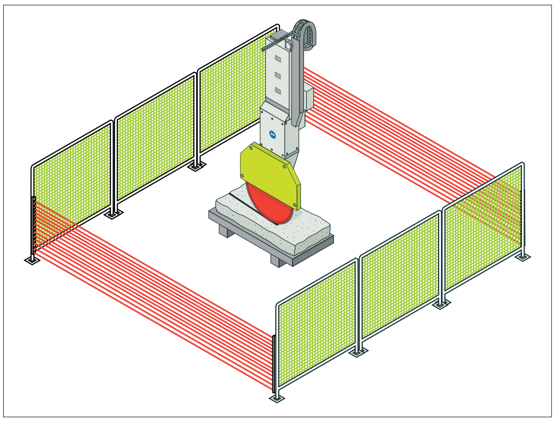


Figure 85: Stone saw with light curtains at access points

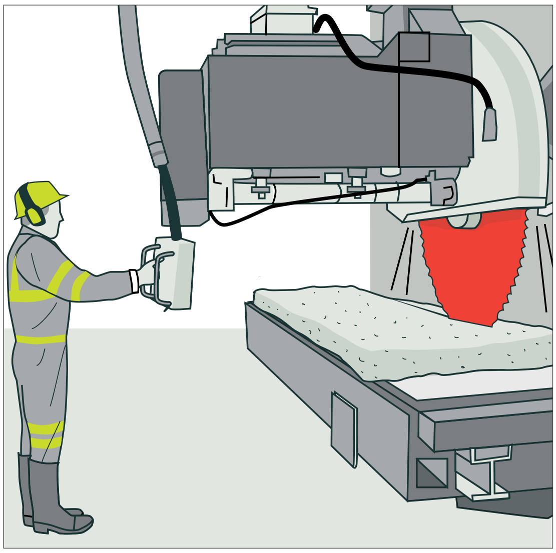


Figure 86: Remote operation controls on stone saw

12.8.4 GUARDING AND MAINTENANCE

Where maintenance requires normal guarding to be removed then additional measures will be needed to prevent danger from the mechanical, electrical and other hazards that may be exposed. This is also necessary if access is required inside existing guards. There should be clear company rules on what isolation procedures are required, and in what circumstances (eg some cleaning of mixing machinery may require isolation, even though it might not be considered a maintenance task).

Tensioning, tracking, lubrication and other maintenance is usually done while equipment is running. To eliminate the risk of injury, rods and nuts should protrude out beyond the guards. Consider grouping the lubrication points for access outside the guards (refer Figure 87).

Consider manual handling when removing guards for maintenance to be carried out. Lifting attachments on guards may be required.

For more detailed information on maintenance and repairs, including isolation and tag out, see section 17.

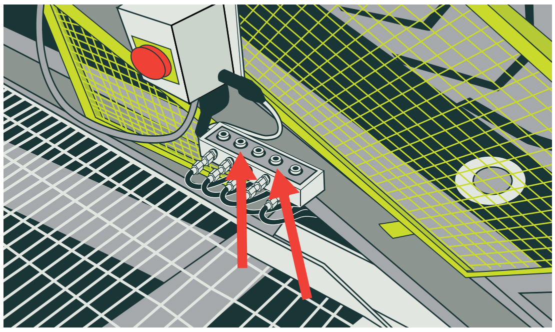


Figure 87: Example of remote greasing points

12.9 CONVEYORS

12.9.1 ANTI-RUN BACK DEVICE AND CONTROLLED BRAKING ON CONVEYORS

Any inclined conveyor has the potential to either run back (where the direction of the material is up) or run-away (where the direction of the material is down). These situations can be prevented by installing an anti-run back device (or sprag clutch) and controlled braking systems.

For more detailed information on anti-run back devices and controlled braking systems see *AS/NZS 4024 Safety of Machinery – Part 3610: Conveyors – General Requirements* or *AS/NZS 4024 Safety of Machinery – Part 3611: Conveyors – Belt Conveyors for Bulk Materials Handling.*

12.9.2 CONVEYOR CROSSOVERS AND UNDERPASSES

As well as the guarding requirements outlined in section 12.8 you must provide safe crossing points where a conveyor may be crossed[66]. Crossing over or under conveyors should be prohibited except where safe passageways are provided.

[66] The Regulations, regulation 124 (1) (d)

Access routes (as defined by the *Building Act 2004*) must maintain a minimum of 2.1 metres clearance overhead[67]. However, where people can reach into moving parts the clearance overhead should be a minimum of 2.7 metres[68] in accordance with *AS 4024.1 Series*.

124 Conveyor belts

(1) The mine operator must ensure that, where a conveyor belt or belts are used at the mining operation, the conveyor belt or belts are:

(c) designed, installed, and used in such a way that will protect any person near or travelling under a conveyor belt form being struck by a falling objects or objects:

(d) designed, installed, and used in such a way that will address the hazards arising from the interaction between people and the conveyor belt. This must include provision for the safe crossing of conveyor belts, where they may be crossed:

Whenever conveyors pass adjacent to, or over, work areas, roadways or other passageways, protective guards should be installed. The guards should be designed to catch and hold any load or material that may fall off or become dislodged from the conveyor (for more information on conveyor skirt boards see 12.8.1).

Where conveyors are operated in tunnels, pits and similar enclosures, ample room should be provided to allow safe access and operating space for all workers.

12.9.3 PRE-START WARNINGS ON CONVEYOR BELTS

Pre-start warnings must be provided on conveyor belts to address any hazard when they are started[69].

On overland conveyor systems, the devices should be placed at the transfer, loading, and discharge points and those points where workers are normally stationed. Warning signs stating "conveyor may start without warning" should be strategically placed along overland conveyors where it is reasonably foreseeable that people may gain access.

For more information on pre-start warning systems see section 12.11.

12.9.4 RECLAIM TUNNELS

The nature of reclaim tunnel operations means the presence of people in the tunnel is normally only required on an infrequent and irregular basis. Loading operations are usually remotely activated and control room operators may not expect workers to be in the reclaim tunnel which can lead to hazardous situations. Workers should only enter the reclaim tunnel to inspect, clean or maintain the system when effective safe systems of work are in place.

Reclaim tunnels may be a confined space entry (see section 16.1.4).

12.10 EMERGENCY STOPS

Emergency stops, including pull wire emergency stops, should not be used as a substitute for guards. They are only a backup for other control measures. Emergency stops should be in red with a yellow background where practical and signs should be erected for easy identification (refer Figure 88).

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[67] Compliance Document for NZ Building Code – Clause D1: Access Routes
[68] AS/NZS 4024.3610 C2.1 (currently draft)
[69] The Regulations, regulation 124 (1) (a)

Do not use emergency stops to lock-out the plant or equipment because the actuators can separate from the contacts. If this happens, the control will show the plant is off but it is actually on.

Emergency stops should:

> be prominent and clearly and durably marked
> be immediately accessible to each user of the plant or equipment
> have red handles, bars, push buttons or pull cords (labels can also be used)
> not be affected by electrical or electronic circuit failure.

Mine operators must fit an emergency stop system that can be activated at any accessible point along the length of a conveyor belt[70].

For more detailed information on emergency stop controls see the WorkSafe *Best Practice Guidelines for the Safe Use of Machinery* and *AS/NZS 4024 Safety of Machinery: Part 1604: Design of controls, interlocks and guarding – Emergency stop – Principles for design.*

Figure 88: Emergency stop with signage (photo courtesy of Fulton Hogan Miner Rd Quarry and NZ Steel Taharoa)

12.11 PRE-START WARNING SYSTEMS

Pre-start warning systems should be provided on machinery where sudden, unexpected operation could cause serious or fatal injuries to those who may be close to the machinery.

Because mines and quarry processing areas can be noisy and spread out it will normally be appropriate to provide both visual and acoustic prestart warnings that work in conjunction with one another.

[70] The Regulations, regulation 124 (1) (b)

Acoustic signals should:

> sound for long enough before the plant or equipment starts to provide adequate warning to anyone who may be in a position of risk
> loud enough so they can be heard in the area they are providing a warning for
> be at a level higher than the ambient noise without being excessive or painful
> be clearly different from any other warning signals or alarms.

Visual signals (eg flashing lights) should be placed so people close to the plant or equipment will have the best opportunity to see it. You may need multiple visual signals depending on the set-up of your plant and whether or not an acoustic signal will be sufficient to provide warning. Where visual signals are used they should be of a suitable brightness and colour contrast to the background.

For more detailed information on acoustic and visual signals see *AS/NZS 4024 Part 1904: Design, controls, actuators and signals – Indication, marking and actuation – Requirements for visual, auditory and tactile signals.*

12.12 ELECTRICITY

The *Electricity (Safety) Regulations 2010*:

> state the generic rules and requirements about electrical safety, and what is deemed to be electrically safe and unsafe
> deal with the design, construction and use of works, installations, fittings and appliances
> provide for installations to be designed and installed under *AS/NZS 3007 Electrical equipment in mines and quarries – Surface installations and associated processing plant*
> define certification and documentation required for all electrical works
> set out in schedules all of the applicable Standards, with a focus on the adoption of international Standards
> define requirements relating to safety management systems (SMSs)
> provide for offences including infringement offences.

The amendments to the *Electricity (Safety) Regulations 2010* in December 2013 complement the Regulations. They improve design requirements, periodic assessment and verification of safety requirements, specific requirements relating to Prescribed Electrical Work (PEW), design, maintenance and day to day operations.

It is important any electricians you use to perform electrical work are familiar with the *Electricity (Safety) Regulations 2010* and they certify all work they perform. One particularly important document is *AS/NZS 3007:2013 Electrical equipment in mines and quarries – Surface installations and associated processing plant*. Make sure all electricians are familiar with this Standard.

Mobile and relocatable equipment at alluvial mines and quarries must be assessed yearly against AS/NZS 3007 by a qualified mining electrical inspector[71].

Machinery must be properly grounded before use and all connections, switches and cables must conform to the *Electricity (Safety) Regulations 2010*.

As a general rule:

(a) Use Residual Current Devices (RCD's).
(b) Electrical substations should be kept clean and not used as stores. They should be kept locked with access to authorised workers only.
(c) All equipment should be part of the electrical maintenance and inspection scheme.
(d) Batteries should be treated with caution. Manufacturer's instructions should be followed for maintenance and precautions to be taken (ie PPE).

[71] *Electrical (Safety) Regulations 2010*, regulation 78D

(e) Dust accumulations can have a serious effect on the safe functioning of electrical equipment. Make sure housekeeping procedures are in place.

(f) All electrically powered equipment should be capable of being isolated. The isolation points should be clearly labelled and means of isolation provided (see section 17.2).

(g) Where the operators have been properly trained it may be appropriate to access some electrical equipment for the purposes of resetting trips. In these cases it may be permissible to open cabinet doors provided the equipment inside is properly shrouded to prevent inadvertent access or arc flash.

(h) Switchboards should be securely locked at all times. Where wiring is damaged it should be reported immediately. Water should not be allowed to accumulate in switch boards or switch rooms.

(i) Underground cables and pipes should be accurately located on a site plan and identified before digging.

For more detailed information on safety around underground cables and pipes see the WorkSafe *Approved Code of Practice for Excavations for Shafts and Foundations.*

12.12.1 FLEXIBLE CORDS

Flexible cords must have a current tag issued in accordance with *AS/NZS 3760 In-service safety inspection and testing of electrical equipment*[72].

A flexible cable or cord (for supply purposes) is one that has one end connected to a plug with pins designed to engage with a socket outlet, and the other end either:

> connected to terminals within the equipment, or

> fitted with a connector designed to engage with an appliance inlet fitted to the equipment.

Flexible cords are prone to damage because they are often outdoors in operational areas and can be subject to falling material, repetitive use, movement, vibration and extremes of weather. Regardless of the date of the tag all flexible cords should be examined before being plugged in and used. Consider any shock or tingle as a warning of a potential safety problem. If this occurs immediately switch off, isolate and remove the cable and do not be use it again until tested by a competent electrician.

Figure 89: Flexible cords with tags

12.12.2 TRAILING CABLES

Safe systems of working with trailing cables should include meeting the New Zealand *Electricity (Safety) Regulations 2010* and *AS/NZS 3007 Electrical equipment in mines and quarries – Surface installations and associated processing plant.*

These safe systems of working with trailing cables should also include:

> Regular inspections including in-situ visual inspection by machine operators and regular documented safety assessments (at least annually).

[72] *Electricity (Safety) Regulations 2010*, regulation 26

> Route criteria including support measures (where applicable), methods and heights for crossings, location of cables in proximity to roadways, protection measures required where it is necessary for vehicle crossings and so on.
> Methods for relocation of cables and provision of adequate equipment to perform the task such as cable reelers or relocators.
> Defined methods for manual handling and provision of adequate mechanical lifting aids to eliminate manual handling sprains and strains. Equipment to separate and join plugs should be sought.
> Regular inspection, maintenance and testing performed on substation earth systems including earth mats, earth impedance and earth connection points, protection relays and trip batteries.
> Provision of unique clear identifiers for each cable and trailing cable plug and substation outlet.
> Defined standards for the circumstances under which trailing cable protection relays can be reset and power re-energised onto a cable where the relay has indicated a fault to be present.
> Developing, implementing, monitoring and reviewed systems of high voltage switching, access and authorisation.
> Minimising direct handling of energised cables. Anyone required to directly handle energised trailing cables should wear insulating gloves covered by leather outer.

Training should be provided in the above and in trailing cable hazard awareness for all people required to work with them. Workers associated with relevant tasks should be consulted in relation to the development of the systems and standards mentioned above.

12.13 CRANES AND LIFTING EQUIPMENT

Where there is a crane on site, you must comply with the *HSE (Pressure Equipment, Cranes and Passenger Ropeways) Regulations 1999* and should comply with the *Approved Code of Practice for Cranes*. Fixed cranes includes gantry cranes, overhead hoists, monorail systems, davit arms or fixed lifting points. The structures supporting the crane must be certified by a chartered professional engineer with respect to design, construction and non-destructive testing, as relevant.

The structure certificate issued must specify:

(1) design standards referenced

(2) maximum permissible safe working load and any load limitations or conditions

(3) details of equipment that may be used on the certified structure[73].

Items of mobile plant, not originally designed as a crane used for load-lifting incidental to their principal function are exempt from the *Health and Safety in Employment (Pressure Equipment, Cranes, and Passenger Ropeways) Regulations 1999*. This is subject to the following conditions as applicable:

(1) Lifting points and equipment used for rigging loads are to be certified by a Chartered Professional Engineer; and

(2) In the case of hydraulic excavators with an operating weight of 12 tonne or more the following additional conditions apply:

   (a) The equipment is not to be modified to make it operate as a crane other than the provision of a lifting point; and

   (b) Hose burst protection valves are required; and

[73] **Note:** Some equipment is exempt from this requirement. Refer to *Notice of Exemption for Equipment under the Health and Safety in Employment (Pressure Equipment, Cranes, and Passenger Ropeways) Regulations 1999, New Zealand Gazette, No 188, page 4517, 17 December 2009*

(c) Operators and ground support personnel are to be adequately trained as required by section 13 of the *HSE Act*; and

(d) Operations are to be carried out in accordance with the *Approved Code of Practice for Load-lifting – Rigging*; and

(e) The equipment is to have a loading chart available to operators[74].

All sites should develop a safe system of work for the use and management of all lifting equipment in accordance with the WorkSafe *Approved Code for Practice for Load-lifting Rigging*. This includes but is not limited to:

> Every lifting appliance and item of loose gear shall be clearly and permanently marked with its WLL by stamping, or where this is impracticable or not recommended, by other suitable means. Also, a unique identifying numbering system to clearly identify individual items should be used.

> Visual inspection prior to and after use.

> Examination by a competent person regularly depending on frequency, use, and environmental conditions but not exceeding 12 months.

> A register should be kept for lifting equipment. The register should show the date of the last recorded examination or test, and any alterations.

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[74] *Notice of Exemption for Equipment under the Health and Safety in Employment (Pressure Equipment, Cranes, and Passenger Ropeways) Regulations 1999, New Zealand Gazette, No. 61, page 1784, 3 June 2010*

PART D

13/

WORKER FACILITIES

IN THIS SECTION:

You must provide suitable and sufficient numbers of facilities to make sure the health and safety of everyone at the site. Facilities are those that are necessary for the well-being of your workers, such as washing, toilet, rest and changing facilities, and somewhere clean to eat and drink during breaks.

Keep all facilities in a clean and sanitary condition.

Facilities must comply with the *Building Act 2004*, *Building Code, Health and Safety in Employment Regulations 1995* and local authority bylaws as appropriate.

For more detailed information on facilities see:

> WorkSafe *Guidelines for the Provision of Facilities and General Safety in Commercial and Industrial Premises*.

> *Guidelines for the Provision of Facilities and General Safety in Forestry Work*.

13.1 WASHING FACILITIES

Cold water, cleansing agents and suitable hand drying facilities must be provided at all work sites[75].

Where chemicals are being handled, mixed or applied, showers or suitable cleaning agents may be needed. Additional emergency showers may also be required (refer to the safety data sheet).

13.2 TOILETS

Toilets must be provided in accordance with the *Building Act 2004, Building Code* and *Health and Safety in Employment Regulations 1995.*

Facilities should be as near as practicable to the work, but may be off-site if transport is provided. Facilities should not be so remote as to discourage their use by workers.

Toilets must be kept clean and tidy, and be convenient to workers[76].

13.3 DRINKING WATER

An adequate supply of wholesome drinking water[77] must be readily available, and should be clearly labelled as drinking water. A common drinking container should not be used. Containers for drinking water should be kept clean and protected from contamination.

13.4 FACILITIES FOR EMPLOYEES WHO BECOME ILL AT WORK

Rest facilities, or if necessary, transport to home or medical assistance for employees who become ill at the place of work must be provided[78].

[75] *Health and Safety in Employment Regulations 1995*, regulation 4 (2) (b)
[76] *Health and Safety in Employment Regulations 1995*, regulations 4 (1), 4 (2) (a) and 9
[77] *Health and Safety in Employment Regulations 1995*, regulation 8
[78] *Health and Safety in Employment Regulations 1995*, regulation 6

13.5 FACILITIES FOR CHANGING AND STORING CLOTHES

You must provide an area where workers can change, in privacy, clothes that become wet or contaminated at work[79]. Adequate clean space should be provided so workers can store clothes not used at work where appropriate.

13.6 FACILITIES FOR MEALS

You must provide facilities for workers to have meals and rest periods in reasonable comfort and sheltered from the weather[80]. Any facility used for shelter and meal purposes must not be used for the storage of tools, materials or petroleum products.

Suitable rubbish disposing facilities should also be available.

[79] *Health and Safety in Employment Regulations 1995*, regulations 5 (2) (b) and 5 (2) (c)
[80] *Health and Safety in Employment Regulations 1995,* regulation 4 (2) (k)

PART D

14/

SITE SECURITY AND PUBLIC SAFETY

IN THIS SECTION:

You must consider ways in which working the site may create a risk not only to workers but to the public.

This section describes how to manage site access and other areas that may pose a danger to the public.

From a health and safety perspective, it is good practice to divert public rights of way around mines or quarries. Where it is not possible, precautions should be implemented, based on a detailed risk assessment of the route and the area around the site. The precautions should be reviewed regularly.

14.1 ACCESS TO SITES

Access to sites should be controlled to make sure unauthorised persons cannot travel to a location where they may be at risk from site operations[81]. This is particularly important for sites where there are sales to the public or in residential areas. Control measures may include signage, automated barrier arms or worker controlled areas (eg a weighbridge operator).

14.2 BARRIERS

Providing and maintaining suitable barriers around the site to discourage trespass may be appropriate. Trespass means entry to the site without express or implied permission.

Barriers are appropriate where it is reasonably foreseeable that members of the public, including children, are likely to trespass on the site, and could suffer injury if they did so.

The type of barrier required depends on the risks. In a rural area, where risk of public access is low, hedges, trenches and mounds may be enough. In areas where there is evidence of persistent trespass which places them at significant risk, substantial fences may be required.

Workers should be encouraged to report cases of trespass or evidence that people have been on the site. They should also be told what action to take if they discover trespassers.

14.3 SIGNAGE

Suitable signs warning people of the possible hazards at the site should be erected at entry points and, where necessary, along boundaries (refer Figure 90 and Figure 91). Any signs should be maintained in a legible condition.

[81] *HSE Act,* sections 15 and 16

Figure 90: Examples of signage warning of hazards

Figure 91: Example of sign at gate

PART D

15/

WORKER HEALTH

IN THIS SECTION:

Managing the health and wellbeing of your workers is an important part of being a good employer. It also pays dividends in terms of increased productivity, reduced sick leave, improved staff morale, and loyalty.

This section describes how to:

> identify and manage risks to workers' long-term health
> monitor workers' health
> protect workers from specific hazards including vibration, dust, fumes, ultraviolet radiation, and chemical or biological hazards
> help workers handle the physical and mental pressures of work safely
> provide appropriate personal protective equipment (PPE).

Ineffective workplace health hazard management is responsible for significantly higher levels of injury and death than workplace accidents. Within the context of occupational health, effective management is achieved by ensuring relevant health hazards are identified and, as a key objective, eliminated at source. It is only appropriate to control health hazards by reducing the likelihood of harm when elimination is not practicable. Personal Protective Equipment (PPE) is the lowest form of control and should be a last resort.

For controls to be effective, managers, workers and their representatives should:

> have easily accessible information on the nature of a health hazard and how it can be controlled and monitored. This information must be updated as knowledge on new health hazards becomes known, and new techniques for managing them are developed
> have the necessary capability – both through access to equipment and technology, and the managerial skills to make sure good systems are in place
> be motivated to take action to control exposures to health hazards and reduce risk.

15.1 WORKER HEALTH PRINCIPAL HAZARDS AND CONTROL PLAN

To determine whether there are principal hazards that may have long-term effects on mine workers' health, it is necessary to consider situations workers may be exposed including, but not limited to:

> the materials, substances or fumes workers may be exposed to, and the likely consequences of any such exposure (ie coal dust, silica dust, diesel particulates, welding fumes, chemicals and so on)
> the type of tasks undertaken (eg work outdoors, working in extremes of temperature, manual handling), and the place in which they are undertaken
> the equipment or tools being used and how workers interact with them (eg noise and vibration)
> the length of time workers may be exposed to any potentially hazardous material, fumes, substances or situations
> the hours of work (including travel time to and from sites, and shift work), sleep disruption, sleep deprivation and individual workload
> the influence drugs or alcohol may have on a worker.

You cannot accurately assess the risk of some hazards without undertaking scientific testing or measurement by a competent person. This includes checking that relevant exposure standards are not being exceeded (eg by using noise meters to measure noise levels, and dust deposition meters to measure airborne dust). Extractive sites should undertake workplace and individual monitoring for the following hazards:

> dust (including diesel particulates)
> noise
> vibration
> welding fumes and gases (where applicable).

If the degree of hazard or risk is not clear, the advice of an occupational health, occupational hygiene or occupational medical specialist should be sought.

If there are principal hazards relating to worker health at a mining operation, the SSE must ensure there is a principal control plan for the mining operation. This must comply with regulations 107 and 108 of the Regulations.

The worker health control plan must contain information detailed in regulation 108 of the Regulations. In summary, the worker health control plan must address how the following hazards will be monitored and controlled:

> noise and vibration
> dust, diesel particulates and fumes
> working in extremes temperatures and humidity
> changes in atmospheric pressure
> manual handling and lifting
> hours of work, and fatigue
> psychosocial hazards (stress, bullying and violence)
> ultraviolet and ionising radiation
> biological hazards
> any other hazard that may adversely affect the health of workers.

The worker health control plan must also set out:

> development of strategies to deal with the consumption of drugs or alcohol
> a process for obtaining urgent medical treatment for mine workers where required.

The worker health control plan should be developed in the context of the whole health and safety management system, and not in isolation from other plans, processes and procedures that rely on the control plan. This will ensure gaps and overlaps in information and procedures are identified and used in the implementation of suitable controls to minimise the likelihood and potential risks and impacts.

15.2 WORKER HEALTH MONITORING

When using minimisation hazard controls, you must monitor employees' exposure to the hazard (work environment monitoring) and, with employees' informed consent, monitor their health in relation to the hazard[82].

To make sure personal health information is kept private; manage disclosure of health monitoring information. Typically, the occupational health practitioner will provide a summary of health monitoring results that do not identify or disclose any individual. These summarised results can be used to determine whether health hazard controls are achieving the desired level of protection.

Offer and pay for medical examinations to each worker at the following times:

1. immediately before the worker starts work (pre-employment medical)

[82] *HSE Act,* section 10(2)(e)

2. immediately before the worker stops working at the site if their last medical is more than 12 months old (exit medical)
3. periodically throughout their employment and no less than every 5 years (usually done annually but this is dependent on medical practitioner advice)[83].

Consult with workers before choosing a medical practitioner or nurse to carry out the health monitoring (or medicals). Health monitoring must establish the level of health of workers as it relates to the work they are carrying out at the time[84].

You must make records of health monitoring available to WorkSafe on request. Such records must not identify or disclose any individual unless first obtaining the workers consent[85].

Records of health monitoring must be kept:

> for at least 30 years after the monitoring took place in the case of any hazard that is known to have a cumulative or delayed effect (ie noise induced hearing loss or respirable dust exposure)

> for at least 7 years after the monitoring took place or until the worker stops working at the site, whichever is the later In the case of all other hazards.

15.3 NOISE

You must take all practicable steps to ensure workers are not exposed to noise levels above 85 dB(A) $L_{Aeq,8h}$ and a peak noise level of 140 dB L_{peak}. This is regardless of whether they are wearing a personal hearing protection device.

The 85 dB(A) exposure limit is based on an 8-hour working day, it is highly likely extractive operations will need to take into account extended shifts in any noise assessment. This is due to the longer period of time a person is exposed to potentially hazardous noise, and the shorter time the person's ears have to recover before noise exposure resumes. Situations may also exist when the longer exposure time is a key factor in noise exposure exceeding the exposure limits.

Much can be achieved by careful design and maintenance of equipment and possibly by changing work practices.

Methods for reducing exposure include:

(a) using low noise machinery many extractive sites equipped with modern machinery and vehicles achieve noise exposures below workplace exposure standards

(b) reducing sound radiating surfaces (eg using mesh guards instead of plate metal)

(c) vibration isolation (eg operators' cabins and vehicle cabs)

(d) using sound absorbing linings (eg in vehicle cabs and engine cover linings)

(e) using exhaust silencers (eg on pneumatic drill rigs and vehicle engines)

(f) using enclosures around equipment (eg to control noise in workshops)

(g) using noise refuges for workers (eg a cabin at the control console of crushing and screening equipment)

(h) maintenance (eg replace defective silencers and repair broken windows in vehicle cabs).

Such measures may be used alone or in combination. The list is not exhaustive and other techniques may be applicable. Many effective solutions are low cost.

Personal protective equipment (PPE) (ear protectors) should only be used as an interim solution. It may be used long-term when all other reasonably practicable measures have been taken but have not, in themselves, achieved adequate noise reduction. Reducing noise exposure is the main objective.

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[83] The Regulations, regulation 128(1)
[84] The Regulations, regulation 128(2)
[85] The Regulations, regulation 128(4)(a)

For more detailed information on noise control methods see the WorkSafe *Approved Code of Practice for the Management of Noise in the Workplace*. This includes information on workplace exposure standards, work environment monitoring, health monitoring and personal protective equipment (PPE).

15.4 VIBRATION

There are two types of vibration which may cause harm to workers. Whole body vibration (WBV) and hand-arm vibration (HAV).

WBV is the vibration and shock you feel when you sit or stand on a vehicle or machine travelling over rough ground or along a road. It can also be the vibration when you work near powerful machinery such as a rock crusher. Shocks can occur, for example, when driving over bumps or potholes.

Exposure to WBV at low levels is unlikely on its own to cause injury, but it can aggravate existing back injuries which may cause pain. Effects of long-term exposure to WBV include:

> disorders of the joint and muscle disorders, especially the spine
> cardiovascular, respiratory, endocrine and metabolic changes
> digestive system problems
> reproductive damage in women
> vision or balance impairment
> discomfort and interference with activities.

HAV is the vibration and shock transmitted to your hands and arms when using handheld powered tools or equipment which vibrates while in operation.

HAV can cause hand-arm vibration syndrome (HAVS) and carpal tunnel syndrome (CTS) which can be debilitating. The risk of developing HAVS or CTS depends on the length of time a person is exposed for and the magnitude of the vibration.

You can reduce and control vibration exposure by:

> maintaining plant, equipment and vehicles
> reducing speed
> designing and constructing machinery and vehicles to lessen vibration emission
> maintaining roadways and other vehicle operating areas
> purchasing or replacing hand-held tools with ones with less vibration emission
> purchasing or replacing machinery or vehicles with ones with less vibration emission
> reducing time spent using hand-held tools or driving
> organising work and designing workstations to avoid uncomfortable postures and the need for high manual effort to grip, push or pull equipment
> providing personal protective equipment (eg gloves).

15.5 BREATHABLE HAZARDS

15.5.1 RESPIRABLE DUST

One of the health risks from working at an extractive site is the exposure to fine dust, containing particles that may lead to chronic and possibly fatal lung disease. Respirable dust does not have to be visible or irritating to seriously impact on health.

Workers may be exposed to fine dust from:

Hand-operated drills used mainly for drilling small diameter holes in monumental stone quarrying these can be used for explosives, plug and feathers or hydraulic splitters.

Drilling rigs used mainly for drilling holes for blasting, exploration or ground support.

Crushing or milling: Compressive-type crushers produce dust but do not themselves induce excessive air movement, although moving materials do and dust, either from the materials or the actual crushing process, becomes airborne. Impact-type crushing machines involve a rotating part which acts as a fan and generates considerable air movement. With this type of high-reduction crushing, considerable quantities of airborne dust are generated.

Screens used to extract or reject specific-sized material from the feed product. Screening equipment creates dust by degradation, and the action also affects the release of dust in the material.

Conveyors, feeders and loading used to transfer product from one position to another. Dust is released from the transfer points and can be aggravated if not enclosed and protected from wind.

Heating or drying of rock fragments inevitably causes large emissions of airborne dust, unless exhaust gases are fully treated.

Bagging dry materials, particularly powders, and bag damage. Bagging products while damp does not present any dust problems.

Portable hand-operated saws generally used in monumental stone and slate quarries for the cutting of stone and for the creation of slits so wedges can be used for splitting.

Static saws: a wide range of saw types are used for cutting blocks or stone and slate into selected sizes. Most saw blades are diamond tipped and use water for cooling. The water also acts as dust suppression.

Splitting or dressing takes place at monumental stone and slate quarrying operations. Some splitting involves drilling small diameter holes and using plug and feathers, or hydraulic splitters. Using chisels for splitting and dressing of slate creates dust in the replacing operator's breathing zone and the hand dressing of stone (masonry work) also creates dust emissions.

Traffic on haul roads kicking up dust into the air. Fully enclosed cabs and watering of haul roads can help control this hazard.

Other activities including stacking, cleaning (especially when using brooms) and driving are a source of dust. You may need to assess personal dust exposure during these activities.

Hazard controls must include reduction at source. For example:

> dust collectors on drills and dust suppression sprays and other dust collection equipment

> water applied directly to the drill tip and water supply to saws

> screen hoods

> encapsulation

> extraction systems

> integral units

> stockpile dampening.

Control measures must be maintained in an effective state, in efficient working order and in good repair. Where engineering controls are implemented, thorough examinations and tests should be carried out regularly.

15.5.2 DIESEL PARTICULATES

In 2012 the International Agency for Research on Cancer (IARC) found sufficient evidence to conclude diesel engine exhaust is carcinogenic to humans. The physical properties of diesel engine exhaust means it can accumulate in an enclosed space where there is insufficient rate or quality of ventilating air.

Most extractive sites are likely to use diesel engines. Workers near diesel powered equipment may be exposed to diesel emissions or diesel particulate matter. Confined spaces, workshops or when working in deep pits where temperature inversions can cause exhaust fumes to be trapped in the pit are particularly at risk.

To be successful in reducing and controlling the hazards associated with diesel engine exhaust a 'whole of site' approach is required. This will require co-ordination of expertise and a high level of process discipline in many functions including:

> management
> maintenance
> engineering and ventilation
> training
> supply and procurement.

Engineering controls are the most effective strategy for reducing the exposure to diesel emissions and diesel particulate matter. Administration controls, including changes to the way work tasks are performed and personal protective equipment may also be required.

15.5.3 WELDING AND GAS CUTTING FUMES

Welding fumes are a complex mixture of metallic oxides, silicates and fluorides. Fumes are formed when a metal is heated above its boiling point and its vapours condense into very fine particles (solid particulates).

Welding gases are gases used or produced during the welding and cutting processes. Examples are shielding gases, gases produced by the decomposition of fluxes, from the interaction of ultraviolet light, high temperatures with gases or vapours in the air.

Exposure to welding gases and fumes can be fatal. You cannot rely on the sense of smell to detect any of these hazards. Some cannot be smelt at all and the sense of smell can become insensitive to those odours it can detect.

Further information on welding hazards is outlined in section 16.1.5.

For more detailed information on welding safety, including methods of fume control, see the WorkSafe guidance *Health and Safety in Welding.*

15.5.4 LEGIONNAIRE'S DISEASE

Legionnaire's disease (legionellosis) is a type of pneumonia caused by the legionella bacteria which may be found in water systems. Infection is caused by inhaling fine water droplets containing the viable bacteria. There is no evidence to suggest that mining and quarrying present a heightened risk of exposure to legionella compared to other industries. However, large quantities of water can be used at extractive sites for dust suppression and processing.

Risk factors include water, growth temperature range of 20°C to 45°C, nutrients (ie biofilm or algae, rust and scale) and aerosol, spray or mist. Mines and quarry water supplies typically use non-mains supply sourced from bore holes or lagoons. It is usually recycled and prone to contamination by process dust and environmental material such as soil and plant material. Stored water in tanks or pipes maybe stagnant for periods and in warm weather the temperature may rise above 20°C.

The following water systems are likely to include the risk factors described above. However, this list is not exhaustive:

> water being sprayed on to material by fogging cannons or directional misting units
> water being sprayed on to materials for wet suppression of dust at transfer or discharge points
> water being sprayed on to roads for wet suppression of dust using water bowsers or fixed sprays
> use of hoses to clean areas of hard standing around processing plant and site buildings
> water spray from vehicles or wheel washers
> use of water as part of the production process such as barrel washers, wet scrubbers, and cooling of cutting blades on saws

> water curtains for dust control such as for dimensional stone cutting and processing
> emergency showers.

Appropriate control methods should focus on limiting the conditions that encourage growth. By applying simple, low cost measures the potential for growth and thereby the potential for exposure can be significantly reduced and appropriately controlled.

15.6 WORKING IN EXTREME TEMPERATURES

Working in very cold and very hot temperatures can be hazardous to a person's health. Excessive exposure to heat is referred to as heat stress and excessive exposure to cold is referred to as cold stress.

In a very hot environment, the most serious issue is heat stroke which can be fatal. Heat exhaustion and fainting (syncope) are less serious and can affect a person's ability to work.

In very cold temperatures, the most serious issue is hypothermia (or dangerous overcooling of the body) which can be fatal. Another serious effect of cold exposure is frostbite or freezing of the exposed extremities such as fingers, toes, nose and ear lobes.

Victims of heat stroke and hypothermia are unable to notice the symptoms, so their survival depends on co-workers' ability to identify symptoms and seek immediate medical help.

Where workers are, or could be, required to work in extreme temperatures you must implement controls to eliminate or minimise the risks.

For more detailed information on working in extremes of temperature see WorkSafe's *Guidelines for the Management of Work in Extremes of Temperature.*

15.7 MANUAL HANDLING AND LIFTING

Manual handling can result in serious back injuries, musculoskeletal disorders, acute injuries (eg sprains and strains) and injuries sustained through slips, trips and falls.

Assess the manual handling tasks undertaken at your site and determine whether they are necessary. If they are, and you cannot eliminate manual handling by providing suitable lifting equipment, then you should make the task as easy as possible for everyone involved and reduce the time people are required to do it.

For many manual handling tasks there may be a number of control options that appear feasible. Some of the control options may need to be trialled and evaluated before they are finally implemented (to identify whether they are appropriate for that particular work system). This trialling can be relatively quick and informal, or may need to be formal and extensive, to get the best solution possible.

15.8 HOURS OF WORK AND FATIGUE

Fatigue is a physical and mental state caused by a range of influences. It reduces a person's capabilities to an extent that may impair their strength, speed, reaction time, coordination, decision making or balance.

A level of fatigue is a natural response to the mental and physical effort of everything we do. Normally, good quality sleep reverses the imbalance, allowing the body and the brain to recover. However, long working hours, working with intense mental or physical effort, or working during some or all of the natural time for sleep can all cause excessive fatigue.

Workers may work extended hours for long periods of time. Night shifts are also possible as are strenuous physical activities. Travelling to and from the worksite can add hours to the working day, as sites can be in remote locations.

Preventing fatigue begins with careful planning of tasks and their scheduling. Tasks should be designed so extreme exertion (mental and physical) are avoided and there is sufficient recovery time available.

Working hours should be agreed which provide all workers adequate opportunity to manage fatigue, including:

> regular rest breaks
> meal breaks
> a daily or nightly sleep period
> shared driver responsibilities.

Meal and rest breaks for employees must, at a minimum, comply with Part 6D of the *Employment Relations Act 2000*.

15.9 PSYCHOSOCIAL HAZARDS

Psychosocial hazards for the purposes of this guidance include stress, bullying and violence. Stress can be a reaction to bullying and violence. Violence may also result in physical harm.

Violence is a hazard that may be encountered at work. It can occur suddenly, without notice or provocation. It may cause mental and physical pain and suffering and may result in permanent disability or even death.

Bullying affects people physically and mentally, resulting in increased stress levels, decreased emotional wellbeing, reduced coping strategies and lower work performance.

We all experience stress at different times, to varying degrees. When we feel that work is leading to concrete, achievable and worthwhile goals, we almost always rise to the occasion, even with severe difficulties. Where there are urgent deadlines, work overload, poor relationships or other stressors, we mostly cope – if there is a return to 'normal' in a reasonable time. But, when a 'stressful' situation is ongoing or severe or has the potential to cause mental or physical illness, then it becomes a concern. In these cases the *HSE Act* requires the situation to be managed.

Work related stress is not an illness, but can lead to increased problems with ill health, if it is prolonged or particularly intense. Examples are heart disease, raised blood pressure, regular headaches, back pain, gastrointestinal disturbances and various minor illnesses. Psychological effects can be anxiety and depression.

You should take proactive steps to make work healthy, build morale, identify and deal with stressors, and talk with workers.

15.10 ULTRAVIOLET RADIATION

Short term exposure to the sun can result in sunburn and eye injuries. Prolonged exposure to sunlight is a well-established cause of skin cancer, including melanoma. It is the ultraviolet (UV) radiation component of sunlight which is harmful. Even on cloudy days, the UV level may be sufficient to be harmful. Long-term effects on the eye include damage to the cornea, and formation of cataracts.

The risk of skin cancer is higher for outdoor workers because of their prolonged sun exposure. Intense periods of exposure to the sun appear to be the most significant factor for melanoma. While people with certain skin types may be at greater risk, it is important that everyone protects their skin from prolonged exposure to solar UV radiation.

Workers may be exposed to non-ionising radiation from arc welding. People working near welding operations are at risk of "arc eye", a painful condition.

You must ensure the risk posed by exposure to UV radiation is reduced. In some instances, this may be achieved by simply changing the time of day when a task is carried out. Where this is not practicable, protection should be provided including working undercover and providing personal protective equipment.

15.11 CONTAMINATED LAND

Redevelopment of contaminated land, which may be associated with opencast mining or quarrying, can result in exposure to contaminants. The health effects, control measures and surveillance required will depend on the nature of the contaminants encountered. Specific advice from an occupational medical specialist should be sought before redevelopment commences.

15.12 HAZARDOUS SUBSTANCES

Hazards associated with hazardous substances depend on the type of substance and the environment in which it is being used. You should change processes to eliminate exposure to hazardous substances, or replace them with safer alternatives. Refer to the Safety Data Sheet (SDS) for the precautions required for each individual substance.

15.12.1 MERCURY

Mercury can be present in precious and base metal ore and is produced as a by-product of gold and silver processing. Mercury is a very toxic cumulative poison which can affect the brain, the central nervous system and the reproductive system. It can be absorbed by inhalation, ingestion and through the skin.

Mercury poisoning can result from both acute and chronic exposures. It is critical to recognise that exposure to mercury can be without warning and workers may not know the extent to which they have been contaminated. Personal, environmental and biological monitoring should be done to determine the exposure hazard and evaluate symptoms, as necessary.

Information, training, and supervision on the hazards associated with mercury should be given to workers on site.

For more detailed information see:

> Safety Data Sheets for precautions and other hazardous substance information.

> WorkSafe Workplace Exposure Standards (WES).

> Territorial authority plans (regional or district councils) for environmental standards.

> USA Department of Labor Mine Safety and Health Administration (MSHA) 'Best Practices' section of the Controlling Mercury Hazards in Gold Mining: A best practices toolbox for hazard controls.

15.13 DRUGS AND ALCOHOL

People may be under the influence of alcohol or drugs while at work. Workers have a duty to take all practicable steps to ensure their own safety, and alcohol and drugs may affect their ability to do this. This applies whether they are injected, inhaled or taken orally. The increased availability of stronger over the counter legal medication and other prescription medication means the risk of drug-impaired performance by workers may be increasing. The abuse of drugs or alcohol can be on-site or off-site, such as heavy drinking the night before a day shift.

All operations, large and small, can benefit from an agreed drug and alcohol policy, applying to all workers. Such a policy should form part of your organisation's overall health and safety policy. A written drug or alcohol policy has many advantages, including leaving less room for misunderstanding. Key elements of a drug or alcohol policy include:

> a statement on why the policy exists and who it applies to

> who is responsible for enforcing the policy
> a definition of drug or alcohol misuse
> how the operation expects workers to behave
> statements that make it clear how absence for treatment and rehabilitation will be recorded. Examples include sick leave, recognition that relapses may occur and how these will be dealt with, and how the policy will be reviewed and consulted on
> a statement on confidentiality so workers can be assured a drug or alcohol problem will be treated in strict confidence, subject to law
> a description of support available to workers who have a drug or alcohol problem
> a commitment to providing workers with general information about the effects of drugs or alcohol
> the circumstances in which disciplinary action will be taken.

The policy should also outline site rules for workplace events where alcohol is being served. This may include:

> approving any event where alcohol may be served
> carefully managing alcohol consumption
> designating drivers or providing transport if travel is needed after an event
> ensuring non-alcoholic refreshments and food are available
> keeping work vehicle keys safe
> making sure workers do not work after the event if they're still affected by alcohol (including the next day where relevant).

It is an offence to supply alcohol to anyone under 18 without parental consent.

15.14 PERSONAL PROTECTIVE EQUIPMENT (PPE)

PPE should only be considered as a hazard control where you have not been able to eliminate or isolate the hazard. PPE should always be used in conjunction with a documented safe system of work.

Employers must provide all appropriate PPE to employees and make sure it is used correctly, inspected, and maintained to fulfil its protective function and workers are trained in its correct use[86].

Where the following types of PPE are required the specifications and use of these are detailed below:

15.14.1 HIGH-VISIBILITY CLOTHING

High visibility clothing should comply with *AS/NZS 4602.1 High visibility safety garments – Part 1: Garments for high risk applications* or any other Standard embodying the same or more stringent criteria.

High visibility clothing should be worn on the outside of other clothing and not cause additional hazards (eg entanglement).

15.14.2 SAFETY FOOTWEAR

Workers engaged in extractive operations should wear protective footwear which provides foot and ankle support, traction and protection appropriate to the task they perform.

Where footwear requires protective toe caps they should comply with *AS/NZS 2210.1 Safety, protective and occupational footwear – Guide to selection, care and use* or any other Standard embodying the same or more stringent criteria.

When fitted, laces should be securely tied at all times.

[86] *HSE Act*, sections 10 (2) (b) and 19 (a)

15.14.3 SAFETY HELMETS

Safety helmets should comply with *AS/NZS 1801 Occupational protective helmets.*

Helmets should be inspected regularly for damage and deterioration.

Helmets should be replaced immediately if damaged, or three years after the issue date (if recorded), or in accordance with the manufacturer's specifications. Where the issue date is not recorded the helmet should be replaced three years after the manufacture date which is moulded into the peak of the helmet.

15.14.4 HEARING PROTECTION

Hearing protectors should comply with *AS/NZS 1270 Acoustics – Hearing protectors,* or any other Standard embodying the same or more stringent criteria.

15.14.5 EYE PROTECTION

Eye protection should comply with *AS/NZS 1337.1 Personal eye protection – Eye and face protectors for occupational applications,* or any other Standard embodying the same or more stringent criteria.

People who wear prescription glasses can have these made to comply with the above standard, or alternatively safety glasses or goggles that can be fitted over prescription glasses are available.

15.14.6 GLOVES

Gloves should comply with *AS/NZS 2161.2 Occupational protective gloves, AS/NZS 2161.3 Occupational protective gloves – Protection against mechanical risks* or any other Standard embodying the same or more stringent criteria.

15.14.7 FALL ARREST SYSTEMS AND DEVICES

Fall arrest systems and devices should comply with *AS/NZS 1891.1 Industrial fall-arrest systems and devices – Part 1: Harness and ancillary equipment* and *AS/NZS 1891.3 Industrial fall-arrest systems and devices – Part 3: Fall-arrest devices,* or any other Standard embodying the same or more stringent criteria.

Fall arrest systems should never be used as a primary hazard control.

Develop a rescue plane before using a harness system. It is critical that a suspended worker can be promptly rescued.

A worker suspended in a harness can develop suspension intolerance. This is a condition in which blood pooling in the legs can lead to loss of consciousness, renal failure and, in extreme cases, death.

For more information refer to section 6.5 of WorkSafe's *Best Practice Guidelines for Working at Height in New Zealand*.

15.14.8 RESPIRATORY PROTECTIVE DEVICES

Respiratory protective devices used when there is potential for harm to persons exposed to dust, fumes, gases or chemicals should comply with *AS/NZS 1715 Selection, use and maintenance of respiratory protective equipment* and *AS/NZS 1716 Respiratory protective devices,* or any other Standard embodying the same or more stringent criteria.

15.14.9 HAZARDOUS SUBSTANCE HANDLING

Personal protective clothing should be worn during the handling, mixing and application of chemicals or other hazardous substances.

The protective clothing to be worn should comply with the instructions detailed on the manufacturer's safety data sheet (SDS) for the specific substance being used.

PART D

16/

PREVENTING FALLS FROM HEIGHT

IN THIS SECTION:

Many falls from height are caused by a failure to plan and organise work properly. Start by planning a safe approach.

This section describes how to prevent falls when:

> climbing on or off vehicles
> working around heavy vehicles
> covering loads
> accessing machinery
> using ladders
> working near highwalls or faces.

There is a reasonably good understanding in the extractives industry that if the distance of a possible fall is greater than 3 metres, all practicable steps must be taken to prevent any fall from occurring. The *HSE Act* requires steps to be taken to prevent the fall from occurring if there is any chance of harm resulting, even if a possible fall is less than 3 metres.

Regulation 21 of the *Health and Safety in Employment Regulations 1995* is the source of the often-quoted "3 metre rule". It is mistakenly believed that no further action is needed where a person could fall less than 3 metres. That belief is wrong and ignores the overall duties in the *HSE Act*.

Where the hazard of a fall exists you must consider, in this order:

(1) Whether the job can be done without exposing a person to the hazard (eliminate). In some cases elimination may be achieved at the design and purchasing stages. For example, maintenance activities able to be carried out at ground level.

(2) If elimination is not practicable, steps should be taken to isolate people from the hazard. This can be achieved using safe working platforms, guardrail systems, elevated work platforms, scaffolds or mobile scaffolds.

(3) If neither elimination nor isolation are practicable, steps should be taken to **minimise** the likelihood of any harm resulting. This may include use of safety harnesses or other types of fall restraint or fall arrest systems.

For more detailed information on preventing falls from height see the WorkSafe *Best Practice Guidelines for Working at Height.*

16.1 CLIMBING ON OR OFF VEHICLES

Access to heavy vehicles should be by a well-constructed ladder or steps. Ladders or steps should be well built, properly maintained and securely fixed. Where steps or ladders extend to the ground, the use of interlock systems is required to prevent the vehicle moving or starting until the ladder or step has been correctly stowed.

Avoid using suspended steps wherever practicable. If they cannot be avoided, use rubber or cable suspension ladders, not ladders made of chains. Ladders and steps should slope inward towards the top if this is reasonably practicable. They should not slope outwards towards the top.

Rungs or steps on vehicles should:

> be level and comfortable to use
> have a slip-resistant surface
> not allow, for example, mud, grease, or oil to build up dangerously (eg grating could be used to allow things to pass through a step).

The first rung or step should be close enough to the ground to be easily reached – ideally about 40 cm and never more than 70 cm. Place ladders or steps as close as possible to the part of the vehicle requiring access.

Opening (and holding open) a cab door on a vehicle should not force a driver to break the 'three point hold' rule or to move to an unsafe position.

Vehicle owners should consider retrofitting safer access ways to eliminate the risk of falling (refer Figure 92 and Figure 93).

Figure 92: A stairway and platform were retrofitted to this haul truck to increase driver access and egress safety (photo courtesy of Newmont Waihi and MacMahon)

Figure 93: This excavator has a good access system, with platforms, guardrails, kick plates and ladder. The ladder is interlocked so the vehicle cannot be started without the ladder being raised (photo courtesy of Newmont Waihi and MacMahon)

16.2 ACCESS AND EGRESS TO HEAVY VEHICLE WORKING AREAS

Wherever practicable, use walkways. Walkways should be made of slip-resistant grating (with enough space for mud or oil to pass through the grate and away from the walkway surface) or another slip-resistant material.

To prevent thrown mud from making them slippery, position walkways, steps, ladders, and handrails away from wheels if possible.

Top and middle guard rails may be needed to protect people when they are standing or crouching. Consider collapsible rails.

Vehicle owners should consider fitting guardrails if they are not already present (refer Figure 94). If features are retrofitted to existing vehicles, the alterations should not affect the structural integrity of the vehicle or the visibility of the operator.

Figure 94: Guardrails were retrofitted to this excavator to protect workers accessing the top of the machine for maintenance purposes (photo courtesy of NZ Steel, Taharoa)

16.3 COVERING LOADS

Loads must be covered whenever there is a risk of load shedding due to wind action or movement when travelling on a public road[87]. Covering loads or removing covers can be hazardous, especially when carried

[87] The Truck Loading Code – specialised requirements (Loose bulk loads)

out manually. You must consider the risks associated with load covering and take effective measures to make sure covering and uncovering loads is done as safely as possible. Consider the types of loads and vehicle, how often covering or uncovering happens and other specific characteristics of the workplace.

There are several but some options are better than others. A method of covering and uncovering that does not involve getting on to the vehicle or even touching the cover should be the first choice.

A hierarchy of solutions may look something like this:

> leaving the load uncovered if it is safe to do so
> using automated or mechanical covering systems which don't require people to go up on the vehicle (refer Figure 95)
> using manual covering systems which don't require people to go up on the vehicle (refer Figure 96)
> using work platforms to provide safe access to carry out covering from the platform without having to access the load (refer Figure 97)
> using gantry or harness systems to prevent or arrest a fall (refer Figure 98).

Consider the following points whatever method of covering is used:

> Do not overload the vehicle and try to load evenly to avoid the need for trimming. Load evenly along the length of the vehicle (not in peaks) or use a loader to pat down the load to flatten peaks.
> Train and instruct staff on safe systems of work (and provide refresher training where necessary). Supervise and monitor covering and uncovering activities.
> Regularly check covers are in good condition, and replace when necessary. Visually check straps and ropes used for pulling and securing the cover.
> Regularly inspect, repair and maintain covering mechanisms, platforms, gantries and fall-arrest equipment (like harnesses and lanyards).
> During loading, unloading and covering, consider vehicles used by workers of more than one company 'shared workplaces' and arrange for suitable controls to be followed by everyone concerned.
> Ropes, straps and covers can snap or rip. The driver should avoid leaning backwards when pulling the cover tight.
> Park vehicles on level ground, with their parking brakes on and the ignition key removed.
> Cover vehicles before leaving the site.

However it is done, carry out covering and uncovering in designated places, away from passing vehicles and pedestrians and, where possible, sheltered from strong winds and bad weather.

Figure 95: Automated covering system

Figure 96: Manual covering system

Figure 97: Platform covering system

Figure 98: Overhead gantry harness system

16.4 ACCESS TO FIXED PLANT AND MACHINERY

For information on access to fixed plant and machinery see section 12.7.

For information on preventing falls while undertaking maintenance on fixed plant and machinery see section 17.1.1.

16.5 PORTABLE LADDERS

Portable ladders should comply with *AS/NZS 1892.1 Portable ladders* metal or any other Standard embodying the same or more stringent criteria.

All portable ladders should have their safe working load certified by the manufacturer and be inspected prior to every use for any damage.

Portable ladders should be used for low-risk and short-duration tasks. The user should maintain three points of contact with a ladder or stepladder to reduce the likelihood of slipping and falling. Ladders and stepladders do not offer fall protection and therefore should be the last form of work access equipment to be considered.

For more information on ladders and stepladders see WorkSafe *Best Practice Guidelines for Working at Height in New Zealand.*

16.6 WORKING NEAR HIGHWALLS OR FACES

Any person who works on or near the edges of faces or highwalls has the potential to fall. Typically these are the driller, shot-firer and person carrying out the daily inspection. Other people potentially working on or near edges are surveyors, engineers, explosives truck workers, planners, geologists, geotechnical engineers and fencers.

A hierarchy of control is:

> A windrow, a fence or other physical barrier capable of supporting a person's weight if they fall against it should be in place along the edge (refer Figure 99).

> If a barrier is not practicable, you should determine a distance from the edge that is safe to work and demarcate this area with a fence (ie para-webbing fence or warratah wire type fencing). The safe distance should be a minimum of two metres (refer Figure 100).

When installing or removing any barrier other than a windrow, provide a travel restraint system such as a harness. Connect this harness to a fixed position that restricts workers' ability to work outside the safe area (refer Figure 101).

A risk assessment should be carried out to establish a safe system of work for any person likely to be in a position where they may fall from a face. Consider the geology and stability of the face, the ground conditions, weather, lighting equipment being used, the need to adjust burdens, marking hold positions and profiling.

Windrows are preferable to other less substantial barriers but may hide cracks or signs of instability along the edge (refer figure 99). Windrows should be:

> constructed only after inspection of the area below. Faces need to be inspected for faults, change in appearance, loose surface, evidence of falling rocks, water seepage, joints and cracks

> constructed a metre or two from the edge where possible so any cracks or deterioration of the edge can be seen

> constructed from suitable material to avoid trip hazards

> a minimum height of one metre (for pedestrian protection only)

> regularly inspected and maintained.

Workers should be trained in the appropriate selection and use of harnesses before starting work. Make sure workers are closely supervised until assessed as competent.

Vehicles should not be parked under high walls, due to the hazard of rock falls.

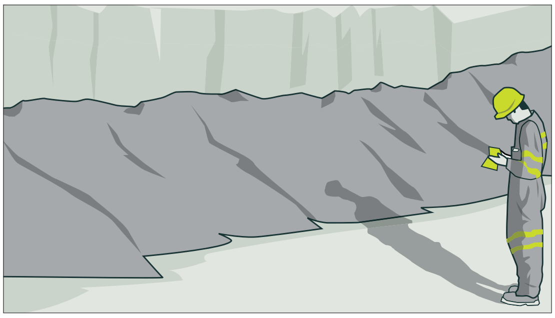

Figure 99: Example of a pedestrian windrow

Figure 100: Example of non-weight supportive barriers

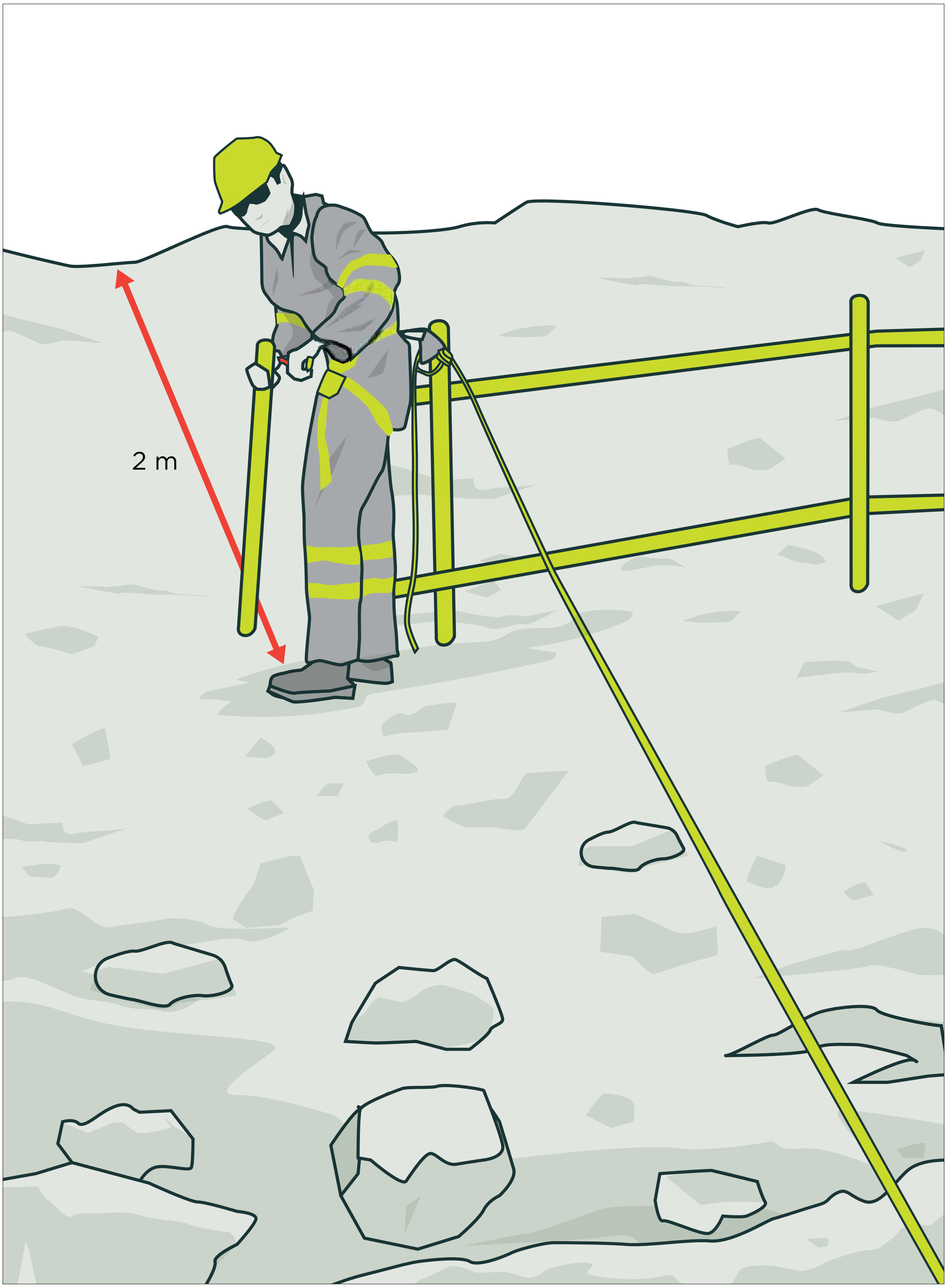

Figure 101: Example of fall restraint system

PART D

17/

MAINTENANCE AND REPAIRS

IN THIS SECTION:

Tasks such as maintenance, repairs, servicing, clearing blockages and cleaning can be dangerous. Workers can be fatally or seriously injured if they don't manage the risks carefully.

This section describes how to:

> identify and manage common hazards including falls, energy sources, confined spaces and equipment for welding or cutting
> isolate equipment and use safe lockout and permit procedures to keep workers safe
> inspect and service vehicles safely
> prevent and clear blockages in crushers or hoppers.

You must establish a maintenance and inspection programme to ensure equipment and machinery is safe to use. Maintenance and inspection programmes should take into account:

(a) the operational environment the machinery or vehicles are being used in, particularly where subject to corrosion or rot
(b) the original equipment manufacturer's recommendations.

Maintenance and inspection programmes should take into account the whole of the machinery or vehicles including, as appropriate:

> the structure of the machinery (bracing, supports)
> safety features (ie emergency stops, guarding, emergency equipment, props)
> integrity of walkways, stairs, ladders, railings or guardrails
> integrity of holding vessels (ie tanks, hoppers)
> integrity of lifting equipment (ie chains, strops, hooks, gantry cranes, lifting eyes, quick hitches)
> signage and other warning devices (ie lights, alarms).

Mine operators must ensure a competent person examines any machinery that has been stopped for the preceding 24 hours or longer before it is started. In addition the mine operator must ensure a competent person examines every accessible area of the site. Include every area containing barriers, machinery and surface infrastructure at least weekly and every area where a worker, is or will be, before every shift and during shifts as required[88]. A written procedure must be included in the health and safety management system setting out:

> what will be examined
> when it will be examined
> how findings will be recorded
> how findings will be actioned[89].

For more detailed information on inspection and maintenance of machinery, including safe systems of work, see the WorkSafe *Best Practice Guidelines for the Safe Use of Machinery.*

[88] The Regulations, regulation 222(1)
[89] The Regulations, regulation 222(2)

17.1 COMMON HAZARDS WHEN UNDERTAKING MAINTENANCE

Undertaking maintenance activities (including cleaning) can potentially expose workers (and others) to significant hazards. The following five hazards merit particular attention.

17.1.1 FALLS FROM HEIGHT

Maintenance work often involves using access equipment to reach raised sections of machinery or vehicles. Eliminating the need to access machinery or vehicles at height by careful design is the most effective control.

Where elimination is not practicable, and frequent access is required, platforms, walkways, stairways and ladders that comply with the *Building Code* should be provided. Where infrequent access is required suitable temporary access equipment with adequate barriers or fall restraint systems should be used.

For more detailed information on platforms, walkways, stairways and ladders see the Department of Building and Housing *Compliance Document for New Zealand Building Code Clause D1 Access Routes and Compliance Document for New Zealand Building Code Clause F4 Safety from Falling.*

Note: *The Compliance Document for New Zealand Building Code Clause D1 Access Routes (NZBC D1) specifies AS/NZS 1657* as an acceptable solution for fixed platforms, walkways, stairways and ladders for access routes for service and maintenance personnel. Provision in *AS/NZS 1657* may exceed the requirements of *NZBC D1*.

For more information on preventing falls from height see section 16.

17.1.2 FALLS OF HEAVY ITEMS

Heavy items sometimes have to be moved, or get disturbed, during maintenance work. If one of these falls, the results can be fatal.

Incidents can include:

> the failure of lifting equipment
> inappropriate lifting and slinging practices
> inadequate supports or supports not resting on level or firm ground
> incorrectly estimating the weight or centre of gravity of the load
> rocks falling from trap points on mobile plant or the headboards of haul trucks.

If a heavy item has to be moved or temporarily supported during maintenance work, it is crucial the risks are assessed and a plan of action is properly thought through. The people responsible for the maintenance work shouldn't presume that things will be okay, that others will know what to do, or the right equipment will necessarily be available. These lifts, or the use of temporary supports may be 'one offs' and will inevitably require more knowledge and skill than routine production tasks.

Make sure:

> everyone involved in maintenance understands the risks
> an assessment of the risks (including the risk of disturbing something inadvertently) is completed and a plan of action decided on, before a heavy item is moved or temporarily supported
> there is someone competent to provide advice on safe slinging and on safe working practices for work involving heavy loads
> any equipment used to lift or support a heavy load is suitable and (where necessary) has been inspected and tested by a competent person

> heavy items are not left unsecured where they may tip over, fall or slip, and no-one works under suspended loads
> equipment is thoroughly cleaned with any loose material removed before maintenance activities commence.

17.1.3 ENERGY SOURCES OR STORED ENERGY

Isolation and lock out arrangements, and in some cases permits to work, are essential to enable maintenance work to be conducted safely.

Before any maintenance work is undertaken you should:

> isolate the power or energy source (usually, but not exclusively, electrical energy)
> apply an isolation device and a sign to indicate that maintenance work is in progress
> dissipate any stored energy (eg hydraulic or pneumatic power
> test and verify isolation is correctly applied.

For more detailed information on isolation systems, see section 17.2.

17.1.4 CONFINED SPACE ENTRY

A 'confined space' is a place which is substantially (though not always entirely) enclosed, and where there is a risk of death or serious injury from hazardous substances or dangerous conditions (eg lack of oxygen). These can include tanks, load out bins, reclaim tunnels, crushers, and poorly ventilated rooms.

You should minimise the time that tasks are undertaken in the confined space. This may be achieved by partially dismantling machinery or undertaking work outside the confined space before entry.

Where confined space entry is required, WorkSafe accepts A*S 2865 Confined Spaces* as the current state of knowledge on confined space entry work.

For more detailed information see, *AS 2865 Confined Spaces* and *WorkSafe Safe Working in a Confined Space.*

17.1.5 WELDING AND GAS CUTTING

Welding can have acute, chronic and long-term hazards to health and safety. These can act quickly or may show up only in the long term.

WorkSafe has adopted the following documents, published by the Welding Technical Institute of Australia (WTIA), as its main sources of advice about health and safety in welding:

> Health and Safety in Welding 2004 – Technical Note 7 (TN7).
> Fume Minimisation Guidelines (FMG).

WorkSafe's *Health and Safety in Welding* publication summarises some of the main points in the relevant sections of both the above publications.

In addition, the *Welding Health and Safety Assessment Tool* is available on the WorkSafe website (www.business.govt.nz/worksafe/). The tool is a detailed assessment to assist in auditing workplaces where electric or gas welding or cutting is carried out. The aim of the audit is to lead a discussion through the essential elements of welding or cutting safe practice so that workplace participants may decide where improvements are required.

Oxygen under pressure and oil or grease can react violently, causing fire and explosions. Do not allow oxygen under pressure and oil or grease to come into contact.

Welding hazards include:

Fires and explosions: These are an ever-present hazard with many welding processes.

Burns: Welding causes items to become hot, creating a risk of burns and fires from hot metal and welding spatter.

Fumes: Fumes generated by different welding processes may range from being of nuisance value to highly toxic. Health effects can occur very soon after exposure (eg exposure to cadmium fumes can be fatal within hours) or may not result until after many years. Fume control requires appropriate ventilation equipment and may require advice from a specialist.

Electric shock: Welding processes that use electricity pose both obvious and subtle hazards of electric shock – which can be fatal. Take standard precautions, as explained in the WorkSafe *Health and Safety in Welding* publication, when using welding equipment. Expert assistance can be needed in some circumstances to identify subtle hazards. Appropriate equipment selection, set-up and maintenance is important and may require specialist advice to ensure safety.

Compressed gases: Compressed gases in cylinders pose a number of hazards. Safe use methods are outlined in *TN7* section 5.

Hazardous substances: Hazardous substances used during some welding processes can require highly specialised methods of control (eg extremely toxic hydrofluoric acid). Use a specialist in these situations.

Toxic gases: Precautions for preventing toxic gases from causing harm are outlined in *TN7* sections 5 and 10. Toxic gases may be:

> used in or generated by the process (eg acetylene, ozone, nitrogen oxides, carbon monoxide)
> generated when coatings on metal surfaces are heated (eg galvanised steel, epoxy resins, degreasing agents, paint)
> generated when the arc flash and some degreasing chemicals or paints react (eg phosgene or phosphine).

Suffocation: Inert gases used during welding can flood an area and lower its oxygen content, especially in confined spaces. Suffocation can result. For more detailed information on confined space entry see section 17.1.4.

Radiation: Arc flash is a well-known hazard of welding. Standard precautions (PPE) should be used to prevent eye and skin exposure – for the worker and others in the vicinity. Reflecting surfaces make exposure to radiation more likely. For more information on PPE requirements see *Health and Safety in Welding.*

Heat stress: Working for long periods in hot environments can lead to distress and in an extreme, fatal heat stroke. Specialist advice must be sought if welders work in hot environments (see *TN7* section 23). For more information on heat stress see section 15.6.

Dust: Associated processes (grinding) may generate hazardous levels of dust. For more information on dust see section 15.5.

Noise and vibration: Noise and vibration levels during some welding processes can be high and should be controlled or appropriate hearing protection should be worn. For more information on noise and vibration see sections 15.3 and 15.4.

Manual handling: Some welding processes may involve heavy or repetitive handling. For more detailed information on manual handling see section 15.7.

Specific processes: Several processes are discussed in *TN7*:

> plasma cutting
> brazing and soldering
> thermal lancing.

Providing health and safety information and advice on welding and cutting processes can be complex. There are many subtleties and traps for the unwary or inexperienced. Specialist advice may be required.

17.2 ISOLATION AND LOCKOUT OF ENERGY

Energy isolation is much more than putting a lock and tag on a switch. To effectively isolate workers from energy you need to know what energy is, and how it can be safely isolated on specific machinery and vehicles.

More information on isolation and lockout of energy can be found in Appendix N: Isolation and lockout of energy. This includes information on the following:

> What are types of energy?
> Energy isolation procedures.
> Is lockout and energy control the same thing?

17.2.1 LOCKOUT AND TAG OUT SYSTEMS

Lockout and tag out systems are the placement of a lock and tag on an energy-isolating device. They indicate that the energy-isolated device is not to be operated until removal of the lock and tag in accordance with an established procedure.

Lockout is the isolation of energy from the system (a machine, equipment or process) which physically locks the system in a safe mode. The locking device (or lockout device) can be any device that has the ability to secure the energy-isolating device in a safe position (ie lock and hasp).

Tag out is the labelling process that is used when lockout is required. The process of tagging out a system involves attaching or using an indicator (usually a standardised label) that includes the following information:

> Why the lockout and tag out is required (eg repair or maintenance).
> The date and time the lock and tag was attached.
> The name of the authorised person who attached the lock and tag to the system.

Only the authorised person who put the lock and tag onto the system is allowed to remove them. This procedure helps to ensure the system cannot be started up without the authorised person's knowledge.

WHY LOCKOUT AND TAG OUT ARE IMPORTANT

Safety devices such as guards or guarding devices are installed on systems to maintain worker safety while these systems are being operated. When performing non-routine activities these safety devices may be removed but there must be alternative methods in place to protect workers from the increased risk of injury of exposure to the accidental release of energy. Non-routine activities include maintenance, repair, set-up, or the removal of jams or misaligned feeds.

The main method used and recommended to protect workers from risk of harm in these cases is the use of a lockout and tag out procedure (LOTO).

A LOTO procedure will prevent:

> contact with a hazard while performing tasks that require removal, by-pass, or deactivation of safe guarding devices
> unintended release of hazardous energy (stored energy)
> unintended start-up or motion of machinery, equipment or processes.

LOCKOUT PROCEDURES AND WORK INSTRUCTIONS

The written lockout procedure should identify:

> what needs to be done
> when it needs to be done
> the tools available to do it
> who is supposed to do it
> who needs to be notified.

Work instructions should identify how the lockout process is to be carried out in a step-by-step process including how stored energy is controlled and de-energised, how isolation can be verified, and how and where lockout devices are installed. Work instructions should be machine, equipment or process specific and include pictures or images of what is being described.

There should be one lockout procedure, and as many sets of work instructions as required, depending on the number of systems that require lockout.

For more information on lockout systems and isolation procedures, including responsibilities, see the WorkSafe *Best Practice Guidelines for Safe Use of Machinery.*

For more detailed information on writing health and safety documents, see WorkSafe's *Writing Health and Safety Documents for your Workplace.*

17.3 PERMIT TO WORK SYSTEMS

A Permit to Work (PTW) system is a formal documented process used to manage work identified as significantly hazardous by making sure all safety measures are in place before work starts.

A PTW system is also a way to communicate between site management, plant supervisors, operators and those who carry out the hazardous work. Essential features of a PTW system are:

> clear identification of who may authorise particular jobs (and any limits to their authority) and who is responsible for specifying the necessary precautions
> training and instruction in the issue, use and closure of permits
> monitoring and auditing to make sure the system works as intended
> clear identification of the types of work considered hazardous
> clear and standardised identification of tasks, risk assessments, permitted task duration and supplemental or simultaneous activity and control measures.

The terms 'permit to work', 'permit' or 'work permit' refer to the paper or electronic certificate or form used to authorise certain people to carry out specific work at a specific site at a certain time. It also sets out the main precautions needed to complete the job safely.

17.3.1 WHEN ARE PERMIT-TO-WORK SYSTEMS REQUIRED?

Consider permit-to-work systems whenever the intention is to carry out particularly hazardous work. PTW systems should not be applied to all activities, experience has shown their overall effectiveness may be weakened. Permits-to-work are not normally required for controlling general visitors to site or routine maintenance tasks in non-hazardous areas.

Permit-to-work systems are normally considered most appropriate to:

> non-production work (ie intrusive maintenance, repair, inspection, testing, alteration, construction, dismantling, adaption, modification or cleaning)
> non-routine operations
> jobs where two or more individuals or groups need to co-ordinate activities to complete the job safely
> jobs where there is a transfer or work and responsibilities from one group to another (ie shift changeovers).

More specially, the following are examples of types of jobs where permits could be considered:

> work of any type where heat is used or generated (eg by welding, flame cutting, grinding) and work which may generate sparks or other sources of ignition
> work which may involve breaking containment of a flammable, toxic or other dangerous substance or pressure system, and work involving the use of hazardous or dangerous substances, including explosives
> work on high voltage electrical equipment or other electrical equipment which may give rise to danger

> entry and work within confined spaces
> pressure testing
> work affecting evacuation, escape or rescue systems
> work at height
> any other potentially high-risk operation.

17.3.2 PERMIT TO WORK SYSTEM PROCESS

For more information on the permit to work system process, please see Appendix O: Permit to work system process.

17.4 INSPECTING AND SERVICING VEHICLES

Vehicles at extractive sites work in harsh environments and require effective maintenance to avoid developing defects. Establish a programme of daily visual checks (or pre-start checks), regular inspections and servicing schedules according to the original vehicle manufacturer's instructions, and the risks associated with the use of each vehicle.

Inspections and maintenance should include, where appropriate:

Vehicle Control

> braking systems
> steering
> tyres, including condition and pressures
> safety devices such as interlocks.

Driver Safety

> seats and seat belts
> mirrors, cameras and other visibility aids
> lights and indicators
> warning signals
> windscreen washers and wipers
> firefighting equipment.

Vehicle Maintenance

> condition of cab protection devices (such as ROPS and FOPS)
> condition of tailgates
> condition of hydraulic pipes and hoses
> fluid levels
> functional checks on the vehicle
> other accessories such as quick hitches.

Where vehicles are hired, determine who is responsible for maintenance and inspection during the hire period and make this clear to all parties.

Put in place a safe system of work that addresses issues such as safely blocking the vehicle and its attachments, isolating stored energy (ie gravity) and preventing the vehicle from inadvertently being started. When using jacks they should be rested upon suitable load bearing substrata. Raised objects should be lowered wherever practicable (eg excavator or loader buckets).

Determine a procedure to address defects where they are found in vehicles or attachments. Such procedures could include:

> recording defects when completing daily visual checklists (pre-start inspections) scheduled inspections, daily visual checklists and maintenance logs
> establishing protocols for safety critical defects (when a vehicle should be removed from operation, time frames to fix specific defects and so on). For example, how deep does a cut in the tyre need to be before they should be replaced?
> a system to isolate vehicles when safety critical defects are found. For example keys or other starting devices removed and secured until repairs are started.

MAINTENANCE UNDER HYDRAULICALLY RAISED PARTS OF VEHICLES

Many vehicles use hydraulics to raise, lift or move material or parts of the vehicle (eg truck trays, front end loader buckets, excavator booms and drilling rigs). These raised parts have stored energy and you must provide supports or other devices to prevent raised parts dropping or being lowered while workers are under them[90].

Consider:

> removing the elevated part before other maintenance work takes place (eliminate the hazard)

> fitting a restraining system to the elevated part

> fitting the tray or bucket with a built-in prop

> ensuring restraining system controls are clearly marked and shrouded or protected from accidental operation

> fitting hydraulic cylinders with over centre valves.

BRAKE TESTING

A suitable inspection scheme should be in place to ensure brakes are in good condition at all times. This is often combined with other maintenance work.

Electronic brake testing equipment is available to regularly and accurately measure brake performance (eg an electronic system may be permanently fitted in a haul truck). This will show deficiencies in the brake system before they become a problem. The site Health and Safety Management System should require operation, monitoring and maintainance of brake systems according to original vehicle manufacturer (OVM) recommendations, as a minimum.

It should be ensured that:

> the driver tests the brakes at the start of every shift (pre-start inspection), including the park brake and foot brake

> the condition of brake system components is monitored according to OVM's recommendations, reducing the likelihood of catastrophic failure and ensuring they continue to function as intended

> brake system performance is tested according to OVM's recommendations in both static and dynamic situations

> drivers and maintenance workers can access OVM operating and maintenance manuals at site as appropriate

> braking system repair, monitoring, inspection and testing records are readily available at site

> drivers and maintenance workers are trained in the relevant aspects of braking systems

> safety critical aspects of vehicle operation, including emergency braking systems, retarders and other controls available in the event of engine failure (eg accumulators), are incorporated into driver training and assessment processes, with appropriate input from competent maintenance workers

> operating and brake maintenance practices for contractors' vehicles are not inferior to the vehicle maintenance practices adopted by site*

> contractors' vehicles are not allowed to operate on site unless maintenance and testing records are checked to verify the integrity of brake systems*

> brake maintenance, including processes used for contractors' vehicles, is regularly audited for effectiveness*

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[90] Regulation 15 of the *Health and Safety in Employment Regulations 1995*

* **Note:** A "contractor" is a person engaged (other than as an employee) to undertake work at the site, not a customer

> if OVM manuals are unobtainable (eg due to the age of vehicle), prepare manuals so effective brake system operation and maintenance strategies can be established. Use people with appropriate skills and technical expertise to facilitate the process.

Brake system maintenance strategies

Correct brake system functioning depends on the condition of system components, which in turn depends on the quality of the maintenance. Any brake system maintenance strategy should focus on detecting and rectifying a defect before it results in a loss of brake function.

Brake system maintenance strategies should initially be based on the original vehicle manufacturer (OVM) recommended maintenance programs, and on condition monitoring, inspection and testing schedules. OVM stipulated operating procedures and repair techniques help make sure brake system integrity is not compromised.

The OVM information should be stored, maintained, updated and be readily accessible by relevant workers, whether it is in hard copy, electronic copy, or on-line based systems.

Hazard identification and risk assessment aimed at improving brake system reliability should consider anything that could affect the safe operation of vehicles. This could include site conditions, maximum loads, operating speeds, operating grades, effects of heat fade, component failure, and loss of pressure.

Controls needed may include more frequent component inspections for wear or damage, and regular brake performance verification techniques. These could include Dynamic Brake Testing (DBT), electronic brake test equipment and thermographic temperature profiling, to detect poor performance.

Note that a positive DBT result doesn't necessarily verify brake system integrity or confirm the system has been maintained to OVM recommendations. It only indicates the brakes were effective at the time of testing.

In introducing a DBT program, the risk assessment to determine appropriate controls should consider, but not be limited to:

> OVM consultation on any deviations from the stated recommendations

> applying relevant brake performance testing standards or appropriate industry practice

> site facilities and limitations relating to surface, space, and controlling vehicles in case of brake failure during testing

> variations in test methodology and acceptance criteria for different vehicle types and categories (for more detailed information see *AS 2958.1-1995 Earth-moving machinery – Safety – Wheeled machines – Brakes*)

> reliability of the DBT test instruments

> applicability and integrity of the standards, procedures and methods used to interpret the results

> training and competency of workers conducting the tests.

Industrial trucks and load shifting equipment (forklifts, mobile cranes)

Inherent instability and lack of traction of forklifts and cranes, particularly on ramps and slopes, present a challenging risk management task. Operators should understand the brake system design limitations and that brake system monitoring, inspection, testing and maintenance are appropriate for the risks in particular applications.

The Australian Standard *AS 2359.13-2005 Powered industrial trucks – Brake performance and component strength* provides guidance on methods for assessing and testing the performance and components of brakes fitted to industrial trucks with rated capacities up to, and including, 50 tonnes.

Safe forklift operation on gradients largely depends on the type, size and design of the forklift. Ask the OVM if you're unsure of the braking system's performance capabilities.

For more detailed guidance on requirements for the operation, maintenance, repair and modification of industrial trucks see WorkSafe *Approved Code of Practice for Training Operators and Instructors of Powered Industrial Lift Trucks (Forklifts)*. Also see the supporting document *Safety Code for Forklift Truck Operators: Front Loading Forklift Trucks.*

17.4.2 TYRE SAFETY

The purpose of this section is to describe some of the hazards associated with tyres in service. There is also guidance and preventative measures to avoid or minimise those hazards when working with tyres or combating tyre fires, explosions and potential explosions.

This section deals with these hazards separately, but care should be taken to ensure overlapping areas are adequately dealt with in operating procedures.

WORKING WITH TYRES

Four major hazards when working with tyres:

> compressed air
> manual handling
> exploding or disintegration of wheels and tyres
> noise.

Lack of training or experience in the handling and maintenance of wheel and tyre assemblies (especially with bead lock systems) can increase risks.

Compressed air

The eyes are particularly at risk when compressed air is in use, both from high-velocity air and from particles of dust, metal, oil and other debris, which can be propelled by the air. Suitable eye protection should always be worn.

Suitable overalls or other substantial clothing will protect the skin from light particles and debris, provided they are not blown at a high velocity. However, overalls cannot offer protection against high-velocity air at close range. Particles can be blown through overalls and skin and into the body. Air can be blown into the bloodstream, causing swelling and intense pain, particularly if any cuts, punctures or sores are present, making entry easier. The air can be carried to the small blood vessels of the brain, lungs or heart, resulting in death. Workers should not use compressed air to dust themselves down.

All pressure gauges and control devices should be checked against a master pressure gauge at regular intervals or immediately after any heavy impact or other damage. Compressed air hand tools should be maintained and checked regularly.

Compressors and associated equipment such as air-receivers should be regularly inspected in accordance with a schedule of planned maintenance to make sure they meet legal requirements[91] and are safe to use.

Manual handling of heavy objects

The tyre and wheel assemblies of large vehicles are usually too heavy to be manually handled safely.

The safe handling of many loads encountered in the fitting and maintenance of large earthmoving tyres and wheel assemblies can only be undertaken using specialist tyre-handling equipment. Special attachments may be required on standard handling equipment (eg fork lifts) to deal appropriately with large tyres and wheels.

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[91] *Health and Safety in Employment (Pressure Equipment, Cranes, and Passenger Ropeways) Regulations 1999*

Exploding wheels and tyres

Large tyres and wheel assemblies are heavy objects, but when they explode they are thrown violently by the force of the escaping compressed air. An exploding wheel is a high-speed projectile that can kill or seriously injure anyone in its path.

Divided wheel, split-rim and locking-rim wheel and tyre assemblies are especially likely to explode if poorly maintained, incorrectly fitted, or if assembled or disassembled while inflated.

The most common faults are:

> over-inflation
> removal of split-rim fastening nuts instead of wheel fastening nuts
> failure to ensure correct seating of split rims or tyre beads
> the use of damaged parts, or replacement parts with lower strength than the original equipment.

Non-original after-market nuts and bolts and other fixings could be inadequate.

It is essential to deflate tyres before wheel removal to ensure removing the wrong nuts does not result in a serious or fatal accident.

All off-road vehicles should have a maintenance system in place for rims and wheels in accordance with *AS 4457.1 Earth Moving Machinery – Off-the-road wheels, rims and tyres – Maintenance and repair – Wheel assemblies and rim assemblies.*

Noise

Hearing damage can affect tyre fitters just as easily as other at-risk occupations. Causes of noise-induced hearing loss are compressed air blowing freely, noise from impact wrenches and wheel parts and tools dropping on concrete workshop floors. Engineering solutions to manage excessive noise are preferred. The selection of air-tools for their noise-level characteristics should form part of the purchasing system.

Noise from steel impacting on concrete floors can be reduced with special floor surfaces or mats. Any residual noise must be dealt with by restricting the operators exposure. Where noise exposure cannot practicably be further reduced, hearing protection must be provided and its use must be enforced.

For more detailed information on noise management see the WorkSafe *Approved Code of Practice for Worker Health in the Extractives Industry.*

TYRE SAFETY CAGES AND EXCLUSION ZONES

It is strongly recommended all tyres, including small units, be inflated within a suitable restraint.

Tyres on split-rim and detachable-flange wheels should be contained by a cage guard, or other suitable restraining device, when being inflated after being dismantled or repaired.

Tyres that have a large volume, or are inflated to high pressures, should be contained by a cage guard or other restraining device when being inflated, after being repaired or otherwise removed from the wheel. This includes truck, forklift or earthmoving plant tyres.

If restraints are not available, a suitable system of work is to be used (eg inflating from behind a barrier).

Most car or light vehicle wheels and tyres are strongly constructed and have small internal air volume. They therefore do not require high pressures. Such tyres pose minimal risk to the service person and, if correct fitting procedures are adhered to, problems would not normally be expected. However, some light vehicles have divided wheels that require cage inflation. In general, inflate light vehicle tyres with the jaws of the tyre-fitting machine restraining the wheel.

FIRES AND EXPLOSIONS OF TYRES IN SERVICE

Mechanisms of tyre fires and explosions

The primary cause of tyre fires is the application of heat to the tyre, or development of heat within the tyre structure by one or more mechanisms. The same primary causes can result in a violent explosion of the tyre under some circumstances.

Heat can be conducted through the rim base to the bead area of the tyre where a small quantity of rubber can be pyrolysed. The gases given off in the process can be ignited by the continued application of heat. An explosion could originate from the point of heating, with the flame fronts travelling around the tyre in opposite directions and causing a rupture where they meet.

A temperature rise sufficient to cause problems can be generated by other sources of heat, such as:

> electrical earthing through the tyre as a result of lightning strike or power-line contact

> wheel component heating through misuse of brakes or electric-wheel motor problems

> internal tyre damage as a result of excessive speed, road camber deficiencies and ply separation.

A uninflated tyre may explode in the same manner as an inflated tyre if sufficient heat is applied to it.

Other factors that can increase the likelihood of a fire or explosion are:

> The auto-ignition temperatures of different types of bead lubricants and other introduced materials vary widely. Before any material is introduced into the tyre air chamber, its auto-ignition temperature should be checked, and if the figure is lower than that for the tyre liner or bead, it should not be used. Auto-ignition information can be found on a product's safety data sheet (SDS).

> The accidental use of an incorrect inflation medium (eg LPG or other explosive gases) through contaminated air supply or other means.

> Carbon dust given off from pyrolysis of the tyre liner. This dust can auto-ignite at temperatures as low as 200°C, the lowest auto-ignition temperature of any material likely to be encountered in a tyre.

> Low flash point fuels and solvents can be absorbed by tyre rubber. This can increase the likelihood of a tyre catching fire where a heat source is introduced, increase the seriousness of any fire that does eventuate, or both.

A tyre explosion can occur even where no fire is visible. Smoking tyres or brakes should be treated as a potential tyre explosion and the vehicle isolated accordingly.

Prevention of tyre fires

To prevent tyre fires you should:

> ensure correct inflation of all tyres and check on a daily basis

> ensure no hot work is undertaken around the wheels and rims

> make sure trucks are not overloaded

> consider installing on-board tyre pressure and temperature sensors.

Prevention of tyre explosions

To prevent tyre explosions consider implementing the options listed below:

> **Nitrogen inflation:** nitrogen inflation will significantly reduce tyre explosions.

> **Inhibiting agents:** Consider the use of fire inhibiting agents and fireproof coatings on the inner surface of the tyre.

> **Earthing vehicles:** Consider earthing vehicles against lighting strikes so the tyres do not provide the earthing path.

COMBATING TYRE FIRES AND POTENTIAL EXPLOSIONS

If a vehicle catches fire or a heat source is recognised and there is a potential for a tyre explosion, you should immediately establish a prohibited zone of at least 300 metres around the radius of the vehicle. The prohibited zone should remain in place for at least 24 hours following the removal of the heat source. An emergency crew should remain in attendance during this period.

For more detailed information on vehicle fires see section 11.9.7.

17.5 BLOCKED CRUSHERS OR HOPPERS

Clearing blocked crushers or hoppers can be very hazardous and many plant operators have been killed carrying out this task. Blockage incidents can be greatly reduced by supplying material that is sized to match the primary opening.

Preventing of oversize feed material starts at the face, with good fragmentation. Removing oversize material before delivery to the plant and vigilant control of the crusher feeder, will make blockages less likely.

Causes of crusher blockages can be grouped under two main headings:

Stalling, due to:

> electrical or mechanical failure
> material jammed in the chamber causing an overload
> overfeeding material
> entry of tramp metal or wood
> accumulation of material in the crash box
> accumulation of fine material in the crusher discharge chute.

Bridging, due to:

> oversize feed material
> excessive clay or other fines in the crushing cavity, preventing small material passing through the crusher
> a foreign body in the crusher feed or discharge chamber, obstructing the feed material.

17.5.1 PREVENTION

Every effort should be made to prevent oversize material or tramp metal entering the crusher feed hopper, by:

> designing any site blast to achieve optimum rock fragmentation
> training and instructing the loader driver not to load oversize material
> using sizing bars or grids on crusher feeds
> following the manufacturer's recommendations on the rate, presentation of feed and crusher settings
> instituting a programme of good housekeeping to prevent scrap steel entering into shovel buckets
> ensuring the bucket size is appropriate to the capacity of the crusher
> regular inspection of metal parts (eg bucket teeth, dumper wear plates and drilling components) to make sure they are unlikely to break off and enter the crusher feed
> the strategic placing of electrical magnets or the installation of metal detectors to prevent tramp metal from entering the crusher
> the use of level indicators for feed control
> maintenance of drive systems
> removal and adequate cleaning of the discharge chute.

A properly designed crushing operation should not need any person to be present on the crusher access platform during normal crushing operations.

17.5.2 CLEARING BLOCKAGES

BRIDGED CRUSHERS

The preferred method of clearing a bridged crusher is by using a hydraulic arm.

The hydraulic arm may be permanently mounted, or an excavator fitted with a static pick or a hydraulic hammer. Where the arm is operated remotely (eg by radio control) closed circuit television (CCTV) is an invaluable tool in assisting the operator.

Depending on the risk assessment result, clearing out a bridging blockage with a hydraulic arm or similar may be carried out with or without the crusher still operating. Prohibited zones should be established in case of fly-rock.

When hydraulic arms are not available, and it is necessary for a worker to enter the crusher to position hooks or slings, the crusher and feeder must be stopped, isolated and locked-out in accordance with the manufacturer's or supplier's instructions and safe working practices (refer section 17.2).

Other options (which require more specialist expertise and competence) include: gas or chemical expansion and hydraulic ramp plates. Other options considered should be subject to a detailed and thorough risk assessment.

The crusher should be shut off and isolated before considering the use of bars and hand hammers. Bars should never be used on or near a crusher while it is running.

Consider the risk of large pieces of feed material moving and causing trap or crush injuries.

Do not use wedges due to the risk of them becoming a projectile (this has caused fatalities in the past).

STALLED CRUSHERS

A stalled crusher should be treated as possibly being jammed with tramp metal or wood, which could be ejected with fatal consequences. Safe systems of work should be issued to plant operators detailing what to do in the event of a crusher stalling which should include:

> clearing the area of all workers
> notifying the site manager of the stalled crusher
> isolating power to the crusher and associated plant
> undertaking risk assessment for clearing the blockage
> implementing hazard controls.

CLEARING BLOCKED CONE CRUSHERS

Many cone crushers are fitted (or can be retrofitted) with tramp metal hydraulic release systems or hydraulic assisted upper concave removal, to prevent or eliminate hazards associated with blocked cone crushers.

For cone crushers that do not have these systems, follow the guidelines in sections 17.5.2.1 and 17.5.2.2 above.

HAZARD OF ENTRAPMENT AT HOPPERS

There is the potential for an accident if anyone attempts to walk on the material that has been dumped into a hopper. The hazards are that they may be drawn into the feeding material, or, if the material is hung up, they may be drawn in when the material breaks free. The material in the hopper may look solid, but there may be a hidden void where it has bridged over the feeder. Anyone walking on the material is at risk of being engulfed if the bridged-over material collapses.

Mechanical devices should be provided (eg vibrators or air cannons) during normal operations so people are not required to enter or work where they are exposed to entrapment by the caving or sliding of materials. Where people are required to enter or work near the hopper:

> provide platforms or staging
> stop supply and discharge of material
> lock and tag out equipment
> implement working at height procedures as required.

PART D

18/

EMERGENCY MANAGEMENT

IN THIS SECTION:

An emergency occurs when there is an unexpected event that requires urgent action to protect the health, safety and wellbeing of workers or other people. Every operation, whether covered by the Regulations or the Act must have an emergency plan.

This section describes:

> the process for developing an emergency plan
> the key questions to answer in emergency planning
> how to respond to an emergency
> what to do after the emergency plan is developed.

18.1 WHAT IS AN EMERGENCY, AND WHAT ARE MY DUTIES?

An emergency is an unplanned or unexpected event that requires immediate action to protect the health, safety and wellbeing of people. Emergencies occur when controls to hazards fail, putting workers or other people at an immediate risk of harm. Reestablishment of controls, or use of emergency management controls, is urgently required before somebody is harmed. Section 6 (e) of the Act requires employers to develop procedures for dealing with emergencies that may arise while employees are at work.

Part 4, subpart 4 of the Regulations states that where one or more principal hazards are identified, operations must have an Emergency Management Principal Control Plan. A principal hazard is defined in Regulation 65 of the Regulations as:

(a) any hazard arising at any mining operation that could create a risk of multiple fatalities in a single accident or a series of recurring accidents at the mining operation in relation to any of the following:

- (i) ground or strata instability
- (ii) inundation and inrush of any substance
- (iii) mine shafts and winding systems
- (iv) roads and other vehicle operating areas
- (v) tips, ponds, and voids
- (vi) air quality
- (vii) fire or explosion
- (viii) explosives
- (ix) gas outbursts
- (x) spontaneous combustion in underground coal mining operations; and

(b) any other hazard at the mining operation that has been identified by the site senior executive under regulation 66 as a hazard that could create a risk of multiple fatalities in a single accident, or a series of recurring accidents at the mining operation.

Operations that identify principal hazards should follow the Regulations.

For lone workers, Section 17 of the Act places a duty on self-employed people to ensure that no action or inaction of the self-employed person while at work harms the self-employed person or any other person. Where there is potential for an emergency, this should include the development of an emergency plan.

When developing an emergency plan, the work should be undertaken with a realistic view that an emergency will likely occur in the near or distant future. Every site must plan for these events. A good emergency plan should be developed using a risk based process. Following the process below will enable operations to answer the right questions in order to develop a plan that is relevant to their specific operation:

ASSESS POTENTIAL EMERGENCIES	
What events could occur at the operation or close by that would require immediate action to protect the health, safety and wellbeing of workers or other people?	How can the operation respond to each identified emergency?

MAKE THE PLAN				
What elements of an emergency response can be planned in advance?	Who should be consulted when developing the plan?	How will relevant parts of the plan be made accessible to workers in the event of an emergency?	How can the operation's infrastructure be prepared in advance for an emergency response?	How can advanced planning be relayed to workers within the operation?

IDENTIFY NEEDS AND CONFIRM CAPABILITY REQUIREMENTS		
What resources will the operation need to respond to the identified emergencies?	What training is needed for workers for general emergency response purposes, and what extra training is needed for designated personnel to competently undertake their duties?	What actions or positions will require a designated role or position in an emergency?

TEST, PRACTICE, AND REVIEW THE PLAN				
How will the emergency plan be tested for effectiveness?	How often will exercises occur?	What types of exercises will the operation need to conduct?	How will areas for improvement be identified?	Who will review or audit the emergency plan and how often will this happen?

Table 9: Developing an emergency plan

18.2 KEEP IT SIMPLE, AND PROPORTIONATE TO THE SIZE OF THE OPERATION

In order for an emergency plan to be effective, it should be kept as simple as possible, and proportionate to the size and scope of the operation. Larger operations and operations that carry principal hazards will require more complex plans, more trained personnel and more on site equipment than small operations or lone workers. Regardless of the size of the plan or the operation, the actions for workers to take in an emergency should be accessible and easy to follow.

In small operations, having the basics of emergency management in place should be sufficient. In larger operations and operations with principal hazards, there will be a greater need for a larger emergency plan.

However large or small, an emergency plan should be accessible, and understood by the workers that must activate it, or follow it in an emergency. This can be done by developing procedures for actions that should be taken in an emergency, and keeping them in a single place, visible to all workers and emergency services. It can be helpful to include workers who have had experience in emergency work as they can help identify emergencies and the response procedures needed.

18.2.1 LONE WORKERS AND SMALL OPERATIONS

Small operations and lone workers/operators have different needs to larger operations as there are not enough workers on site to manage an emergency in the same manner as larger operations. Taking the following actions could be sufficient:

1. notifying emergency services of location and entry point to site
2. providing GPS coordinates to emergency services and New Zealand Mines Rescue Service
3. providing adequate means of communication
4. maintaining up to date first aid certificates and providing adequate first aid material including bandages, splints, blankets and cage stretcher
5. setting out a suitable place to land a helicopter
6. providing a list of essential phone numbers to request assistance.

Lone workers should be aware that nobody will be on site to summon emergency services in the event they become injured or trapped. Where there is no service for mobile phones, personal locator beacons could be carried when working on site to be activated in the event of an emergency. This will enable distress signal to be received by emergency services.

It should be noted however, that it will take longer for emergency services to arrive on site when using a personal locator beacon, so good hazard management is critical.

The operator at this operation, a lone worker, has an emergency station set up with first aid kit and buoyancy aid (refer Figure 102). It is visible to emergency services on entry to the site and contains the equipment necessary for immediate response to surrounding hazards that is not kept inside the digger cab. This operator also carries a personal locator beacon with him to communicate in the event of an emergency. For the size and scope of this operation, the emergency station is "fit for purpose".

Figure 102: Example emergency station Photo supplied by New Zealand Petroleum and Minerals

18.3 ALL EMERGENCY MANAGEMENT PLANS SHOULD BE BASED ON THE COORDINATED INCIDENT MANAGEMENT SYSTEM

Sometimes, emergencies can escalate from a minor, site level incident to a large multi-agency emergency response. At other times, the incident may be so serious that a large multi-agency response is required immediately. A large response uses the Coordinated Incident Management System (CIMS). This system is best supported when operators base their entire emergency management plan on this system.

18.3.1 WHAT IS CIMS?

CIMS is an emergency response system that describes:

> how New Zealand agencies coordinate, command, and control their response to an incident of any scale
> how the response can be structured
> the relationships between the respective CIMS functions and
> the relationships between the levels of response.

CIMS can expand or shrink to fit any type of emergency. However, it is easier for CIMS to support large scale emergencies when the fundamental principles are used in the emergency management plan. A copy of the CIMS Green Book, which details the principles of CIMS, can be obtained from the Ministry of Civil Defence and Emergency Management website – www.civildefence.govt.nz

18.4 ASSESS POTENTIAL EMERGENCIES

Section 7 of the Act places a duty on employers to ensure there are effective methods in place for the systematic identification of hazards, whether new or existing, and assessment to determine whether they are significant hazards. All operators should take the same approach, set out in the Regulations. This is because this systematic process is the correct method in order for all duty holders to discharge their obligations.

Lone workers/operators should also follow the process laid out in the Regulations as good practice.

18.4.1 WHAT HAS THE POTENTIAL TO CAUSE HARM AT THE OPERATION?

Regulation 54 states that a risk appraisal must be undertaken in order to identify hazards. This is commonly known as a broad brush risk assessment. A good risk appraisal should uncover all hazards on the site and in close proximity. Operators should look not only at the hazards on site, but also in the surrounding environment. For example, if an operation was situated in a bushy area, there may be a risk of a forest fire, or flooding if the operation is close to a river. Operators should also look at other risk assessments and incident investigations that have been completed.

18.4.2 WHAT'S THE WORST THAT CAN HAPPEN?

Following a "risk appraisal", Regulation 55 states that the hazards identified in the risk appraisal should be assessed to determine the inherent risk of harm. This means that operators should be asking themselves what the worst case scenario could be when assessing each hazard. Following identification of the worst case scenario, operators should determine how that may affect workers or other people in the vicinity of the operation and how they may need to respond to prevent or minimise damage. If the controls for the hazard fail, and urgent action is required to protect the health, safety and wellbeing of workers or other people, an emergency plan for that hazard is required.

Greater focus should be placed on hazards that have the potential to result in a fatality, or a permanent injury. However an even greater level of focus should be placed on principal hazards that have been identified by way of developing a Principal Hazard Management Plan for each principal hazard. In the event that principal hazards have been identified, an Emergency Management Principal Control Plan should be developed in accordance with Regulations 104 and 105. See the Approved Code of Practice for Emergency Readiness in Mining Operations for further information on developing Emergency Management Principal Control Plans.

Once potential emergencies have been identified, they should be assessed for the most practical response, having regard to the resource and capability within the operation, as well as the size of the operation.

18.5 IDENTIFY NEEDS, AND CONFIRM CAPABILITY REQUIREMENTS

Following the risk appraisal and risk assessment, in which potential emergencies and responses have been identified, operators should assess what they need to do in order to make the identified responses viable. This includes identifying the necessary equipment and infrastructure, what certain people or positions will be required to do in the case of each emergency and ensuring they are trained to be able to carry out those duties.

18.5.1 WHAT RESOURCES WILL THE OPERATION NEED TO RESPOND TO EMERGENCIES?

Resources include:

> the equipment that will be required in order to respond to emergencies, such as fire extinguishers

> the written material that should be provided to workers, such as procedures and duty cards

> the people that will be required including emergency services

> for operations with principal hazards, the infrastructure that will be necessary to carry out a full scale, multi-agency response.

18.5.2 WHAT ACTIONS OR POSITIONS WILL REQUIRE A DESIGNATED ROLE OR POSITION IN AN EMERGENCY?

The most commonly identified role for an emergency is that of a "first aid" provider, such as a "first aider" in smaller operations, or a more highly qualified medic in larger operations. All operators, regardless of the size or the hazards they carry, should have one of these. In small operations, this could be a person with a workplace first aid certificate. In some of the larger operations, there can be paramedics or workers trained in pre hospital emergency care.

Some operations will need people who are trained to extinguish fires. These could be workers who are operating in areas with a high risk of fire, or other workers who can extinguish the fire while the worker from that area escapes safely.

A worker may also be needed to ensure all workers are evacuated from the area of danger by accounting for people.

Operators should consider designating appropriate workers to communicate with families, to secure the site to prevent public access, and to communicate with emergency services until their arrival. In the event of large scale emergencies, where the emergency services are a significant distance from the operation, incident controllers, and other experts may be required to commence a CIMS based emergency operation ahead of their arrival.

18.5.3 WHAT TRAINING IS NEEDED FOR WORKERS FOR GENERAL EMERGENCY RESPONSE PURPOSES, AND WHAT EXTRA TRAINING IS NEEDED FOR DESIGNATED PERSONNEL TO COMPETENTLY CARRY OUT THEIR DUTIES?

Having assessed what resource and positions are required, the next step is to ensure the appropriate workers are trained in the use of the equipment and how to competently fulfil their roles. This is a critical element to ensuring the success of an emergency plan.

A good rule to follow is that any knowledge required for an emergency that is not ordinarily a part of a workers day, will need to be provided in the form of training. For example, a first aider will need to be trained in first aid. A person working in an area where there are fire extinguishers provided for a first response will need to be trained in their use. An incident controller or other specialist providing advice to emergency services will need CIMS training. Lone workers may also require training in effective use of personal locator beacons.

Other training may be required in an informal setting, such as training workers on how to quickly and effectively secure the site, and who they should allow to come on site in the event of an emergency. Another form of informal training is how to raise the alarm when there is an emergency, and what information needs to be provided to emergency services during a 111 call.

18.6 MAKE THE PLAN

Once the key elements of the emergency plan have been developed during the risk, capability and resource assessments, they will need to be brought together with further information in a formal emergency management plan.

18.6.1 WHO SHOULD BE CONSULTED WHEN DEVELOPING THE PLAN?

Workers should always be consulted when developing an emergency plan. As an emergency plan is a part of the wider health and safety management system, operators are obligated under section 19B of the Act to consult with workers. This is an important step as front line workers often have good knowledge of hazards. Their point of view may inform the development of the plan.

Regulation 104 of the Regulations states that emergency services must be consulted. With regard to surface operations, emergency services to be consulted are the New Zealand Fire Service, the New Zealand Police, and the ambulance provider for the region in which the operation is situated. Operators should also consult New Zealand Mines Rescue Service as a matter of good practice.

Consulting with emergency services can assist with planning in advance. For example, emergency services will be made aware of the presence of the operation in the area, its hazards, its capability, its GPS location and Police will likely wish to know what mobile phone coverage is available. If there is none, Police will then know they will need to bring in a mobile cell tower in the event of a large scale emergency. In having consulted with emergency services, a significant amount of planning in advance has already been done. Emergency services can also offer advice for further planning that should be undertaken.

18.6.2 WHAT ELEMENTS OF AN EMERGENCY RESPONSE CAN BE PLANNED IN ADVANCE?

If something can happen during an emergency that can be anticipated and planned for, the plan should be made. The only aspects of emergency that cannot be planned for are the unexpected events that happen at the time. There are very few aspects of an emergency that cannot be planned for. Regulation 105 (1) provides minimum requirements for what must be addressed in an Emergency Management Principal Control Plan:

The coordination and control of emergencies. The plan should set out the incident control arrangements which should be as simple as possible. There should be a single person in overall charge of operations – this will normally be the manager but other arrangements may also be possible and should be considered. The plan needs to provide for who will be assigned roles if people are not available. Also consider what other resources may be needed in order to effectively manage emergency situations. This plan should be able to support CIMS principles in case a larger response is required.

The people (or positions) at the site who will have responsibilities in relation to emergencies and the detail of those responsibilities. These will vary with the circumstances of the site and the results of the risk assessment. These functions may include, but are not limited to:

> coordinating the emergency response, alerting and liaising with rescue or emergency personnel, and regulator personnel (eg Specialist Health and Safety Inspectors, from WorkSafe, regional council staff, district council staff)
> accounting for people at the site at the time of the incident and
> control of emergency supplies
> provision and maintenance of facilities for rescue personnel where required and providing plans and other information to rescue personnel as required
> providing transport of casualties, rescue workers and supplies where required
> operation of communication systems
> informing and consulting with worker representatives and next of kin where required
> communication with the media where required
> fire wardens and site emergency response teams.

The availability of the Mines Rescue Trust and other emergency services to respond to an emergency: Operations should consider the distance emergency services will need to travel and the time it will take them to respond in an emergency. A procedure to ensure prompt notification of all relevant emergency services and the Mines Rescue Trust Plans should list the details of all relevant emergency services, the mine rescue trust and any other specialist emergency response personnel. Details should include phone numbers and where relevant, roles within an organisation. Names are only appropriate where there is some certainty the most up to date information is always available.

The events that trigger the activation of the plan. These events come from the identification and assessment of potential emergencies. Examples of events that would trigger the activation of the emergency plan could include: vehicle collision, rock fall, the presence of smoke or fire, or a medical emergency. One of the more obvious and well known 'activation triggers' is upon hearing a worker shout "emergency, emergency, emergency!".

The plan should be immediately activated and workers should be trained, and empowered to do so with confidence. It is easy to deescalate a large emergency once further information comes to hand, but it is impossible to bring back the ten to fifteen minutes of lost time that can ultimately save lives. Therefore, it is better to have a false alarm than a slow start, or no alarm at all.

The use of communication systems in emergencies. Determine how and what communication systems are used in an emergency. This can include:

> clearing radio channels,
> ending all non-essential phone calls,
> communication black-outs,
> the availability of additional communication devices (eg satellite phones and the communication systems of the Police).

Good communications are of paramount importance in an emergency, particularly in remote areas and for lone workers. Suitable communication equipment might range from alarms to more sophisticated public address or closed-circuit television systems. Radios or telephones can enable rapid communication if they are carefully positioned. They may, for example, be fitted to mobile plant or backup service vehicles, or issued to appropriate individuals. Electrical systems, radios or mobile telephones may be unsuitable where explosives are in use, or where there is a risk of an explosive atmosphere.

The giving of timely notice, information and warnings to anyone potentially affected, including the people nominated as next of kin by workers. Consider:

> Developing a call tree so the right people are notified at the right time.

> Determining how and when next of kin will be notified. This may be dependent on the severity of casualties and the location of the next of kin. Notification could be via support services (Police).

> Determining how and when neighbouring properties will be contacted.

> Determining how and when status updates will be communicated.

As a part of the general health and safety management system, emergency contact details for all workers should be prepared and kept up to date through regular reviews.

Measures to be taken to isolate an area affected by an emergency. Measures will be dependent on the type of emergency. Some examples include barriers to block access to unsafe areas or posting sentries at the gate to stop vehicles entering an area. Others may include pre-planning the development of fire breaks to prevent fires from spreading into surrounding areas during an emergency.

The means to locate and account for people in the event of an emergency. Operators should have a system in place to accurately account for and locate all workers or visitors in the event of an emergency. This is good practise for all quarry and alluvial mine operators, and a legal requirement for other mine operators as defined in section 19M of the Health and Safety in Employment (Mining Operations and Quarrying Operations) Regulations 2013.' Sign in registers, worker tag boards or radio frequency identification (RFID) tags are some of the ways operators could locate and account for people. A suitable system will depend on the size of the operation or site, the number of workers, the frequency of visitors, working times and shifts, and the risks that may be present.

Evacuation in an emergency, including the conditions that will prompt withdrawal when there is an imminent risk of harm. Operators should determine what responses are necessary to ensure all people escape safely and when evacuation is necessary. Evacuation may include first response, self-escape, aided escape or aided rescue. For example a person in a confined space may be able to self-escape or may require aided rescue. Prompt withdrawal, for example, may include where smoke alarms are activated, when ground movement has been detected, or when weather warnings are issued. Operators should also determine the hazards produced as a result of the emergency that workers self-escaping and self-rescuing may face and what responses are necessary to affect their escape or rescue.

Appropriate transportation from the site. You should include in your plan the provision and method for removing all people on site to a designated suitable, safe area. This may include visitors and members of the public. Note that walking is a limited option as this plan should include the transport of casualties.

First aid arrangements including first-aid equipment, facilities, services and the workers who are qualified to provide first aid. Measures will be dependent on the type of incident and the availability and response times of emergency services. One way to identify the first aid needs of the site is to complete a Workplace First Aid Needs Assessment. WorkSafe's *First Aid for Workplaces, A Good Practice Guide* has a sample assessment. An example of some of the equipment that may be needed is when providing first aid to casualties in large vehicles. It can be difficult to remove casualties from height and if attempts are made to remove them from the vehicles prior to treating them, this can cause significant delays in providing treatment and in some cases, lower the likely survival rate. Having a detachable basket that can be attached to mobile plant for the provision of first aid to drivers of large earthmoving equipment and other mobile plant may be an effective option.

Provision for all aspects of firefighting, including adequate compatible firefighting equipment, procedures for firefighting and training workers in firefighting. Firefighting equipment should be strategically positioned and be of a suitable type for the potential fires that could occur. For example a fire extinguisher capable of fighting fuel fires should be positioned in all vehicles.

PHMPs are required to include a description of the emergency preparedness for the principal hazard. It is recommended all relevant information is recorded in the Emergency Management Principal Control Plan, with a reference in the PHMP, to ensure only the most up to date information is followed in the event of an emergency.

Further to the minimum requirements in Regulation 105 (1), all parts of the emergency plan that require a worker to take action should have a corresponding procedure indicating the steps and actions that must be taken.

While operations covered by this guidance may not fall under the Regulations, this is the minimum that all operations should address in their emergency plan, as a matter of good practise. Smaller operations and lone workers may be unable to fulfil all of these requirements. The requirements laid down in 18.2.1 as a minimum are sufficient for these operations.

Suitable equipment to respond to identified emergencies should be made available for use, so that the plan can be successfully implemented in the event of an emergency. The choice of emergency equipment will depend on the emergencies that have been identified, the complexity of the site, and the distance from emergency services. Examples of the type of rescue and emergency equipment which may be required include:

- breathing apparatus (for confined space entry)
- ropes
- ladders (rigid or rope)
- tripods, winches
- tools (ie pickaxe, crowbar, shovel, cutters)
- stretchers and blankets
- buoyancy aids (ie lifejackets or lifebuoys)
- rescue boats
- chemical spill kit
- fire extinguishers
- fire hose reels
- bush fire kits
- first aid supplies
- self-rescuers
- a mobile generator to power emergency lighting
- lifting and cutting equipment such as hydraulic props, hardwood wedges in various sizes, lifting bags and cylinders, pneumatic pick
- resuscitation equipment
- defibrillator

> detachable personnel basket for large earthmoving equipment
> lifting hoops
> a sanitary area designated for the provision of first aid, such as a first aid room.

Rescue and emergency equipment should be subject to appropriate inspection to make sure it is always ready for use. Where rescue equipment is provided, enough people should be trained to use it without endangering themselves or others. Training in rescue equipment should be specific to the type of emergency (eg confined space rescue, heights rescue, use of a fire extinguisher).

Regulation 125 states that Mine Operators must ensure there are adequate and appropriate means available at the site to deal with any crush injuries and to rescue a trapped or injured person. Regulation 127 states Mine Operators must ensure that suitable resuscitation equipment is available and people trained to use the equipment are available at the site at all times. A procedure must be in place for workers to raise the alarm when resuscitation equipment is required. Larger operations that use more advanced medical personnel should consult them as to the most suitable equipment, and whether they are trained to use it. If not, training should be provided.

Means of escape should be taken into account when designing both fixed and mobile workplaces. An alternative exit should always be provided in mobile equipment. These can be purpose built hatches or windows that can be easily removed or broken with a special tool. Fire extinguishers should also be provided on equipment where there is a risk of fire.

Well-constructed and maintained roadways allow emergency vehicles easier access. These vehicles are generally made for road use and are not suited to difficult terrain. In an emergency, it can be helpful to have a person waiting at the site entrance to direct the emergency services. Where there is a risk of fire, there should be enough room for at least three fire appliances and several other emergency vehicles to park.

In remote areas it may be faster for emergency services to respond with a helicopter. An area for a helicopter to land should be planned for and passed to emergency services during consultation.

Important: Don't forget the back-up plan. Sometimes the best procedures fail and it is important to have a back-up plan in the event that this happens. A good example of this is fires on mobile plant such as large trucks. These are known to carry an elevated risk of fire, so many operations use a built in fire suppression system. However, these do not always properly extinguish the fire, so a fire extinguisher is usually provided to finish the job. In the event that the fire extinguisher does not work, there is a procedure in place to withdraw workers and other people from the area and let the fire burn out. When developing procedures, operators should always ask the question "if it fails, then what?"

18.6.3 HOW WILL RELEVANT PARTS OF THE PLAN BE MADE ACCESSIBLE TO WORKERS IN THE EVENT OF AN EMERGENCY?

Emergency response and evacuation plans are normally designed as a "grab and go" procedure detailing specific actions to be taken in emergency scenarios. Emergency response and evacuation plans may also include signage and bullet point procedures placed in appropriate areas, such as doorways or close to areas where immediate response is required. These should be kept as simple as possible, and should contain checklists of tasks in the order in which they should be carried out. They should also be accessible to the workers who have to use them. This can be done by designating a specific area as an emergency area where all emergency procedures and rescue equipment are kept (aside from equipment that is fixed in specific areas for immediate response). And keeping duplicates close to the areas where immediate response will be required.

For larger operations the use of TARPs may be appropriate.

For smaller operations an emergency response plan flipchart (a set of simple forms that can help you identify and manage your emergency procedures) is available from the Environmental Protection Authority (EPA). Phone 0800 376 234 or email hsinfo@epa.govt.nz to order a free copy or download a pdf version from www.business.govt.nz/worksafe/information-guidance/all-guidance-items/emergency-procedures.

Most workers may only need to be able to leave their workplace and go to a designated place of safety in the event of an emergency. Section 12 (1) (a) of the HSE Act states employers must inform workers on what to do if an emergency arises. This should be an integral part of training at all operations, and should be included in site inductions for workers and other people.

The SSE must, and alluvial mine and quarry operators should, ensure emergency management control plans are regularly tested using practice drills and involving relevant emergency services (eg the Fire Service, St John's, Mines Rescue Trust and company rescue services). Regular testing should be at least every three months. More regular testing may be needed, as identified through the assessment processes.

18.6.4 HOW CAN THE MINING OPERATION'S INFRASTRUCTURE BE PREPARED IN ADVANCE FOR AN EMERGENCY RESPONSE?

Preparing the site is merely an extension of section 18.5.2 where it is stated that if it can be planned for, the plan should be made.

All procedures that have been developed and the equipment required for emergency response should be placed in an area that is easy for all workers on the site and emergency services entering the site to find. This could become a designated emergency station. Fire extinguishers should be placed where they will be needed, for example inside trucks and on barges.

Further copies of response procedures should be placed close to the area in which they will be needed.

When consulting with Police, they may advise what preparation they would like to see undertaken for a large scale emergency response. Ideally this would be a room for around 15 people with good communication systems and a lot of whiteboard space. This is called the incident control point. However in small operations, not all sites will have infrastructure that enables this. Advice given from Police should be taken in these situations.

Further site preparations should be marked out on a site map that shows the safe forward point, inner and outer perimeters of the operation. The outer perimeter basically marks out the site. The inner perimeter marks out the area that is particularly hazardous, that only the rescue/recovery team should cross.

A staging area where emergency services can muster and be briefed should also be marked out. This should be between the inner and outer perimeters, and not so close to the incident control point as to disrupt the incident management team.

In larger operations, first aid equipment should be strategically placed on the site to ensure it is easily accessible. All emergency equipment should be marked out on a map of the site and adequate signage to indicate where specific equipment is kept (such as the defibrillator if one will be made available) should be placed around the site.

Figure 103 shows a common incident at quarrying, mining and alluvial mining operations. Operators should determine the worst case scenario resulting from an emergency of this nature and develop their response plans around minimising harm from there.

Figure 103: Vehicle overturn emergency

18.7 TEST, PRACTISE AND REVIEW THE PLAN

An emergency management plan cannot be said to be effective until every component of the plan is tested in a practical sense. This can be done using a series of exercises, which also assists with ensuring the plan is regularly practised, however the plan should be practised regularly once it is said to be effective. When the plan has been tested and practised, or when new hazards arise on site, the plan should be reviewed. It should also be audited on an annual basis to ensure it has been reviewed at times it should have. The plan should also be reviewed following any emergency that occurs on the site.

18.7.1 HOW WILL THE EMERGENCY PLAN BE TESTED FOR EFFECTIVENESS?

Regulation 106 states that the emergency plan must be tested regularly using practice drills, and involving emergency services. This enables the emergency services to provide advice on any gaps in training or in the plan that may need to be filled. It also tests the effectiveness of the plan.

Every component should be tested for effectiveness. For larger operations, this means that there should be an exercise that involves the notification of families, accounting for people in the operation and notifying all managers on or off site of the emergency. If there are any areas of the plan that are deemed ineffective, the appropriate amendments should be made and tested again in the next exercise.

Testing should be carried out using realistic scenarios based on the hazards identified and planned for, with further events if it could reasonably be expected that further issues will arise during an emergency.

18.7.2 HOW OFTEN WILL EXERCISES OCCUR AND WHAT TYPES OF EXERCISES WILL THE OPERATION NEED TO CONDUCT?

Regulation 106 (1) (b) of the Regulations states that the SSE must ensure workers are provided with training in the emergency management control plan and that the provision of this training is recorded. This is an important aspect of emergency planning in any operation.

Practice drills are essential so everyone knows what to do in an emergency. This includes contractors employed at the site. In the case of contractors employed on short contracts, visitor training may be more appropriate. Such contractors should be accompanied at all times by a person who has appropriate emergency training.

Exercises should happen at minimum, on a quarterly basis in order to develop a “second nature” response in workers on the site. Exercises should be both anticipated for the purpose of training, and conducted without the prior knowledge of workers for the purpose of experience. Don’t forget to add variety into exercises, so that all aspects of the emergency plan can be tested.

The most likely scenarios, and life preserving, escape and rescue scenarios should be exercised more frequently. Where a worker may be required to take action to save their own life or others, this should be a key area of concentration. Other aspects of the emergency plan should be exercised regularly, but not at the expense of the lifesaving components.

The aspects of an emergency plan that will always be used, such as contacting all managers both on and off the site, and accounting for people, should be practised during all exercises.

18.7.3 HOW WILL AREAS FOR IMPROVEMENT BE IDENTIFIED?

Nobody has a "perfect plan". Gaps will always be identified in emergencies. Gaps and areas for improvement can be identified using post-exercise debriefs where workers and managers can all state what they saw going well, and what didn't go so well. Observers from emergency services can also be used to provide advice. One of the key factors in identifying areas for improvement is not to jump to blaming the worker when something goes wrong.

Often, it can be a case of the procedure not being written simply enough, or equipment being unavailable, or in the wrong place. Training can also be a factor. Identifying these issues will enable the plan to be reviewed with a view to improving it for retesting at a later stage.

18.7.4 WHO WILL REVIEW OR AUDIT THE EMERGENCY PLAN AND HOW OFTEN WILL THIS HAPPEN?

All plans need to be reviewed and audited on a regular basis. Each emergency management plan should contain a section identifying the person or position that will audit the plan, to ensure it is compliant, it addresses all potential emergencies on the site and it is practical.

This should be done on a set basis, such as annually. This should be the person with the highest statutory position on site, such as the quarry manager or the SSE.

Each emergency plan should be reviewed after each exercise, when new hazards are identified. In accordance with Regulation 94, emergency plans must also be reviewed after real emergencies prior to operations recommencing. This should be the person responsible for developing the emergency management plan, in consultation with the person who would normally audit the plan. When there are significant changes to emergency plans, further consultation with emergency services may be required.

Understanding and enacting the emergency plan that has been developed for the operation could save your life and the lives of others.

PART D

19/

WORKER PARTICIPATION

You must provide opportunities for workers to participate effectively in ongoing processes to improve health and safety. Use a worker participation system to manage this process.

This section describes:

> the legal requirements for worker participation
> good-practice guidelines for putting an effective system in place.

Reasonable opportunities must be provided for employees to participate effectively in improving health and safety at work. For a mining operation (opencast mines) this includes all mine workers, not just employees. The worker participation system must be a documented system.

The HSE Act does not require you to adopt a particular system. In fact, there is a clear expectation that you and your workforce (and unions representing any employees), will, in good faith, work out the systems and processes that best suit the workplace's particular circumstances. This collaboration should provide the best opportunities for workers to participate effectively in health and safety.

For mining operations, where a worker participation system is not in place within the prescribed time periods in section 19U of the HSE Act, the default system of Schedule 3 of the Regulations applies.

If one or more mine workers request a health and safety representative, at least one must be included as part of the worker participation system.

For quarries and alluvial mines, a worker participation system must be developed if there are 30 or more employees, or an employee (or a union) requests one be developed. Where agreement cannot be made on an employee participation system, the default system set out in section 19D and Schedule 1A of the HSE Act applies.

The default system requires that an election for a health and safety representative is held.

WorkSafe considers it good practice to:

> implement a documented system for worker participation based on good faith and a clear commitment to health and safety outcomes
> have at least one health and safety committee for every location or site and that each committee focus on safety critical aspects of the mining or quarrying operation
> have effective, empowered and informed site health and safety representatives that are trained under the HSE Act.

If a site health and safety representative or committee makes a health and safety recommendation to the employer it must be adopted or a written statement provided setting out the reasons for not adopting it.

PART D

20/

TRAINING AND SUPERVISION

IN THIS SECTION:

Everyone working at the site must be competent for the work they are required to do, or be supervised by competent workers. They, and their managers, need to know the limits of their competence.

This section describes how to:

> identify the skills, knowledge or competencies your workers need
> train workers when they start work and when they need to learn new skills
> keep records to prove what training you have provided.

You must train or supervise workers so they can do their work safely.

The employer or person in control of the workplace must tell workers about the hazards of the work and what they need to do to stay safe.

Training helps people share knowledge and develop skills. It can help influence behaviours and improve health and safety.

A training programme should:

> identify what skills, knowledge or competencies workers need to do particular tasks
> have an induction – to show new workers around the site and tell them about hazards and safety procedures
> provide ways to train workers – for example, use external training providers or do on the job instruction
> make sure people only do work if they're trained or properly supervised
> keep records of workers training and instruction, and identify which job they can and can't do.

People might need extra training for some processes and machinery.

This guidance does not cover formal qualifications required by the Regulations. This provides more detailed information on the role or management, and requirements in relation to roles, responsibilities and competencies of people employed at mines, quarries or alluvial mines.

20.1 IDENTIFY SKILLS, KNOWLEDGE OR COMPETENCIES

There are a number of ways in which you can determine the competencies needed for particular jobs. These include:

> risk assessments and hazard identification processes
> personal performance reviews
> health and safety audits or inspections
> analysis of accident investigations and near-miss reports
> competencies specified by vehicle or equipment manufacturers
> national qualifications framework
> recommendations in Codes of Practice, Guidelines or Standards
> those required by the law.

By comparing the competencies needed with those which people already have, managers can determine what additional skills are required and how these can be achieved, for example through training and coaching.

20.2 INDUCTION TRAINING

Give suitable induction training to everyone who is new to a site, or has been absent for an extended period of time. This is particularly important for those who are new to the industry.

Induction should be job and site-specific. Induction should include relevant aspects of your health and safety policy, the health and safety management system, risk assessments, the arrangements for first aid, fire, evacuation, safe systems of work and so on.

20.3 TRAINING WORKERS

Education and training can be in-house or a formal programme. The aim is make sure each person and the team as a whole can operate safely.

When they have finished training, get them to explain and demonstrate their understanding. Even if a new worker has excellent qualifications and experience, always assess their competence to work on your site.

Further training is likely to be needed whenever:

> someone takes on substantial new responsibilities

> there is a significant change in work equipment or systems of work.

Skills decline if they are not used regularly and refresher training should be provided as necessary to make sure continued competence in skills that are not often used (ie confined space training).

It can be useful to involve experienced workers in training as they are often best placed to understand the risks involved in their work. Take care, however, to ensure bad habits are not passed on.

20.4 SUPERVISION

You must have a skilled worker closely supervise new or untrained workers until they can work safely.

Mine workers who do not require a certificate of competence or who have not achieved unit standards specified by WorkSafe must be accompanied (supervised) at all times by a mine worker who has achieved the unit standards, or has received equivalent training, or holds a certificate of competence, and has at least 12 months experience working at the same kind of mining operation[92].

20.5 USE OF CONTRACTORS

Mines or quarries may use contractors to undertake some or all of the activities on site. The requirement to provide training and supervision and ensure competency to use plant and equipment applies equally to both in-house and contracted workers. You must fully induct contractors on your company's processes and make sure the contractors follow safe working practices.

For more detailed information on the selection and management of contractors see *A Principal's Guide to Contracting to Meet the Health and Safety in Employment Act 1992* and its summary *Health and Safety in Contracting Situations.*

20.6 TRAINING RECORDS

You should keep training records as part of your health and safety management system. This could include copies of external training provider certificates, in-house or on-the-job training records, attendance lists and driver's licences.

[92] The Regulations, regulation 50

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GLOSSARY

TERM	DEFINITION
Affected person (for LOTO)	Is a worker whose job requires them to operate a system, or work in an area in which servicing or maintenance is being performed under LOTO
Alluvial mine operator	Has the meaning given in regulation 3 of the Regulations
Alluvial mining operation	Has the meaning given in section 19L of the HSE Act
ANFO	An explosive material consisting of ammonium nitrate and fuel oil
Angle of repose	The angle of repose is the angle at which the material rests when simply dumped in a pile. This angle will vary somewhat depending on the size and shape of the constituent particles, how the material is dumped (eg how far it is dropped) and the amount of moisture in the material when it is dumped
Approved Handler	Has the meaning given in regulation 3 of the Hazardous Substances (Class 1-5) Regulations
Authorised person (for LOTO)	Is an individual who is qualified to control hazardous energy sources because of their knowledge, training and experience and has been given authority to apply LOTO
Back-break	Rock broken beyond the limits of the last row of holes in a blast
Batter	The portion of a slope between benches (see Figure 2 on page 20)
Bench Benching	A safety feature to catch any rocks or reeling material that falls from the high walls above. A horizontal ledge from which holes are drilled vertically down into the material to be blasted. Benching is a process of excavating where a slope is worked in steps or lifts
Building	Has the meaning given in sections 8 and 9 of the *Building Act 2004*
Building Code	*The Building Code* set out in Schedule 1 of the *Building Regulations 1992*
Competent person	Has the meaning given in regulation 3 of the Regulations and, in general, means a person who has the relevant knowledge, experience, and skill to carry out a task and who has a relevant qualification or certificate
Confined space	A 'confined space' is a place which is substantially (though not always entirely) enclosed, and where there is a risk of death or serious injury from hazardous substances or dangerous conditions (ie lack of oxygen). These can include storage tanks, silos, reaction vessels, enclosed drains and sewers, open topped chambers, ductwork and poorly ventilated rooms
Contractor	Has the meaning given in section 2 of the HSE Act and means, in general, a person engaged other than as an employee to undertake work at the site
Control	An action taken that eliminates, isolates or minimises a hazard
Crest	The top edge of a slope or batter where the ground levels out

TERM	DEFINITION
Dam	Has the meaning given in section 7 of the *Building Act 2004* being "dam— (a) means an artificial barrier, and its appurtenant structures, that— (i) is constructed to hold back water or other fluid under constant pressure so as to form a reservoir; and (ii) is used for the storage, control, or diversion of water or other fluid; and (b) includes— (i) a flood control dam; and (ii) a natural feature that has been significantly modified to function as a dam; and (iii) a canal; but (c) does not include a stopbank designed to control floodwaters"
De-energisation **De-energising** **De-energise**	De-energisation is the process used to disconnect and isolate a system from a source of energy in order to prevent the release of that energy. By de-energising the system, you are eliminating the chance the system could inadvertently, accidentally or unintentionally cause harm to a person through movement, or the release of heat, light or sound
Document Control	The systems by which records are kept, including the allocation of responsibility to specific staff members
Emergency drill	A process of testing training, relating to emergency events, which is repeated from time to time
Emergency (emergency event, emergencies)	An unplanned event that is not controlled where there is a threat to life or the health and safety of people at or outside the operation
Employer	Has the meaning given in section 2 of the HSE Act
Face	The surface where extraction is advancing. May also be referred to as pit face or working face.
FRAS	Fire resistant anti-static
Freeboard (for dams)	The distance between normal reservoir level and the top of the dam
Freeboard (for vessels)	The distance between the waterline and the main deck or weather deck of a ship or between the level of the water and the upper edge of the side of a small boat
Haul vehicles	Vehicles used to haul product or material from the place of extraction to the processing plant, stockpile or tip
Hazard	Has the meaning given in section 2 of the HSE Act
Hazard assessment	The overall process of analysing and evaluating the hazard
Hazard control	Refer to control
Hazard management	The culture, processes and structures that are directed towards the effective management of potential injury, illness, damage or loss
Hazardous substance	Has the meaning given in HSNO

TERM	DEFINITION
Site Health and Safety Representative	Has the meanings given in section 19L of the HSE Act
Heavy vehicles	Includes haul trucks, loaders, scrapers, dozers, water trucks, graders, low loaders, cable reelers, draglines, shovels, backhoes, drills and like equipment. Heavy vehicles are those that transport or extract materials, overburden or reject material
HSNO	Includes both the *Hazardous Substances and New Organisms Act 1996* and regulations made under that Act
Inter-ramp slope	A succession of batters between two access ramp sections (or between a ramp section and floor or crest)
Intrusive maintenance	Maintenance that requires interruption to the process. It usually requires shutdown, isolation of hazardous energy, LOTO, opening or disassembly
Large dam	Has the meaning given in section 7 of the *Building Act 2004* being "large dam means a dam that has a height of 4 or more metres and holds 20 000 or more cubic metres volume of water or other fluid"
Light vehicles	Includes wheel mounted light and medium duty vehicles of various sizes which are primarily used in the transportation of people, supplies, tools and fuel or lubricants. They include but are not limited to lube trucks, utes, SUVs, vans used as worker transporters, tyre mounted cranes, and forklifts, and so on
LOTO	Lockout and Tag out
Maritime Rules	Maritime Rules made under the *Maritime Transport Act 1994*
Mineral	Has the meaning given in section 19L of the HSE Act being "a naturally occurring inorganic substance beneath or at the surface of the earth, and: a. includes metallic minerals, non-metallic minerals, and precious stones; and b. does not include clay, coal, gravel, limestone, sand or stone"
Mining operation	Has the meaning given in section 19L of the HSE Act
Mine operator	Has the meaning given in regulation 3 of the Regulations being: a. has the meaning given in section 19L of the HSE Act; and b. in relation to a particular mining operation, means the mine operator for that mining operation
Misfire	When a blast does not fire correctly, or one or more blast holes do not fire
Mobile plant (for the purpose of this guidance)	Means plant that is not a light vehicle, haul truck or water tanker. For example bulldozer, excavator, loader, scraper and so on
Monitor	To check, supervise, observe or record the progress of an activity or procedure regularly in order to make sure it is being carried out
MOSS	Maritime Operator Safety System

TERM	DEFINITION
Near Miss	An event that has the potential to cause injury or illness if circumstances, such as the interval of time of the event, were different
Non-intrusive maintenance	Maintenance tasks that do not require process interruption, machinery or equipment shutdown, LOTO, entry or disassembly
OHS	Occupational Health and Safety
Opencast coal mining operation	Has the meaning given in regulation 3 of the Regulations
Opencast metalliferous mining operation	Has the meaning given in regulation 3 of the Regulations
Overall slope	The full height of a slope from the toe to the crest which may comprise several batters separated by benches (see Figure 3 on page 31)
Overburden (mines)	In mining overburden (also called waste or spoil) is the material that lies above an area of economic interest. It is most commonly the rock, soil, and vegetation above a coal seam or ore body
Overburden (quarries)	In quarrying overburden is the material that lies above the intended quarry site. It is most commonly the top-soil, sub-soil and vegetation
PCP	Principal Control Plan
Person in charge (in relation to HSNO)	'Person in charge' has the meaning given in regulation 3 of the Hazardous Substances (Class 1-5) Regulations being: "In relation to a place, a hazardous substance location, a transit depot, or a place of work, means a person who is: > The owner, lessee, sub-lessee, occupier, or person in possession of the place, or deport, or any part of it; or > Any other person who, at the relevant time, is in effective control or possession of the relevant part of the place, location, or depot"
Personal protective equipment or clothing	Safety apparel, protective devices and equipment that protect the health and safety of an individual person
PHMP	Principal Hazard Management Plan
Policy	Statement by a site (or company) of its commitment, intentions and principles in relation to its overall health and safety performance
Powder factor	The amount of explosive used per unit of rock. Also called Explosive Loading Factor
PPE	Personal protective equipment
Pre-start check	A safety checklist that is undertaken prior to first use of machinery or vehicles for that day or shift
Principal	Has the meaning in section 2 of the HSE Act – a person who or that engages any person (other than an employee) to do any work for gain or reward

TERM	DEFINITION
Principal control plan	Means a plan required under regulation 92 of the Regulations
Principal hazard	Has the meaning given in regulation 65 of the Regulations. While alluvial mines and quarries are not legally required to appraise risks to determine principal hazards, for the purposes of this guidance we have described risks where multiple fatalities could occur as a principal hazard
Principal hazard management plan	Means a plan required under regulation 66 of the Regulations
Procedure	A set of instructions, rules or a step-by-step description of what's to be done and by whom
Prohibited zone	Zone or area where people are not allowed such as at the bottom of a working tip face, the loading zone around vehicles
Pyrolysis	Chemical decomposition of compounds caused by high temperatures
Quarrying operation	Has the meaning given in section 19N of the HSE Act
Quarry operator	Has the meaning given in regulation 3 of the Regulations
Restricted area or restricted access	Area or zone where people or vehicles are not allowed unless certain conditions are met. For example, entry to an electrical switchboard room may be restricted to maintenance personnel under a permit to work; light vehicles may be restricted to entering a vehicle operating area when traffic has been stopped
Review	Checking to see whether goals have been achieved, and to assess what need to be done in future
Riprap	A layer of large quarried stone, precast blocks, bags of cement, or other suitable material, generally placed on the slope of an embankment or along a watercourse as protection against wave action, erosion, or scour. Riprap is usually placed by dumping or other mechanical methods, and in some cases is hand placed. It consists of rock pieces of relatively large size, as distinguished from a gravel blanket
Roads	A road is a constructed travel way between designated locations designed to accommodate the vehicles that operate at a site. It includes all thoroughfares used by heavy or light vehicles, and any roads used by the public within the site boundaries
Safe Work Procedure	A written instruction that sets out how an activity is to be undertaken at an operation. It can be used for training or observing activities for monitoring or review. Also known as Safe Work Methods Statement, Standard Operating Procedures, Work Method Statement or Task Analysis
SDS	Safety Data Sheet
Serious harm	Has the meaning in section 2 of the HSE Act – death or an injury that is defined in Schedule 1 of the HSE Act
Shotfirer	The competent person in charge of, and responsible for, the loading and firing of a blast

TERM	DEFINITION
Site	A place of work where extractive operations (mining and quarrying) and/or associated activities are carried out
Sleep time	In relation to explosive use, sleep time is defined as the time between charging and firing the shot
SOP	Standard operating procedure
Standard operating procedure	Documented, often step-by-step, processes by which workers can perform each task or aspect of the operation
Stockpile	Material placed, usually on a temporary basis, that is recovered and replaced
SWL	See WLL
SWP	Safe work procedure
Tip	May include an overburden tip or waste material tip of a permanent nature. Often called waste dumps or waste rock stacks
Toolbox meeting	Formal or informal meeting held between workers, usually at the place the work is undertaken (around the toolbox) and usually before a shift or a specific job starts. Sometimes referred to as a tailgate meeting
Tourist mining operation	Has the meaning in section 19L of the HSE Act
Tree-felling	Has the meaning in regulation 2 of the *Health and Safety in Employment Regulations 1995*. For the purpose of this guidance paragraph (b) (ii) is the aspect of the definition likely to apply. That is "felling trees by manual or mechanical means for the purpose of land clearance"
Vehicle	Self-propelled equipment or plant used for the carriage of goods, material or people for operational requirements. May include heavy vehicles, light vehicles or mobile plant
Vehicle operating areas	Other vehicle operating areas are all areas on or at a site where operations involve the use of vehicles other than roads. For example, tip points, stockpiles or loading areas. It includes any vehicle operating areas used by the public within the site boundaries

<table>
<tr><th>TERM</th><th>DEFINITION</th></tr>
<tr><td>Soils and very weak rock</td><td>As defined by the NZ Geotechnical Society Incorporated Field Description of Soil Analysis Guideline (Dec 2005) Table 3.5 Rock Strength Terms being:
<table>
<tr><th>Term</th><th>Field identification of specimen</th><th>Unconfined uniaxial compressive strength q_u (MPa)</th><th>Point load strength $I_{s(50)}$ (MPa)</th></tr>
<tr><td>Very weak</td><td>Crumbles under firm blows with point of geological hammer. Can be peeled by a pocket knife.</td><td>1 – 5</td><td rowspan="2"><1</td></tr>
<tr><td>Extremely weak (also needs additional description in soil terminology)</td><td>Indented by thumb nail or other lesser strength terms used for soils</td><td><1</td></tr>
<tr><td colspan="4">Note: No correlation is implied between q_u and $I_{s(50)}$</td></tr>
</table>
</td></tr>
<tr><td>Stronger rock</td><td>As defined by the NZ Geotechnical Society Incorporated Field Description of Soil Analysis Guideline (Dec 2005) Table 3.5 Rock Strength Terms being:
<table>
<tr><th>Term</th><th>Field identification of specimen</th><th>Unconfined uniaxial compressive strength q_u (MPa)</th><th>Point load strength $I_{s(50)}$ (MPa)</th></tr>
<tr><td>Extremely strong</td><td>Can only be chipped with geological hammer</td><td>>250</td><td>>10</td></tr>
<tr><td>Very strong</td><td>Requires many blows of geological hammer to break it</td><td>100 – 250</td><td>5 – 10</td></tr>
<tr><td>Strong</td><td>Requires more than one blow of geological hammer to fracture it</td><td>50 – 100</td><td>2 – 5</td></tr>
<tr><td>Moderately strong</td><td>Cannot be scraped or peeled with a pocket knife. Can be fractured with single firm blow of geological hammer</td><td>20 – 50</td><td>1 – 2</td></tr>
<tr><td>Weak</td><td>Can be peeled by a pocket knife with difficulty. Shallow indentations made by firm blow with point of geological hammer</td><td>5 – 20</td><td><1</td></tr>
<tr><td colspan="4">Note: No correlation is implied between q_u and $I_{s(50)}$</td></tr>
</table>
</td></tr>
</table>

TERM	DEFINITION
WLL	Means the working load limit, the maximum working load designed by the manufacturer. This term is now used instead of SWL (safe working limit)
Work Instruction SOP	See Standard Operating Procedure
Worker (for the purposes of this guidance)	A person who works at the site. May include, but not limited to, employer, employees, workers, contractors, sub-contractors, specialists and consultants
Worker participation	A system for the participation of workers in health and safety matters, as described in Part 2A and Part 2B of the HSE Act
Working bench	The level on which the excavator is sitting on or the trucks are running on

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> Department of Building and Housing *Compliance Document for New Zealand Building Code Clause D1 Access Routes and Compliance Document for New Zealand Building Code Clause F4 Safety from Falling.*

> Maritime New Zealand *Barge Stability Guidelines.*

> Ministry of Consumer Affairs *New Zealand Electrical Code of Practice for Electrical Safe Distances (NZECP 34:2001).*

> New Zealand Geotechnical Society Inc. *Field Description of Soil and Rock: Guideline for the Field Classification and Description of Soil and Rock for Engineering Purposes.*

> New Zealand Transport Agency (NZTA) *The official New Zealand Truck Loading Code.*

> NZTA *Heavy Vehicle Stability Guide.*

> NZTA *Ministry of Transport Signs and Markings Manual (MOTSAM).*

> NZTA *Traffic Control Devices Manual (TCDM).*

> NZTA *Code of Practice for Temporary Traffic Management (COPTTM).*

WORKSAFE PUBLICATIONS

> *Approved Code of Practice for Excavations for Shafts and Foundations.*

> *Approved Code of Practice for Load-lifting Rigging.*

> *Approved Code of Practice for Managing Hazards to Prevent Major Industrial Accidents.*

> *Approved Code of Practice for Operator Protective Structures on Self-Propelled Mobile Mechanical Plant.*

> *Approved Code of Practice for the Management of Noise in the Workplace.*

> *Approved Code of Practice for Training Operators and Instructors of Powered Industrial Lift Trucks (Forklifts).*

> *Best Practice Guidelines for the Safe use of Machinery.*

> *Best Practice Guidelines for Working at Height.*

> *Ergonomics of Machine Guarding Guide.*

> *Fact Sheet: A Hazard Management System for Mining Operations.*

> *First Aid for Workplace, A Good Practice Guide.*

> *Guidance for a Hazard Management System for Mines.*

> *Writing Health and Safety Documents for your Workplace.*

> *Guide to Developing Safety Management Systems for the Extractives Industry.*

> *Guide to Health and Safety in Welding.*

> *Guidelines for the Management of Work in Extremes of Temperature.*

> *Health and Safety in Contracting Situations.*

> *Principal's Guide to Contracting to meet the Health and Safety in Employment Act 1992.*

> *Safe Working in a Confined Space.*

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> *Welding Health and Safety Assessment Tool.*

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> HSENI *Guidance Document: Geotechnical Appraisal and Assessment.*

> HSENI *Toolbox Talk: Inspections of Sand Faces.*

> Hurwitz D.S *Backing collisions: A Study of Drivers' Eyes and Backing Behaviours using Combined Rear-view Camera and Sensor Systems.*

> Institut de echerché Robert-Sauvé en santé et en sécurité du travail (IRSST) *RG-490 A User's Guide to Conveyor Belt Safety, Protection for Danger Zones (chapter 2.6).*

> IRSST *RG-597 Prevention of Mechanical Hazards (chapter 6).*

> US Department of Labour Mine Safety and Health Administration (MSHA) *Number PH01-I-6: Dump-point Inspection Handbook.*

> MSHA *Accident Prevention Program Safety Idea: Work Boat Safety AP2002-S047.*

> MSHA *PH99-I-4: Haul Road Inspection Handbook.*

> MSHA *Controlling Mercury Hazard in Gold mining: A Best Practices Toolbox.*

> National Institute of Safety and Health (NIOSH) *Final Report: Blind Area Study-Large Mining Equipment – Blind Area Diagrams for Selected Mining Vehicles, John Steele, 2006.*

> NSW Trade and Investment Mine Safety Operations Branch (NSW Trade and Investment) *MDG28 Safety Requirements for Coal Stockpiles and Reclaim Tunnels.*

> NSW Trade and Investment *MDG 1010:2011 Minerals Industry Safety and Health Risk Management Guideline.*

> Quarries National Joint Advisory Committee (QNJAC) *Toolbox Talk: Drilling and Blasting – The Post-blast Inspection.*

> QNJAC *Toolbox Talk: Inspections of Rock Faces.*

> Queensland Government Department of Employment, Economic Development and Innovation *Safety Alert No. 44 V2 Prevention and Management of Blast Fumes (March 2011).*

> Queensland Department of Mines and Energy H&S Division *Safety Bulletin (SB 6): Handling & Management of Surface Trailing Cables.*

> Queensland Department of Mines and Energy *Guidance Note QGN10 Handling Explosives in Surface Mines and Quarries.*

> Queensland Government Mines Inspectorate *Safety Bulletin No. 101: Brake System Maintenance – Rubber Tyred Vehicles.*

> Safe Work Australia (SWA) *Draft Code of Practice: Ground Control in Open Pit Mines.*

> US Department of Labour Occupational S&H Administration (OSHA) *Safety and Health Information Bulletin SHIB 01-25-2013: Hazards of Operating Unguarded Stone Cutters and Splitters in Landscaping and Other Worksites.*

> Welding Technical Institute of Australia (WTIA) *Health and Safety in Welding 2004 – Technical Note 7 (TN7).*

> WTIA *Fume Minimisation Guide (FMG).*

> Western Australia Department of Mines and Petroleum (DMP) *Guideline Open Pit Mining through Underground Workings.*

> DMP *Safety Bulletin No 65: Design and Operation of Dredges on Ponds.*

> DMP *Tyre Safety, Fires and Explosions – Guideline.*

> WorkSafe Victoria *Guidance Note: Preventing Falls from Quarry Faces.*

> WorkSafe *Victoria Safety Alert: Preventing Mobile Plant Fires.*

WEBSITE LINKS

> WorkSafe's emergency procedure flipchart www.business.govt.nz/worksafe

> Information on drivers medical nzta.govt.nz/resources/results.html?catid=53

> Information on HSNO requirements www.business.govt.nz/worksafe

> Information on inspecting small dams, constructing small dams or the Building Code www.dbh.govt.nz/small-dams-guidance

> Information on maritime law and associated requirements www.maritime.govt.nz

> Information on ratio/grade conversions www.1728.com

> Information on transport law and road signs and markings www.nzta.govt.nz

> NIOSH Final Report: Blind Area Study – Large Mining Equipment – Blind area diagrams for selected mining vehicles.

STANDARDS

> AS 2187.2-2006 Explosives – Storage and Use Part 2: Use of explosives.

> AS 2359.13-2005 Powered industrial trucks – Brake performance and component strength.

> AS 2359.2-2013 Powered industrial trucks – Operations.

> AS 2865-2009 Confined Spaces.

> AS 2958.1-1995 Earth-moving machinery – Safety – Wheeled machines – Brakes.

> AS 4024.1-2006 Series Safety of machinery.

> AS 4457.1-2007 Earth Moving Machinery – Off-the-road wheels, rims and tyres – Maintenance and repair – Wheel assemblies and rim assemblies.

> AS/NZS 1270:2002 Acoustics – Hearing protectors.

> AS/NZS 1337.1:2010 Personal eye protection – Eye and face protectors for occupational applications.

> AS/NZS 1657:1992 Fixed platforms, walkways, stairways and ladders. Design, construction and installation.

> AS/NZS 1715:2009 Selection, use and maintenance of respiratory protective equipment.

> AS/NZS 1716:2012 Respiratory protective devices.

> AS/NZS 1801:1997 Occupational protective helmets.

> AS/NZS 1892.1:1996 Portable ladders – Part 1: Metal.

> AS/NZS 2161.2:2005 Occupational protective gloves – General requirements.

> AS/NZS 2161.3:2005 Occupational protective gloves – Protection against mechanical risks.

> AS/NZS 2210.1:2010 Safety, protective and occupational footwear – Guide to selection, care and use.

> AS/NZS 2801:2008 Clothing for protection against heat and flame – General recommendations for selection, care and use of protective clothing.

> AS/NZS 2906:2001 Fuel containers – Portable – Plastics and metal.

> AS/NZS 3007:2013 Electrical equipment in mines and quarries – Surface installations and associated processing plant.
> AS/NZS 3760:2010 In-service safety inspection and testing of electrical equipment.
> AS/NZS 4602.1:2011 High visibility safety garments – Part 1: Garments for high risk applications.
> AS/NZS ISO 31000:2009 Risk Management – Principles and Guidelines.
> ASTM F852-08 Standard Specification for Portable Gasoline Containers for Consumer Use.
> NZS 5823:1989 Specification for buoyancy aids and marine safety harnesses and lines.
> NZS 5823:2001 Specification for buoyancy aids and marine safety harnesses and lines.
> NZS 5823:2005 Specification for buoyancy aids and marine safety harnesses and lines.
> SA/SNZ HB 436:2013 Risk management guidelines – Companion to AS/NZS ISO 31000:2009.
> SA/SNZ HB 89:2013 Risk Management – Guidelines on risk assessment techniques.

LEGISLATION

> *The Building Act 2004.*
> *Building (Dam Safety) Regulations 2008.*
> *The Building Regulations 1992 (Building Code).*
> *Electricity Act 1992.*
> *Electricity (Safety) Regulations 2010.*
> *Employment Relations Act 2000.*
> *Hazardous Substances and New Organisms Act 1996 (HSNO).*
> *Hazardous Substances (Classes 1 to 5 Controls) Regulations 2001.*
> *Hazardous Substances (Disposal) Regulations 2001.*
> *Hazardous Substances (Identification) Regulations 2001.*
> *Hazardous Substances (Packaging) Regulations 2001.*
> *Hazardous Substances (Tracking) Regulations 2001.*
> *Hazardous Substances (Fireworks, Safety, Ammunition, and Other Explosives Transfer) Regulations 2003.*
> *Health and Safety in Employment Act 1992.*
> *Health and Safety in Employment (Mining Operations and Quarrying Operations) Regulations 2013.*
> *Health and Safety in Employment Regulations 1995.*
> *Health and Safety in Employment (Pressure Equipment, Cranes and Passenger Ropeways) Regulations 1999.*
> *Fire Service Act 1975.*
> *Fire Safety and Evacuation of Building Regulations 2006.*
> *The Land Transport Act 1998.*
> *The Land Transport Act 1998 Land Transport Rule: Vehicle Lighting 2004 (Rule 32005).*
> *Maritime Transport Act 1994.*
> *Maritime Transport Act 1994 Maritime Rules.*

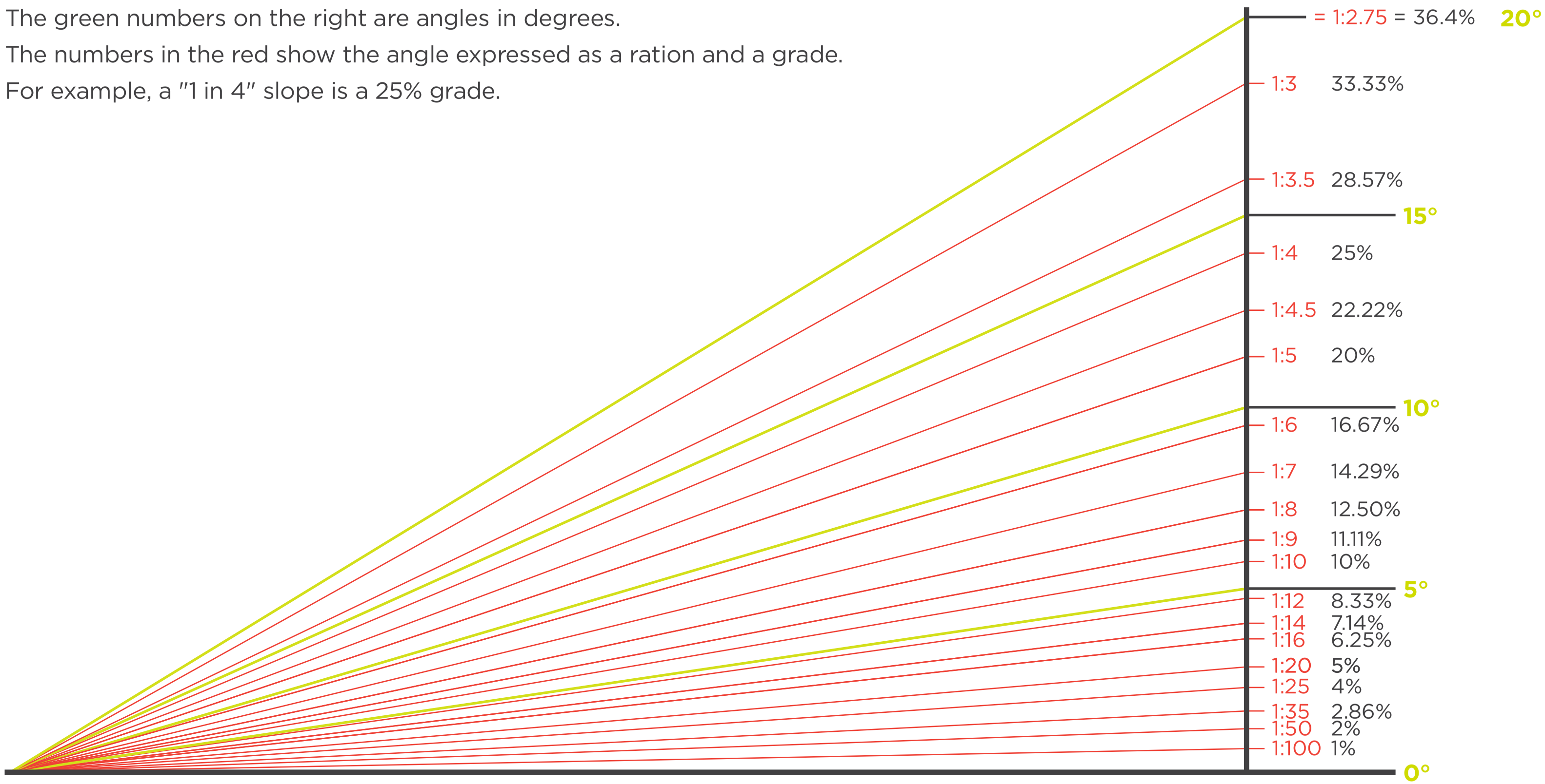
23/

APPENDICES

IN THIS SECTION:

23.1 APPENDIX A: RATIO TO PERCENTAGE GRADE CONVERSION

The green numbers on the right are angles in degrees.
The numbers in the red show the angle expressed as a ration and a grade.
For example, a "1 in 4" slope is a 25% grade.



Source: www.1728.com

23.2 APPENDIX B: ISSUING PERMIT TO WORK CERTIFICATES

WORK TO BE DONE	POSSIBLE HAZARDS	TYPE OF PERMIT (OR CERTIFICATE)	SOME PRECAUTIONS TO CONSIDER	SOME EQUIPMENT TO CONSIDER
Entry into a vessel, sump, pit or other confined space	> Oxygen deficiency > Oxygen enrichment > Toxic or corrosive gases > Flammable gases or liquids > High temperature > Low or cryogenic temperature > Toxic or flammable residues	Confined Space Entry	> Atmosphere analysis > Material removal or steaming out > Forced ventilation > Fresh air supply > Physical isolation > Temperature normalisation > Rescue equipment > Standby people	> Toxic or flammable gas and oxygen monitor > Safety harness and hoist > Breathing apparatus > Resuscitator > Respiratory protective equipment (RPE)
Working on or breaking into pipelines or pressure vessels	> Toxic or corrosive gases or liquids > Flammable gases or liquids > Cryogenic liquids > High pressure > Vacuum	Pipework and Vessels	> Physical isolation > Material removal or steaming out > Inert gas plugging > De-pressurising > Atmosphere analysis > Spill containment	> Helmet > Visor or safety glasses > Ear protection > Gloves > RPE > Toxic or flammable gas monitor > Spill clean-up kit > Fire extinguishers
> Welding **> Brazing** **> Soldering** **> Grinding** **> Flame cutting**	> Flammable gases or liquids > Combustible liquids or solids > Explosive dusts > Flammable residues > Rubber lined vessels	Hot Work	> Remove materials or cover with fire blanket > Atmosphere analysis > Material removal or steaming out > Inert gas purging > Post work checks	> Fire extinguishers > Hose reel > Fire blanket > Toxic or flammable gas and oxygen monitor > Sand > Sand bucket

WORK TO BE DONE	POSSIBLE HAZARDS	TYPE OF PERMIT (OR CERTIFICATE)	SOME PRECAUTIONS TO CONSIDER	SOME EQUIPMENT TO CONSIDER
Work at height (injury from falling possible)	> Fragile roof > Overhead lines > Electricity > Chimney or exhaust stack emissions > Soft ground > Vehicle movement > Weather conditions	Work at Heights	> Isolate and lock off power to overhead electrics > Provide safe access and place of work > Atmosphere analysis > Stop emissions > Clear and cordon off ground beneath work area	> Scaffolding > Crawl boards > Edge protection > Safety harness and fixing > Toxic or flammable gas and oxygen monitor > RPE > Elevated work platform
Repair or maintenance of powered machinery	> Electricity > Gas > Moving parts > Stored energy eg eccentric shafts	Electrical and Machinery Isolation	> Electrical isolation > Switches locked off > Warning notices (tags) > Stored energy dissipated	> Circuit tester > Personal padlocks > Specialist lockout devices > Warning notices (tags)
Digging or excavating (other than extraction of product)	> Underground services > Electric cables > Gas pipes > Water mains > Solvent or corrosive pipes > Compressed air > Drains or sewers > Overhead cables	Digging or Excavation	> Locate and identify underground services > Provide shoring in trenches > Atmosphere analysis	> Underground cable detector > Toxic or flammable gas and oxygen monitor
Examples: > **Asbestos removal** > **One-off work with hazardous substances** > **Demolition** > **Installation projects** > **Construction work** > **Disconnecting or isolating emergency systems (eg alarms, automatic extinguisher systems)**	To be identified	Special	To be identified Specialist advice may be needed	To be identified

23.3 APPENDIX C: FIELD DATA COLLECTION

There are several tools and techniques available for field data collection. These include:

> **Surface geophysical** data collection methods provide initial identification of major lithological units and structural features, such as fracture zones.

> **Downhole geophysics or logging** provides data that can be used to determine lithological boundaries, structures and the in situ mechanical, physical and chemical properties of the rock mass.

> **Core drilling** enables an adequate understanding of the subsurface conditions for input to geotechnical design. The number of boreholes required will depend on:
>
> - the level and reliability of already available geological and geotechnical information
> - the complexity of site geology
> - the size and operating life of the quarry or mine.

Core samples retrieved from boreholes can be logged using direct observation, or downhole cameras and digital photography.

> **Field testing**: Geotechnical data collection from exposed rock can be carried out using 3D digital photogrammetric techniques.

> **Laboratory testing**: Rock samples can be tested in a laboratory to determine intact rock properties.

23.4 APPENDIX D: GEOLOGICAL MODELS

23.4.1 THE GEOLOGICAL MODEL

The purpose of the geological model is to show a three dimensional (3D) visualisation of the materials present. Different material types often have different strength characteristics, which affect the process of slope design.

Use a competent person to develop an accurate, well-understood geological model. This requires an understanding of geological events that led to the formation of the ore body, regional and local structure, lithology, topography, morphology and regional stress field as well as geotechnical requirements for slope design.

THE STRUCTURAL MODEL

The purpose of the structural model is to describe the orientation and spatial distribution of the structural defects (discontinuities) that are likely to affect the stability of slopes. The defects can be divided into two groups:

> large structural features such as folds and faults that are widely spaced and continuous along strike and dip across the entire site (major structures)

> closely spaced joints, cleavage and faults that typically do not extend for more than two or three benches or batters (minor structures).

Use a competent person to develop structural models.

The structural model can be developed using computer based 3D modelling tools. Ideally, the major and minor structures are recorded in at least two separate overlays. This allows efficient assessment of their combined effect as well as individual effects on the stability of the slope.

ROCK MASS MODEL

A rock mass model shows the engineering properties of the rock mass made up of various material types and structural defects. The rock mass properties include the intact pieces of rock, the structures that cut through the rock and the rock mass itself. These properties govern the performance of the slope and therefore the design approach.

In a slope constructed in stronger rock, failure can occur along geologic structures which are considered pre-existing planes of weakness in otherwise solid rock. In relatively weak materials (ie weathered or soft rock) failure can occur through the intact material or along geologic structures. In some situations (in strong rocks as well as in weak materials) failure could occur partly along geological structures and partly through intact rock material. It is therefore important to determine the engineering properties of:

> intact rock or soil
> structural features
> the rock mass in the various geological units.

HYDROGEOLOGICAL MODEL

The presence of groundwater in a slope can have significant negative effects on stability. In the case of sites excavated within weak materials (eg clay or completely weathered rock) pore pressures play a significant role in stability. High pore pressures reduce the effective stresses and simultaneously reduce the shear strength of both soil or rock material and rock mass. High water pressures also reduce the shear strength of structural defects in un-weathered strong rock. This leads to structurally controlled instability.

Groundwater (depending on chemistry) can contribute to corrosion of ground support and reinforcement, if used as a method of slope stabilisation. This would significantly reduce their effectiveness.

Groundwater can also create saturated conditions and lead to water ponding within an excavation which can lead to unsafe conditions. Other problems that could result from saturated conditions or standing water include loss of access to all or part of the excavation, difficulties in using explosives and reduced efficiency in the equipment used at the site.

It is therefore important to develop a good hydrogeological model early on. This allows effective control measures to be designed and implemented. Preliminary data required for the development of the hydrogeological model can be obtained from boreholes drilled for resource evaluation and geotechnical site investigations. However, purpose designed drilling and testing programs are required for the hydrogeological characterisation of the rock mass.

Use a competent person to carry out hydrogeological modelling.

For more information on groundwater and surface water control see section 3.5.5.

23.5 APPENDIX E: TYPES OF ANALYSIS

Basic types of analysis are:

Rock Mass Rating (RMR) and Mining Rock Mass Rating (MRMR) Classification Systems: At early stages of site development, if data is limited and the geotechnical model has not been fully developed. Here empirical approaches based on rock mass classification methods such as RMR and MRMR can be used for preliminary slope design. These methods are largely based on qualitative studies of rock mass failures and are only considered useful for initial assessment of failure through the rock mass (Jakkubec J. and Esterhuizen).

Kinematic analysis of structurally controlled failures: The analysis of removability of rock blocks from the slope without referring to the forces that cause them to move. It is based on stereographic projections and is mainly applied to batter designs. It may also be used for large scale slope design, if anticipated failure is controlled by structures.

Limit equilibrium analysis: A two-dimensional method of analysis widely used for the determining Factor of Safety against rotational shear failure in soil slopes. It can be applied to assess structurally controlled “kinematically unstable” rock block and wedges in batter and inter-ramp scale. It can also be used to assess against failure through rock material or rock mass in batter, inter-ramp and overall slopes. The major limitations of limit equilibrium analysis are that it assumes the unstable mass can be characterised by solid blocks and it cannot represent either deformation or displacement of the failing rock mass.

Numerical analysis: Numerical analysis is based on numerical modelling tools such as finite element and distinct element methods. It can overcome some of the limitations of limit equilibrium analysis as it can model complex rock masses and the deformation and displacement of the failing mass. This analysis is useful for the assessment of both inter-ramp and overall slopes in large opencast mines or quarries.

23.6 APPENDIX F: BATTERS AND FINAL BENCH DESIGN

BATTER HEIGHT AND REACH

The maximum height of a batter should be based on stability and should not exceed the safe reach of the equipment available to clean (scale) the face, unless special precautions are taken. These precautions could include:

- blasting practices that shoot the face clean
- using mobile plant or equipment capable of working a safe distance from the toe while removing material to the toe
- using mobile plant or equipment to clean the face from the top edge
- excavating the batter face in lifts from top to bottom to allow to allow for cleaning immediately above the work area
- providing a buffer (ie a windrow or ditch) of sufficient size to capture any potentially hazardous rock falls.

The height of batters should be determined on an individual basis, based on past extraction conditions of the seam or area, and sound engineering practices.

FINAL BENCH SPACING

Benches perform two important functions. First, they provide stability to a slope by increasing the safety factor. Where a slope contains numerous discontinuities (joint sets, bedding planes, and so on) providing benches at select spacings can increase the stability of the slope. Second, where rilling rock and dirt are a problem, benches can be used to keep these materials from falling into working areas. As such, whether the bench can do these is one of the factors used to determine bench spacing.

Where bench spacing has been decreased to a minimum and rill material is still not contained (smaller size material) you must determine if a significant hazard is present. Material only falling at the base of the batter may not be a hazard, as it does not affect a travel or work area. However, work near the batter should be considered when considering if there is a hazard.

If the configuration of the batter or techniques being used do not keep material from falling into the excavation where workers are exposed, changes to the ground control methods will be necessary. Providing a bench or additional benches in the slope, widening bench widths, modifying blasting techniques, changing the orientation of mining or extraction, and more effective cleaning methods are some of the changes to consider.

FINAL BENCH WIDTHS

The width of benches should be determined by three factors:

- The bench should be wide enough to stop potentially hazardous rock falls and contain any material that falls from the wall above the bench. This is unless other controls are in place (ie rock fences).

> Extended exposure of the wall can cause rilling material to accumulate on the bench. Cleaning may be needed to maintain the bench's effectiveness. If you are cleaning benches the bench width should accommodate any equipment used on the bench. Safe access to the bench must be provided.
> Bench widths should allow for adequate drainage, as described in section 3.5.5.

When designing bench widths the likelihood of achieving the design width should be considered. Even with good blasting and excavation control, the design may not be achieved. The width that can practically be achieved depends on the amount of back-break occurring along the crest during excavation. Back-break from blasting can extend into the bench as much as 3 metres. Presplitting can reduce back-break if the holes are spaced close enough, and plugged as near the top of the hole as possible. This reduces the amount of stemming. Explosive contractors or suppliers may offer other techniques that could be used to handle back-break problems.

23.7 APPENDIX G: ROCK BOLTING SYSTEMS

Rock bolts are tensioned once anchorage is achieved, to actively set up a compressive force into the surrounding rock. This axial force increases the shear capacity and is generated by pre-tensioning of the bolt. In essence, rock bolts start to support the rock as soon as they are tensioned.

Commercially available rock bolts include cone and shell, grouted and chemically (resin) anchored rebar.

Rock dowels can be used instead of rock bolts, when installation of support can be carried out very close to the excavated face or in anticipation of stress changes that will occur at a later excavation stage. Rock dowels are passive reinforcing which need some ground displacement for activation.

Cable bolting is an established technique used extensively for reinforcement of the rock mass adjacent to surface excavations. They can be tensioned or un-tensioned, and may be fully or partially grouted. Thread-bar rock anchors or multi-strand tendon cable anchors can be used where higher loads are required.

Shear pins are reinforcement bars or larger steel, concrete or post sections that may be grouted in situ. They are designed to be placed perpendicular to a particular discontinuity and to act mainly in shear. The support provided by the shear pin is equal to the shear strength of the steel bar and possibly the cohesion of the rock/concrete surface.

Although shear pins are mainly installed perpendicular to the potential slide plane, there are some other applications. These can involve horizontal installations to provide shear support to blocks defined by flat-lying underground workings intersecting the pit wall, or unstable clay seams within an eroded rock wall.

Mesh, where bolting alone is insufficient and support is required for small fractured material, welded or arc mesh secured to the rock bolts, dowels or cable bolts is a suitable form of support. Usually a 100 x 100 mm mesh is used, but the size is determined by the desired bag strength. The use of mesh in very blocky ground reduces the potential for unravelling and can be a very useful ground support method.

W strapping is used to connect the collars of rock bolts. They are nominally 2-3 mm thick and 200-300 mm wide, and can be bolted to follow the contours of the rock face. Support tension can be exerted between bolt sets through the strap.

23.8 APPENDIX H: RETAINING TYPE STRUCTURES

Gabion walls are a traditional effective and practical means of stabilising cuts and slopes. As they apply a surcharge load to the underlying pit wall, they must be installed upwards from a location where there is strong enough rock for a suitable foundation.

Stacked tyres are an alternative to gabions, and may be simpler and cheaper to install. Each stack of tyres should be filled and secured.

Reinforced earth retaining walls are gravity structures consisting of alternating layers of granular backfill and reinforcing strips with a modular precast concrete facing. Because of their high load-carrying capacity, reinforced earth is ideal for very high or heavy-loaded retaining walls.

Tied-back walls generally comprise a concrete wall, often reinforced with mesh or reinforcement bars tied back into the rock wall using cable bolts, or rock bolts in smaller structures. These walls are particularly suited to mining applications where they can be constructed progressively as the benches are mined, using cable bolting meshing and a shotcrete application.

Steel sheet piling is often used in soft soils and tight spaces. They are made out of steel, vinyl, fibreglass or plastic sheet piles driven into the ground and can require a tie-back anchor ‘dead man’ tied by a cable or a rod. For more detailed information on shoring methods see the WorkSafe *Approved Code of Practice for Excavations and Shafts for Foundations.*

23.9 APPENDIX I: CULVERTS

Unless the culverts lead to additional diversionary ditching, provide water run-outs to reduce the velocity to where the water is non-erosive. On shallow slopes (less than 10%) with limited water flows (<0.5 m/s), this can be done with vegetated outflow areas. Energy dissipaters (riprap or tipped rock) may be required where flow rates are higher.

Provide and maintain good drainage to ensure low water levels in the road fill in areas of a naturally occurring high water table (eg swamps or watercourses).

Temporary in-pit roads with high ground water levels can be improved by placing gravel or rockfill over the area, or by installing pumping wells to lower the water table. Pumping wells may be cost effective if it also reduces the water level in, and improves the stability of, the working area.

Make drainage features large enough, and space them apart so they can deal with the greatest expected demands on them.

While it is raining or right after it rains, is a good time to check drainage is working properly.

23.10 APPENDIX J: TRACTION

The forces required for accelerating, turning, or stopping vehicles are caused by the friction generated between the tyres and the road pavement. The amount of friction available varies with different road pavements and is indicated by a friction coefficient, which is a measure of how well the tyre grips the road pavement.

The friction coefficient indicates how much of the total weight of the vehicle can be generated as a force between the tyre and the road pavement. The higher this force, the better the grip on the road and the more control the driver has in climbing, steering, and stopping.

Table 8 shows some typical friction coefficients for a variety of road pavements. Notice the significant differences in values varying from concrete (0.9) down to ice, which can be practically zero. The value of 0.9 for rubber tyres on concrete means 90% of the weight on a tyre is available as braking force (presuming that the brake components themselves can provide this much braking force).

PAVEMENT MATERIAL	DRY	WET
Clay	0.60 – 0.90	0.10 – 0.30
Concrete	0.90	0.60 – 0.80
Gravel road, firm	0.50 – 0.80	0.30 – 0.60
Gravel road, loose	0.20 – 0.40	0.30 – 0.50
Ice	0.00	0.00
Sand, loose	0.10 – 0.20	0.10 – 0.40
Snow, packed	0.10 – 0.40	0.00

Table 10: Typical values for the coefficient of friction between rubber tyres and various road surfaces

These different values show why it is so important drivers adjust their speed to suit the road conditions. All other factors being equal, it will take a longer distance to stop when the traction values are low. If the friction coefficient is reduced by half the stopping distance is doubled once the brakes are applied. Friction values also affect steering ability. Reduce speed when traction is low.

The road pavement coefficients given in Table 10 are the maximum values for the conditions indicated. Maximum tyre grip occurs when the tyre is still rolling and just before the tyre would lockup and slide. Once a tyre locks up and goes into a skid, the available friction is reduced. This reduction can be as much as 50% under poor road conditions. This is why antilock brakes are of such benefit. They help prevent tyres from locking up, so the available friction stays at the higher values. Brakes stop the wheel, but it's the grip between tyre and road pavement that stops the vehicle.

23.11 APPENDIX K: WINDROWS

One way for a windrow to provide restraint is for the windrow to deflect the tyre, and re-direct the vehicle back onto the road. To do this, make the windrow material firm, and the inside slope as nearly vertical as possible (a slope of greater than 40° is recommended[92]). When cutting the inside slope to steepen the windrow, make sure enough material is initially placed so once the windrow is cut, the base width is still adequate. Make the base width at least the width the windrow would have been if both its outside and inside slopes were at the material's angle of repose. Maintain a full base width to serve the function of keeping vehicles back from the edge (refer 5.3.9).

Windrows constructed of broken rock mixed with bonding materials will normally offer restraint due to the interlocking and frictional resistance of the rock pieces. If a windrow is too loose, it will provide little restraint and the vehicle may plough straight through it. If a windrow is firm, but is not steep on the roadway side, the vehicle could ride up and over it (refer 5.3.9).

A windrow can also impede the passage of a vehicle by a combination of the tyre sinking into and raising up as it climbs the windrow material. The vehicle may get bogged down as it plows through. But to effectively impede a vehicle in this way, a windrow generally needs to be larger than axle height. In general the finer the material used, and the less effort that is made in compacting and shaping a windrow, the larger the windrow should be to provide similar restraint.

[92] Source: Source: Stecklein, G. L. (1981) *Haul road berm and guardrail design study and demonstration* (US Bureau of Mines), Restraint system recommendation, p160

Because of the large size and weight of some vehicles, the typical axle-height berms cannot be relied on, by themselves, to completely stop a vehicle except at low speeds. Windrows much larger than axle-height are required to completely stop a vehicle for all possible conditions of speed and impact. Tests have shown a windrow needs to be constructed to a height 3 times the axle height for vehicles under 85 tonnes and 4 times the axle height for vehicles over 85 tonnes to stop a runaway vehicle. This is based on a vehicle contacting the windrow at 48 kilometres at a 30 degree angle of contact[93].

The amount of restraint offered by a windrow depends on the conditions under which the vehicle impacts it. The greater the vehicle speed, or the more head-on the vehicle contacts the windrow; the larger the windrow has to be. For this reason, use larger than typical windrows in areas where it is reasonable to expect more adverse conditions, such as where vehicles would have more speed or would contact the windrow head-on. An example would be where there is a curve at the bottom of a grade. In such cases, increase windrow size or consider other provisions, such as runaway lanes or double windrows (refer 5.3.10).

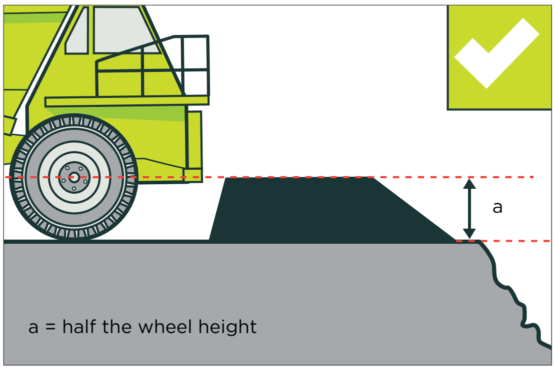


Figure 104: Suitable windrow – firm material big enough to absorb the vehicle's momentum with a steepened inside slope

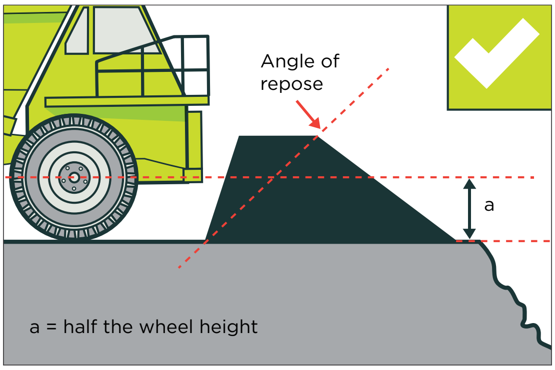


Figure 105: Suitable windrow – the width of the windrow is as wide as the normal angle of repose

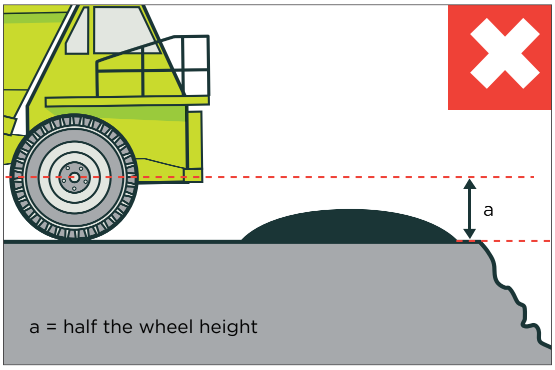


Figure 106: Unsuitable windrow – curved slopes

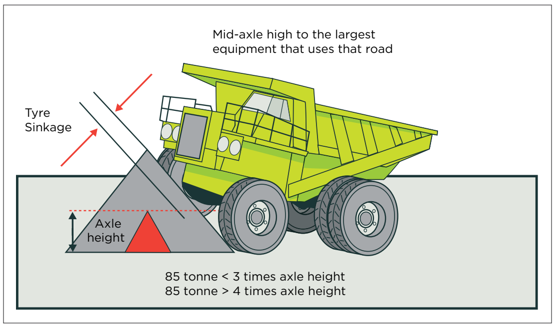


Figure 107: Study on windrow size to offer definite restraint

Make roads wide enough so windrows are constructed on a firm foundation that is level with the roadway. If the road width is inadequate and a portion of the windrow extends over the hillside, the windrow will be more likely to give way when hit and offer little restraint (refer Figure 108).

[93] Source: Stecklein, G. L. (1981) *Haul road berm and guardrail design study and demonstration* (US Bureau of Mines)

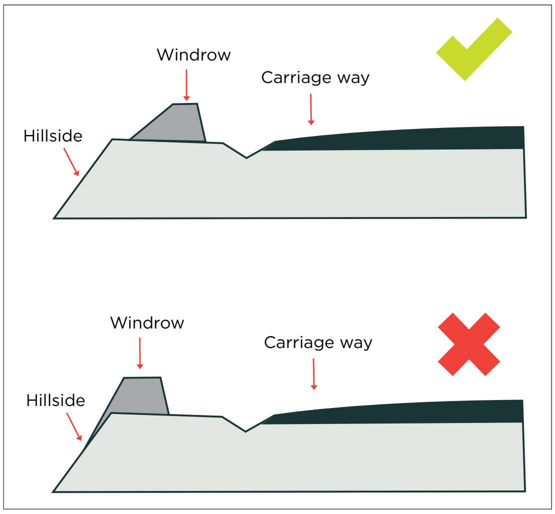


Figure 108: Windrow constructed on firm foundation

Leave gaps in the windrow or other drainage systems provided where necessary, to allow drainage of surface water. Make sure any gaps are not wide enough for a vehicle to pass through. Design them so a vehicle's wheel cannot be trapped at an angle leading away from the travelling direction (see Figure 109).

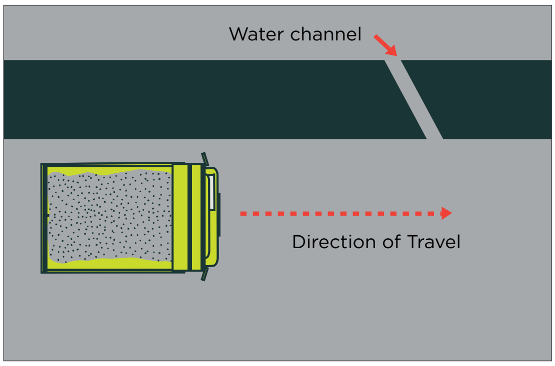


Figure 109: Suitable windrow – gaps in windrow for drainage

23.12 APPENDIX L: MONITORING METHODS

VISUAL INSPECTION

A basic element of a slope movement monitoring program should be visual inspection by a competent person, combined with observation by all workers. Maintain this qualitative, but extremely important aspect of the program throughout the life of the operation.

Workers are required to report rock falls, and be involved in the slope inspection process and in a regular detailed inspection process.

Any visual monitoring program should be supported by instrumentation to provide a quantitative basis for defining any movement.

Develop and implement a procedure for the regular inspection of faces above every place of work and every road used by workers[94]. This is good practise for all quarry and alluvial mine operators, and a legal requirement for other mine operators as defined in section 19M of the *Health and Safety in Employment (Mining Operations and Quarrying Operations) Regulations 2013.'*

The procedure must ensure:

> A competent person examines every area of the site where a worker is present, or is expected to be present, before every shift and at suitable times during the shift.

> Every accessible area of the site (including areas containing barriers, machinery and infrastructure) is examined at least weekly.

It must also ensure that written procedures are available for workers, setting out:

> What will be examined?

> When they will be examined?

> How inspections will be recorded?

> How findings will be actioned?

[94] The Regulations, regulation 222

Practical information and advice on actions to be taken when defects are identified may include:

> if it is safe to work below and above a face
> if there is any loose material on the face
> if there is potential for instability
> whether maintenance is required to the face prior to commencing work
> when further advice is required such as from the geotechnical specialist.

SURFACE EXTENSOMETERS AND CRACK MONITORING

If evidence of movement is detected from visual inspection, the first step in increasing the monitoring program might be simple crack monitoring. Results of visual inspections and crack monitoring are a useful guide when selecting additional secondary monitoring points for detailed survey assessments.

Crack monitoring techniques typically consist of:

> regular detailed mapping of location, depth, width of cracks, rate of extension and opening
> installation of targets on opposite sides of cracks to monitor rates of opening
> installation of surface (wireline) extensometers
> installation of picket lines or line of targets that can be monitored using theodolites or precise levels to detect changes in alignment, location of elevation along a given crack or the crest of the slope.

Surface extensometers for monitoring local wall movement or tip movement can be easily constructed and provide a rugged practical system of monitoring that can be inspected and interpreted regularly by operational workers. They can also be equipped with automatic devices such as lights or sirens to provide warning of excessive movement. More sophisticated units can provide real-time indication of movement to remote locations (ie offices) through a telemetric link.

TERRESTRIAL GEODETIC SURVEYS

The most reliable and complete measurements associated with initial movement can be obtained from conventional geodetic survey techniques, using precise theodolite and electro-optic distance measuring (EDM) combinations or total stations. These systems can be installed by survey workers, generally with survey equipment in regular use at a site.

Primary monitoring points should be surveyed at regular intervals, consistent with the type of rock and expected rates of movement. Surveillance monitoring frequencies vary from weekly to quarterly depending on conditions such as the stage of mining or extraction, mining or extraction rate, changes in piezometric surface and climatic variations.

The individual aspects of a typical system are:

> Control points for the system should consist of the instrument stations near the crest of a slope and reference stations located away (100 metres to 3 kilometres) from mining or quarrying activities. Control points are usually established by conducting a first-order survey, using conventional survey techniques such as triangulation, trilateration or triangulateration, or GPS.
> GPS is much more efficient, accurate and less labour-intensive than the conventional survey techniques when used for control surveys, especially when the network covers a relatively large area. The main requirements are that the system used picks up variances and good quality equipment.
> The stability of instrument stations can be checked by resurveying the control network or reference stations each time the instrument station is used. Make sure reference stations are observed regularly.

Plot and assess data from the survey after each set of readings. If movement is detected, monitoring frequency of secondary points will depend on the size of the failure and movement rates and could be hourly to weekly. For more detailed information on data analysis see section 7.4.

For more detailed information on surveying see the *Approved Code of Practice for Surveying*.

GPS STATIONS

Global positioning systems (GPS) based on satellites orbiting the earth can be used for real-time positioning at any location 24 hours a day in any weather. The positioning is accomplished through the use of timing signals transmitted by the satellites to ground receivers.

With two or more receivers working simultaneously in a so-called differential mode, you can measure relative positions (3D coordinate differences) between the receivers. This will have an accuracy of a few millimetres to about 20 mm over distances up to several kilometres.

Unlike conventional survey techniques (ie those using EDM, total stations and levels) GPS does not require a direct line of sight between survey stations. GPS is not affected by local atmospheric conditions when the GPS baseline length is within 1 km, so GPS is usually more efficient and accurate, and requires less labour than conventional survey techniques. Therefore, GPS has been adopted as the general surveying technique at many extractive sites. The advantages also make it an ideal tool for setting up control surveys for slope monitoring.

RADAR

Where more extensive areas of movement are detected, radar enables real-time monitoring of the movements to help ensure workers below the slope are kept safe. Radar units used in conjunction with geodetic surveying can effectively provide real-time warning of movements and accelerations.

It is important that radar is not the sole basis for monitoring. Further, it is essential to maintain a degree of conservatism in determining when to withdraw workers from below a moving slope, even if it is being monitored by radar. Even small rock falls resulting from the deformation can have serious safety consequences and may not be detected by radar.

SUBSURFACE TECHNIQUES

Costs of subsurface techniques are greater than those for surface instrumentation. These costs can be modest, if available drilling equipment is used and workers perform the installation after instruction from specialists or the instrument supplier. Inclinometers and TDR cables, for example, give very valuable and precise information on the locations of deep-seated slide surfaces, and on rates of movement without which remedial work cannot be adequately planned.

MICRO-SEISMIC MONITORING

Routine real-time micro-seismic monitoring in the opencast environment can provide 3D data where rock breakage or movement is occurring. This data can be used to enhance surface monitoring systems in identifying potential instability and the associated failure mode. The technique is commonly used in underground mining operations and has recently been applied in opencast environments.

MONITORING OF GROUNDWATER PRESSURE

If the slope design is based on achieving a given future pore pressure profile, it is important year-by-year pore pressure targets are developed to ensure depressurisation is occurring at the desired rate.

Include piezometer installations in the most critical areas for slope performance in the final slope design. Target pressures are then developed for each piezometer, for each year of operation.

The components of a groundwater monitoring system could include:

> data acquisition systems
> piezometers
> horizontal drain flows
> dewatering well discharges
> monitoring of slope conditions.

23.13 APPENDIX M: INSTRUMENT DATA

PROCESSING AND PRESENTATION OF INSTRUMENTATION DATA

The primary aim of data processing and presentation is a rapid assessment of information to detect changes that require immediate action. A secondary function is to summarise and present the data to show trends and compare observed with predicted behaviour, so that any necessary action can be initiated.

Present monitoring data in a format that is easy to read and identifies problem areas quickly.

Determine responsibility for processing and presentation of instrumentation data during the planning phase. This should be under the direct control of a competent person on site, or in special cases, consultants who have immediate 24-hour access to the data. Time required for these tasks can be underestimated, resulting in the accumulation of unprocessed data and failure to take appropriate action. Similarly, experienced geotechnical engineers may use much of their time supporting monitoring systems instead of delegating these responsibilities to technicians. This may mean they neglect the required technical analysis to minimise or manage the impacts of potential slope failures. The time required for data processing and presentation is usually similar to, and may even exceed, the time required to collect data.

Data processing and presentation depends on the specific monitoring system. For surveillance monitoring and for small slopes it can often be performed with standard spreadsheet packages. More comprehensive monitoring programs may require commercial survey reduction and geographic information system (GIS) programs.

INTERPRETATION OF INSTRUMENTATION DATA

Monitoring programs have failed because the data generated was never used. If there is a clear sense of purpose for a monitoring program, this will guide the data interpretation.

Aim early data interpretation at determining the accuracy of the monitoring system. For example, atmospheric changes may result in diurnal variations of several times the manufacturer's quoted accuracy for EDM and total station units. This is common particularly in climates where there are significant temperature differences between day and night or climates where temperature inversions can develop in a pit overnight. Filter out these survey accuracy variations as part of the interpretation process, either by setting wider bands before alarms are triggered or by putting emphasis on readings taken at the same time of the day.

The purpose of subsequent data interpretation is to correlate the instrument readings with other factors (cause and effect relationships) and to study the deviation of the readings from the predicted behaviour. By its very nature, interpretation of data is a labour-intensive activity and no technique has yet been developed for complete automatic interpretation.

RESPONDING TO DATA VARIATIONS

Interpretation of data from movement monitoring systems primarily involves assessing the onset of changes in the movement rate. This is generally reflected by acceleration but, where a slope is already moving, deceleration may also occur.

If the material does fail, the site should have a pre-planned response to the movement. This can be achieved through the use of trigger points or trigger action responses (TARPS) established for each monitoring method. A typical system of trigger points might be as follows:

> The initial trigger point would be if the movement rate is double the survey accuracy from the last reading. In this case the reading should be repeated as soon as possible. If the reading is proven correct, additional readings should be taken at an increased frequency.

> The second trigger point would be if the movement rate doubles over two consecutive readings. In this case, the area of the moving prisms should be inspected. If the cause of movement cannot be determined, reduce extraction or mining in the area or suspend it and increase the reading frequency. Until the situation has been fully investigated, continued acceleration of movement should require closure of the pit floor below the moving area.

> If an increase in movement greater than four times the survey error is recorded for any reading, when there has been no previous accelerations noted on a prism, clear the area below the movement immediately until the point has been resurveyed. If the reading is confirmed, keep the area clear until the situation has been investigated.

The reporting procedure in the event of any TARP should be clearly defined and understood by all. Slope failures very rarely occur without some warning, and all workers need to be able to recognise potential hazards and act accordingly. It is recommended TARPs also include actions to be taken where monitoring systems or instruments are no longer operational (ie breakdowns).

REPORTING CONCLUSIONS

After each set of data has been interpreted, report conclusions in the form of an interim monitoring report, and submit this to workers responsible for implementing remedial actions. At the very least, supply management with a monthly summary report of the results from the monitoring program, even if no movement is detected. A final report of the monitoring program is often required, and a technical paper may be prepared.

23.14 APPENDIX N: ISOLATION AND LOCKOUT OF ENERGY

In this section, the term energy refers to anything that can provide power to a system to allow it to perform work. The term system refers to machinery, equipment or processes.

22.14.1 TYPES OF ENERGY

The term energy includes any electrical, mechanical, pneumatic, chemical, thermal or gravitational energy. Some energy sources are obvious, such as electricity, heat in a furnace, or something that might fall. Others may be hidden hazards, such as air pressure in a system or a tightly wound spring.

Electrical energy is the most common form of energy used in workplaces. It can be available live through power lines or it can be stored, for example, in batteries or capacitors. Electricity can harm people in one of three ways:

1. by electric shock
2. by secondary injury (eg burn)
3. by exposure to an electric arc.

Hydraulic potential energy is the energy stored within a pressurised liquid. When under pressure, the fluid can be used to move heavy objects, machinery, or equipment. Examples include braking systems in vehicles or hydraulic lifting arms. When hydraulic energy is released in an uncontrolled manner, individuals may be crushed or struck by moving machinery, equipment or other items.

Pneumatic potential energy is the energy stored within pressurised air. Like hydraulic energy, when under pressure, air can be used to move heavy objects and power equipment. Examples include spraying devices, power washers, or machinery. When pneumatic energy is released in an uncontrolled manner, individuals may be crushed or struck by moving machinery, equipment of other items (ie hoses).

Chemical energy is the energy released when a substance undergoes a chemical reaction. The energy is normally released as heat, but could be released in other forms, such as pressure. A common result of hazardous chemical reaction is fire or explosion.

Radiation energy is energy from electromagnetic sources. This energy covers all radiation from visible light, lasers, microwave, infra-red, ultraviolet, and x-rays. Radiation energy can cause injuries ranging from skin and eye damage to cancer.

Gravitational potential energy is the energy related to the mass of an object and its distance from the ground. The heavier an object is, and the further it is from the ground, the greater its gravitational potential energy. For example, a 1 kilogram (kg) weight held 2 metres above the ground will have greater gravitational potential energy than a 1 kg weight held 1 metre above the ground.

Mechanical energy is the energy contained in an item under tension. For instance, a spring that is compressed or coiled will have stored energy which will be released in the form of movement when the spring expands. The release of mechanical energy may result in an individual being crushed or struck by the object.

Understand that all of these energy types can be considered as either the primary energy source, or as residual or stored energy (energy that can reside or remain in the system). The primary energy source is the supply of power that is used to perform work. Residual or stored energy is energy within the system that is not being used, but when released it can cause work to be done.

For example, when you close a valve on a pneumatic (air) or hydraulic (liquid) powered system, you have isolated the system from its primary energy source. However, there is still residual energy stored in any air or liquid that remains in the system. In this example, removing the residual energy would include bleeding out the liquid, or venting out the air. Until this residual energy is removed from the system, there is a potential hazard.

Control of energy includes isolating the system from its primary power source **and** removing the residual energy.

22.14.2 IS LOCKOUT AND ENERGY CONTROL THE SAME THING?

The terms lockout and isolation are sometimes used interchangeably, but they are not the same thing.

Energy isolation is a broad term describing the use of procedures, techniques, designs and methods to protect workers from injury due to the inadvertent release of energy.

Lockout is the placement of a lock or tag on an energy-isolating device in accordance with an established procedure. It indicates the energy-isolating device is not to be operated until removal of the lock or tag. Therefore, lockout is one way in which energy control can be achieved.

22.14.3 ENERGY ISOLATION PROCEDURES

In most cases, equipment or systems will have safety devices built in. These safety devices include guards and safeguarding devices to protect workers during normal operations. However, during maintenance or repairs, these devices may have to be removed or by-passed. In these situations, an energy isolation procedure is needed. Energy isolation procedures may be part of a Permit to Work system (refer section 17.3).

Energy isolation procedures are used to maintain worker safety by preventing:

> unintended release of stored energy
> unintended start-up
> unintended motion
> contact with a hazard when guards are removed or safety devices have been by-passed or removed.

Developing and implementing energy isolation procedures involves 5 steps:

Gather information: Gather documentation from the manufacturer or designer of the system about:

> Where energy isolating devices are located and procedures for their use.
> Step-by-step procedures for servicing or maintaining the system.
> How to safely address malfunctions, jams, misfeeds or other planned and unplanned interruptions in operations.
> How to install, move, and remove any or all parts of the system safely.

This information will help you to understand how the system was intended to be used, and will provide you with recommendations on how the tasks can be performed safely.

Perform a task analysis: A task analysis is performed by examining all the intended uses of the system from the perspective of both the manufacturer and the user. List all tasks and steps required to accomplish the task. Include any tasks related to any possible misuse of the system in this analysis. When performing the task analysis, at a minimum, consider the following categories:

> machine or process start up
> programming of any machinery PLCs
> commissioning
> all modes of operation
> Interlinked processes such as conveyors, crushers, screens
> operational maintenance such as replacement of GET (ground engaging tools)
> normal and unscheduled stoppages (control failure or jam) and restart and emergency stoppages and restart
> fault-finding and troubleshooting, planned and unplanned maintenance and repair, cleaning and housekeeping.

Perform a risk appraisal and risk assessment: Based on the information from the first two steps, perform a risk appraisal and assessment of how workers will be interacting with the system. Outline where possible hazards are, and what the associated risk of each hazard is.

Examples include:

> a hydraulic hose releases pressurised fluid when it is removed for maintenance purposes
> a barrier or guard has been removed or by-passed
> an interlocked gate closes when a worker is in the hazardous area
> a conveyor moves when a blockage is cleared.

Implement controls: The controls required will follow what hazards and risks were identified during the appraisal and assessment.

The energy-isolating device can be a manually operated disconnect switch, a circuit breaker, a line valve, or a block. Push buttons, selection switches and other circuit control switches are not considered energy-isolating devices. In most cases, energy-isolating devices will have loops or tabs which can be locked to a stationary item in a safe position (de-energised position).

Figure 110: Example of an energy-isolating manually operated disconnect switch with a loop for securing a lockout device (photo courtesy of NZ Steel, Taharoa)

It is good practice to have a process that uniquely identifies all parts of a system including switches, cables, piping and valves. This allows workers to check they are isolating the right energy-isolation device when applying isolation procedures and lock out tag out systems. Make all items readily identifiable and referenced on system plans or diagrams. Permanently label key items of equipment with formal, simple, easily visible and unambiguous labelling wherever mistakes in identification could occur and could result in significant consequences.

Communication, including training: Communicate and train appropriate workers on how the procedure works, their role in the procedures, and what their responsibilities are.

23.15 APPENDIX O: PERMIT TO WORK SYSTEM PROCESS

An example of a PTW process is:

Step 1 – Highlight Potential Hazards: Workers guided by the Supervisor identify potential hazards and implement all necessary safety measures according to the PTW requirements. Work is not permitted to start until Stage 4.

Step 2 – Application for Permit: The Supervisor (or Permit Receiver) applies for permission to start work on a prescribed form. The supervisor then submits the application of the PTW to the Authorised Person (or Permit Issuer) only when all the conditions in the PTW have been fulfilled. The Receiver has to indicate in the PTW that risk assessment was conducted for the task and the safety measures to be implemented.

Step 3 – Evaluation of Permit: The Permit Issuer evaluates and verifies that all safety conditions specified in the PTW have been fulfilled and adequate. They may also recommend additional measures in the PTW when necessary. They need to inspect the work location where the PTW has been applied for with the Receiver during this process.

Only when all safety requirements stated in the PTW are fulfilled, will the Permit Issuer endorse the PTW form and, if required, forward the permit to the authorised manager.

Note: Some companies require an authorised manager to approve work where the initial risk score is at a certain level. For example the task has been risk scored in the High or Extreme category. If this system is not used, Steps 3 and 4 may be done by the Permit Issuer.

Step 4 – Approval of Permit: The authorised manager (or Permit Issuer) may approve and issue the PTW only when they are satisfied that:

> proper evaluation of risk and hazards for the work concerned has been conducted

- no incompatible work will be carried out at the same time and location of the PTW which may pose a risk to the persons at work
- all reasonably practicable safety measures have been taken and all persons involved in the work have been informed of the work hazards under the PTW.

Work is permitted to commence on issue or approval of the PTW. The supervisor then posts a copy of the PTW at work location stated in the PTW. The copy will not be removed from the work location until the duration of the PTW has expired or work stated in the PTW has been completed.

Note: Permit Receivers and Permit Issuers should not be the same person.

Notes

Notes

DISCLAIMER

WorkSafe New Zealand has made every effort to ensure the information contained in this publication is reliable, but makes no guarantee of its completeness. WorkSafe may change the contents of this guide at any time without notice.

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