GUIDELINE

Working at height in underground mines

MIAC

Government of **Western Australia**
Department of **Mines and Petroleum**
Resources Safety

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Contents

Guidelines

A guideline is an explanatory document that provides more information on the requirements of legislation, details good practice, and may explain means of compliance with standards prescribed in the legislation. The government, unions or employer groups may issue guidance material.

Compliance with guidelines is not mandatory but they could have legal standing if it were demonstrated that the guideline is the industry norm.

Who should use this guideline?

This guideline should be used by anyone planning, supervising or conducting work at height in underground mines.

Acknowledgement

This guideline was developed through extensive consultation with industry representatives.

Foreword

This guideline is issued by Resources Safety under the *Mines Safety and Inspection Act 1994*, and has been endorsed by the Mining Industry Advisory Committee (MIAC).

The Act

The *Mines Safety and Inspection Act 1994* (the Act) sets objectives to promote and improve occupational safety and health standards within the minerals industry.

The Act sets out broad duties, and is supported by regulations together with codes of practice and guidelines.

Regulations

The Mines Safety and Inspection Regulations 1995 (the regulations) provide more specific requirements for a range of activities. Like the Act, the regulations are enforceable and breaches may result in prosecution, fines, or directions to cease operations and undertake remedial action.

Standards

Although specific versions of Australian and other standards may apply under the regulations, references to standards in this guideline are undated and it is good practice to consult the latest versions where applicable.

Application

The provisions of this guideline apply to all underground mines as defined in section 4(1) of the Act.

Note: Shaft-sinking practices and the operation of shaft conveyances are beyond the scope of this guideline.

1 Introduction

The underground environment is constantly changing as a mine develops, and those working at height need to be aware of this constantly changing three-dimensional situation. Mining levels frequently vary and a worker does not usually have a visible horizon for orientation.

Underground workers may need to work in or near steeply inclined openings, each with its own unique characteristics and risks. Workers may also be at height during activities such as rise development, working in ladderways or servicing plant. Apart from the potential exposure to falls and falling objects (e.g. loose rock, equipment, tools, materials) when working at height, an additional risk to those workers using work platforms underground is that they can be injured if caught between a rising platform and backs (i.e. roof or upper part) or sidewall of the drive.

Note: In this guideline, steeply inclined openings range from those that are vertical to those inclined at an angle where the rock rills naturally.

In an underground environment, the application of standard operating procedures for working at height can also be affected by limited visibility, workspace constraints, challenging ground conditions and barriers to effective ventilation in rises.

These circumstances mean that working at height underground can mean more than simply addressing the risk of falling. This guideline will assist employers and mine operators to:

- identify the risks associated with working at height in underground mines
- develop and implement a safe system of work to minimise those risks.

Note: This guideline is not intended as a training manual on how to work at height or use fall protection systems, nor is it a summary of the relevant Australian Standards.

Chapter 2 summarises the risk management process. It describes the type of information to be collected and considered when assessing and addressing the risks associated with working at height in an underground environment.

Chapters 3 to 8 describe some common working-at-height scenarios and control measures to consider when working in an underground mine.

Chapter 9 describes measures to mitigate the consequences should a fall occur.

People must be competent in the tasks they are assigned so they can perform them safely. Training and the management and supervision of workers are considered in Chapters 10 and 11, respectively.

Note: A competent person is considered to be someone who is appointed or delegated by the employer or tenement holder to perform specified duties that the person is qualified to perform by knowledge, training and experience.

Chapter 12 describes the emergency response that should be in place if there is an incident.

Appendix 1 lists legislative provisions relevant to working at height in underground mines in Western Australia.

Appendices 2 to 4 include information on relevant Australian Standards and other guidance, and an overview of the hierarchy of control as applied to working at height in underground mines.

2 Risk management process

2.1 Information for risk management

Mining operations should be able to demonstrate how the risks associated with working at height while underground are being controlled so far as is reasonably practicable.

The effective management of the risks while working at height in underground mines can require input from subject specialists, such as engineers (e.g. mining, mechanical, geotechnical, ventilation), safety and health representatives, and other workers involved in the tasks, as well as emergency response personnel.

Issues to be considered during the risk management process include:

- design or layout of underground workings
- previous incident and injury reports and other data covering falls from height or work platform incidents
- availability of suitable equipment for working at height underground
- suitability of inspection and maintenance processes (e.g. ladders, scaffolds, work platforms, registered plant, harnesses, lanyards, anchorage points)
- safe work practices for similar workplaces or processes
- assessment of the knowledge and training needed to perform tasks safely and the adequacy of current competency (i.e. undertake gap analysis)
- whether procedures for all potential emergency situations are sufficient.

2.2 Risk-based approach

In the underground environment, the risk-based approach needs to consider the additional factors and constraints of:

- limited visibility (e.g. only light source is cap lamp, artificial lighting casts shadows on irregular walls and backs)
- restricted work areas (e.g. proximity to backs, narrow openings, projections from walls and backs, pinch points, available work space on work platform)
- mine services restricting access
- breakdowns requiring maintenance work or servicing away from designated workshops
- congested work areas
- exposure to work being undertaken above or below
- scattered or remote work areas
- proximity to other operational mobile machinery
- uneven and sloping ground (e.g. unable to use normal safe lifting techniques such as cranes, equipment stability)
- challenging ground conditions and water ingress
- environmental conditions (e.g. noise, atmospheric contaminants, heat, humidity)
- achieving acceptable ventilation
- availability of fit-for-purpose equipment
- compromised communication between those involved in task and notification of activities to others
- difficulty placing barriers, segregation methods or restraints at some locations
- workforce competency and supervision.

2.3 Risk identification

The potential risks when working at height in underground mines include:

- falling from work platforms or plant
- falling into openings
- falling while working in inclined openings (e.g. rise miner falling off a ladder)

- crushing and lacerations (e.g. work platforms lifting into backs, movement of equipment on platforms)
- being hit by objects (e.g. tools, equipment or rock from above)
- falling due to unexpected movement on uneven sloping surfaces
- musculoskeletal disorders (e.g. sprains and strains on the body from manual tasks made hazardous by awkward sustained postures)
- failure of jacking mechanism (e.g. collapse of work platform)
- failure of locking mechanism holding work platform (e.g. locking pins not fully engaged)
- inadequate ventilation in rises leading to asphyxiation or exposure to noxious gases
- suspension trauma (e.g. injuries associated from hanging from harnesses for a prolonged period).

Identifying these risks requires recognition of the scenarios (i.e. work environment, tasks) that may lead to such consequences.

2.4 Risk evaluation and treatment

Risk is best controlled through application of the hierarchy of control. The higher-order control measures should eliminate, reduce or minimise the risk more effectively than administrative controls or personal protective equipment (see Appendix 4).

2.5 Working alone

There is a legislative requirement for a worker working alone to be inspected, visited or communicated with at least every two hours. Also, if hazardous conditions exist at any workplace, no one is to work alone and a worker must be within sight of another worker.

In modern underground mines, there are a number of tasks that are undertaken alone, either in a separate drive or perhaps up to a kilometre from where others are working.

Where practicable, no-one should work alone at height. A risk assessment should be undertaken and appropriate control measures implemented.

The risks of working alone at height in underground mines can be exacerbated by:

- restricted visibility
- noisy enclosed work spaces
- communications issues
- ventilation issues.

Other matters to consider include:

- worker training and competence
- supervision, including the frequency of supervisor visits
- equipment used
- means and frequency of communicating
- other workers in the vicinity.

If a person falls, workers nearby should be trained to be able to immediately raise the alarm and render assistance.

The risk assessment for activities to be performed by workers working alone (e.g. airleg miners, charge-up workers) should consider situations where:

- personal fall arrest equipment is required
- there is a risk that, if the worker fell, suspension trauma would be likely
- the risk of falling cannot be adequately controlled (e.g. mechanical failure on charge-up basket or work platform)
- the risk of crushing cannot be adequately controlled (e.g. inadvertent elevation of work platform)
- it has been identified that a worker cannot call for assistance should they fall, be ejected from a work platform by a mechanical failure, or be struck by a falling object
- there are concerns about the quality of ventilation
- there are concerns regarding the competency of the worker or adequacy of supervision.

3 Mobile work platforms

3.1 Overview

A mobile work platform provides access for workers, equipment and material to areas that are difficult to reach, particularly those at height. In underground mining, mobile work platforms typically comprise:

- purpose-designed mobile work platforms
- work platforms attached to multi-purpose machines (i.e. work baskets).

Scissor lifts, while classed as a mobile work platform, are designed to operate on hard, level surfaces and therefore tend to be restricted in use to workshops in the underground environment.

As well as falling, the potential for injuries is high if a worker:

- is caught between the rock face or services and the work platform as it is being raised or is in the process of self-levelling
- becomes entangled in moving parts
- is crushed through hydraulic failure or uncontrolled or unexpected movement of the work platform.

3.2 Risk factors

Risks are associated with the use of mobile work platforms in underground mines, and consideration should be given to:

- how to access items being worked on that are restricted by obstructions (e.g. ventilation bag, water pipes, electrical cables, support elements)
- movement and final positioning of the work platform where these are limited by the drive dimensions and services suspended from the backs and shoulders of the drive
- overhead restrictions and protruding objects (e.g. ground support)
- proximity to other work involving mobile plant

- effect of ground surface on stability
- control of work platform (e.g. basket-mounted controls, operator not in basket, self-levelling capability)
- whether the work platform is fit for purpose
- correct implementation of fall protection system
- approved anchorage points within work platform for correct attachment of fall protection equipment
- appropriate risk assessment of job (e.g. requirement to stretch or lean over rails to work on mine service facilities)
- appropriate preventative maintenance schedule
- suitable lighting
- appropriate worker training and assessment of competency.

Falling from height during charge-up operations or when working on services (e.g. installation or removal of electrical cables) is the most common incident type involving mobile work platforms underground. Falls usually result from:

- incorrect or no connection of lanyard to an anchorage point
- failure of a component
- sudden movement of equipment (e.g. being struck by vehicle)
- machine located on uneven or sloping surface causing it to tip when the centre of gravity changes during elevation of the work platform
- operator breaching procedures
- inadequate worker training or assessment of competency.

Workers involved in manual scaling or barring down from a work platform can be injured if:

- they do not understand the geotechnical characteristics of the rock or use inappropriate techniques and
  - rocks hit or fall into the basket and the work platform tips, dislodging the occupants
  - rocks fall into or bounce off the basket, striking the occupants
- there are too many occupants in the restricted working

space of the basket, affecting its stability

- one end of a scaling bar is rested on a boot to prevent it falling through grating while raising the work platform — the bar can be pushed into the foot if the other end is caught against the walls or back.

3.3 Risk mitigation strategies

Safety requirements and considerations associated with mobile work platforms include:

- for work platforms attached to multi-purpose machines, designing the work platform to ensure it is fit for purpose and attaching it securely to the lifting equipment — the work platform, lifting attachments and records should be checked by a competent person before use

  Note: Anyone working from a mobile work platform should understand this risk and have the awareness and training to be able to inspect the attachment mechanism before entering the work platform.

- using scissor lifts that are purpose built for the underground environment
- fitting the mobile work platform with suitable anchorage, as specified in AS/NZS 1891.4 to which workers attach a lanyard and harness
- installing interlocking safety systems to prevent accidental detachment of the work platform
- protecting controls from accidental activation
- fitting the equipment with the means to safely lower the basket in an emergency or a power supply failure
- counterbalancing weight distribution (e.g. using jacks)
- using check valves to control unchecked movement
- use of prestart checks of the equipment and working environment
- the operator remaining in control of the equipment at all times
- restricting the number of workers in the basket
- limiting the transport or tramming of workers in the basket
- ensuring workers remain within the basket while they are being lifted or suspended (except in an emergency)

- not allowing workers to stand on basket rails to gain extra height
- not suspending the basket over workers
- not allowing workers to walk or work underneath the basket
- providing an effective means of communication between a worker in the basket and the operator
- training and instructing of workers operating the platform in safe operating procedures for the particular brand and type of equipment, as well as the safe use of fall arrest equipment and emergency rescue procedures
- holding a high risk work licence as required for erecting scaffolding and operating an elevating work platform with a reach capability exceeding 11 metres
- having an emergency response plan in place.

Where there is a risk of objects falling from the mobile work platform, consider:

- removing any objects not required for the task (i.e. clean work space)
- securing objects (e.g. tools, cabling, pipes) from moving or falling
- restricting the movement of equipment when the platform is elevated
- establishing an exclusion zone that is barricaded, where possible, to restrict access.

A competent person should conduct a risk assessment to ensure the mobile work platform:

- is fit for purpose
- complies with the relevant standards (e.g. AS 1418.10, AS 1418.17).

Mobile work platforms should be maintained in accordance with manufacturer's recommendations including a preventative maintenance schedule. Before use, inspect the platform and attachment mechanism for corrosion and mechanical or structural damage.

Regular inspections should be made by a competent person and records kept of the faults identified and actions taken.

4 Fixed work platforms

4.1 Overview

Fixed work platforms comprise permanent or semi-permanent structures, such as a pinned platform, ladder, scaffold, built-up broken rock, and other structures such as covered openings or sump pump accesses. Landings in ladderways and shafts are sometimes used as work platforms.

A scaffold is a temporary structure specifically erected to support access or working platforms, and is commonly used so workers have a safe, stable platform on which to work when the job cannot be done at ground level.

Scaffolds, when erected correctly, are a control measure to minimise the risk of workers and objects falling when working at height.

4.2 Risk factors

Risks are associated with fixed work platforms in underground mines, and consideration should be given to:

- type of platform to be used and its duty rating
- height of platform to be erected
- scheduling of the work
- layout of the underground workplace
- number of people involved in the work
- surface on which the platform or scaffold will be erected (i.e. ground conditions and the structural integrity of the surface to support the scaffold and its load)
- stability of rockmass
- plant and equipment that will be used on or near the platform
- environmental conditions (e.g. corrosion due to exposure to saline water)
- maintenance practices
- skill and competencies required to erect, use, maintain, alter and dismantle the scaffold.

4.3 Risk mitigation strategies

Safety requirements and considerations associated with fixed work platforms include:

- appropriate design or selection of fixed work platforms, including kick plates and handrail guards
- a competent person should conduct a risk assessment of fixed work platforms and develop and implement a safe system of work, including exclusion zones
- pre-use checks of fixed work platforms
- verification of lateral movement stability following blasting or seismic activity
- an effective means of communication between a worker on a platform and other workers
- training and instruction of workers operating on a platform in the safe operating procedures for the particular platform (e.g. not standing on rails or objects to gain additional height), as well as the safe use of fall arrest equipment and emergency rescue procedures
- confirmation that workers required to erect scaffolding hold a high risk work licence and are assessed as competent
- an emergency response plan.

5 Working near openings

5.1 Overview

When considering scenarios involving openings, the need to work or travel near the opening should be eliminated wherever possible. However, where this is not possible, mine planners need to consider the potential impact of such openings when designing the type of access to a mine, stoping method, ore and waste transfer systems and second means of egress. Controls should be provided for:

- development methods
- rising and winzing methods
- development and production charging
- bogging and tipping
- installation, removal and maintenance of services
- entering and exiting shaft conveyances
- installing physical barriers (e.g. wheel stops or barricades near open stopes or ore passes) and signage
- installing ladders
- installing and removing services
- clearing grizzlies on material passes
- backfilling stopes (e.g. constructing barricade walls, tipping material into stope)
- covering ore passes
- workplace inspections
- maintenance of services
- carrying out inspections and surveys
- shaft inspections and maintenance.

5.2 Risk factors

Risks are associated with working near openings in underground mines, and consideration should be given to:

- type of access, rising, stoping or material transfer
- situational awareness (e.g. visibility of openings)
- ground stability (above or below)
- holes following ground movement
- large rise holes and slots
- service holes
- shrink stoping
- need for delineation
- suitability of barriers and travel ways
- placement, integrity and adequacy of bunding
- trip hazards from recently blasted rock or work materials
- adequacy of lighting
- maintenance of barriers, platforms and warning signs
- communication of workplace changes to workforce
- equipment that is fit-for-purpose
- quality and quantity of ventilation
- maintenance work (e.g. clearing grizzlies)
- adequacy of worker training or assessment of competency.

5.3 Risk mitigation strategies

When planning work near openings, a risk assessment should be conducted by a competent person so that a safe system of work can be developed and appropriate controls implemented for all work near openings.

Where there is the potential for the edge of an opening to be unstable due to blasting activities or ground movement, the following should be considered before commencing work:

- the adequacy of controls identified during the risk assessment for all work near openings
- edge conditions and measures to prevent material being dislodged or dropped into the opening
- whether appropriate fall prevention measures are in place
- in a retreating stope, clear communication or delineation of where the blasted edge should be

  Note: It can be difficult to visually demarcate the edge of a blasted slope.

- restricting access to the level above or below as applicable.

No-one should work near a non-barricaded steeply inclined opening without appropriate controls being implemented and procedures established, and workers trained in applying them. For example, a mechanical means should be used to cover an ore pass.

Before work commences at a steeply inclined opening where personal fall arrest equipment is required, a competent person should inspect the work area to ensure designated controls are in place, and that workers are working with a safe work procedure.

For openings above and below the level, appropriate safety signs should be placed to allow sufficient distance for a mobile plant operator to readily see the warning and stop safely.

6 Rise development

6.1 Overview

A rise is a vertical or steeply inclined development opening driven upwards from any level. Rises are used underground for a variety of purposes, including to:

- create a void for blasting into (i.e. slot)
- allow ventilation of the underground workings
- provide an escape route between levels when equipped with ladders
- access ore that can only be mined by airleg methods
- provide a pass to transfer material.

6.2 Risk factors

After blasting, there is a high potential for loose rock to get hung up on the face, side walls, backs and ladders. If the rise being developed is too steep then the working face is above rather than in front of the miner, and it can be hazardous to re-enter the rise (e.g. for scaling down).

Risk factors to consider include:

- geotechnical properties of the rock
- inclination of the rise
- dimensions of the rise
- length of the rise
- ventilation of the rise
- installation of ladders and services within a rise
- transport of equipment and explosives within a rise
- access to the top and bottom of the rise
- blasting
- ability to carry out visual inspection on re-entry.

6.3 Risk mitigation strategies

A competent person should conduct a comprehensive risk assessment before deciding on the rising method to be used.

To reduce exposure to rock falls, non-entry techniques (e.g. use raise drill or boxhole borer, develop longhole rise) should be used to develop a rise.

For airleg rising, it is recommended that:

- rises are not inclined at more than 60° from the horizontal
- the rise cross section is as small as practicable
- the length of a rise does not exceed the distance that it can be effectively inspected from the entrance using a strong hand-held light (i.e. should not exceed 20 m)
- a steel pipe air–water blast system is installed, and used for an adequate period after each blast and before re-entry

  Note: The air–water blast should be directed to thoroughly sweep the face and dislodge loose material, as well as purging noxious fumes.

- ventilation to the rise face is maintained while the miner is working in the rise
- a bore hole is provided if top access is available
- appropriate fall arrest equipment is used.
- a safe means of getting equipment up to the rise face is established
- barriers and signage warning of the hazards is installed.

Note: Recommendations derived from Resources Safety's Mines Safety Bulletin No. 39 on vertical opening development in underground mines (rise development).

7 Working in ladderways

7.1 Overview

Before the advent of trackless mining, ladderways were often the only means of access or movement for workers and materials between the operating levels and sub-levels of underground mines. Consequently, much effort, skill and experience were devoted at well-managed mines to ensure ladderways were properly sited, installed, equipped and maintained so that they could be efficiently, effectively and safely used. In many underground mines, ladderways still form a primary means of access to some working areas and emergency escape routes.

7.2 Risk factors

Ladderways in some mines have been in place for many years and may have deteriorated to the extent that their use constitutes a hazard. The difficulties of working in ladderways can also be exacerbated by potential deficiencies in ventilation, visibility, manoeuvring space and ground conditions.

Risk factors to consider include:

- transporting commonly used equipment and materials through the ladderway
- inclination and installation of ladders to enable easy and comfortable use of all parts of the ladderway
- fixing of ladders within a shaft or rise
- lengths of ladders and need for bearers or supports to prevent swaying when the ladderway is used
- distance between intermediate landings or rest points of long lengths of ladders
- entry and exit points for ladderways to enable ease of access and egress
- design and manufacture of the ladders
- inspection, scaling and maintenance regimes for ladderways

- damage to ladderways following rockfalls or blasting
- routing and fixing or support of service pipes and cables in ladderways
- water running down ladderways.

7.3 Risk mitigation strategies

A competent person should conduct a risk assessment for tasks to be performed in ladderways.

The top of any permanent ladderway should be properly constructed and decked to prevent material being inadvertently dropped or dislodged into the opening.

Other precautions that will reduce the risks associated with working at height in ladderways include:

- using properly considered, designed and installed means of safely moving equipment up to the rise face (e.g. rope pulley systems, slinging)
- using a rill rope to assist workers climbing a loose rill
- wearing a full body harness attached to an approved fall arrest system that is hooked up to a suitable anchorage point
- using appropriate limited free-fall restraint equipment
- training workers and assessing them as competent in the use of fall arrest equipment.

To safely ascend or descend a ladderway, workers should:

- keep both hands free for climbing and face the ladder
- maintain three points of contact when moving
- securely sling loads on the back and shoulders
- hoist heavy or bulky loads rather than carrying them.

A safe system of work for installing and removing rise ladders should be implemented.

Where work is required in steeply inclined openings, establish a safe approach and firm footing and use fall arrest equipment and overhead protection.

8 Plant

8.1 Overview

As well as mobile equipment, plant used in underground mines includes equipment for:

- conveying
- crushing and hoisting
- maintenance or repair outside of workshop environment
- refuelling
- magazine loading.

The operation, maintenance and servicing of such machinery may require workers to work at height.

8.2 Risk factors

Plant operation

Plant that is operated from an elevated position, or requires workers to climb ladderways or steps to gain access, introduces risk factors into the workplace.

Poor plant design can cause access problems and increase worker's exposure to risk.

Plant maintenance and servicing

The ability to work safely at height on plant in underground mines can be affected by:

- lighting
- access
- location of components being worked on
- availability of fit-for-purpose equipment
- quality of ventilation.

Safe systems of work should be implemented to cover the use of work baskets or fixed work platforms in underground workshops.

Where plant breaks down away from designated workshops, it may be difficult to implement these safe work procedures and a risk assessment should be undertaken to develop the safe system of work.

8.3 Risk mitigation strategies

The risk of falling or being struck by a falling object while working on or with plant should be assessed. It can be controlled through actions such as:

- applying design standards and safety criteria to plant at the purchasing stage
- providing suitable access and egress (e.g. ladderways, steps, hand rails)
- providing suitable anchorage points
- implementing a preventative maintenance program for the plant and its fittings
- ensuring the availability of fit-for-purpose equipment
- providing safe work procedures
- relocating common servicing points so they can be checked and accessed from ground level (e.g. centralised greasing point)
- in the event of a breakdown, moving machinery away from unsupported ground and open voids.

The careful design of plant can eliminate the risks of falling from height during its operation and maintenance. Where practicable, plant should be assessed before it is introduced into the workplace.

Note: Arbitrary points should not be used as anchorage points on plant. Where required, anchorage points should be designed to withstand the expected load. They should not be added to parts of plant that may be subject to fatigue loading or high stresses.

9 Fall protection

9.1 Fall protection systems

The responsible person should ensure:

- all areas where people may be required to work at height have been identified
- suitable controls have been applied following risk assessments
- as far as practicable, controls have been implemented to prevent workers from falling and being injured while working at height.

Where the hazard of working at height cannot be eliminated, a fall protection system should be used. Two systems are typically applied:

- Fall restraint – A person is physically prevented from reaching a point at which a fall is possible. This restriction in movement is usually ensured through a full body harness and either a fixed length or adjustable lanyard.
- Fall arrest – The system does not stop a worker from falling but is designed to prevent a serious injury or fatality if there is a fall. Fall arrest relies on the arrest or stop distance being shorter than the maximum height of a potential fall (i.e. fall clearance).

The decision to use fall protection and choice of system are the responsibility of mine management. If a fall protection strategy is adopted, the responsible person should ensure:

- suitable equipment is provided and used as recommended by manufacturers
- safe working procedures are available, and workers have been trained and assessed by a competent person in the procedures so they can safely carry out the particular activity.

A fall arrest system should be used instead of fall restraint if any of the following situations apply:

- the worker can reach a position where a fall is possible
- the worker is standing on unstable ground and can reach a position where a fall is possible
- there is a danger of the worker falling through the surface (e.g. grizzlies)
- there is the potential for misuse of equipment, which could lead to a free fall.

For example, when working near steeply inclined openings, a worker should wear full fall arrest equipment using the restraint technique to prevent reaching the edge (Fig. 1).

Note: Consult the AS/NZS 1891 series for further information on fall arrest systems and devices.

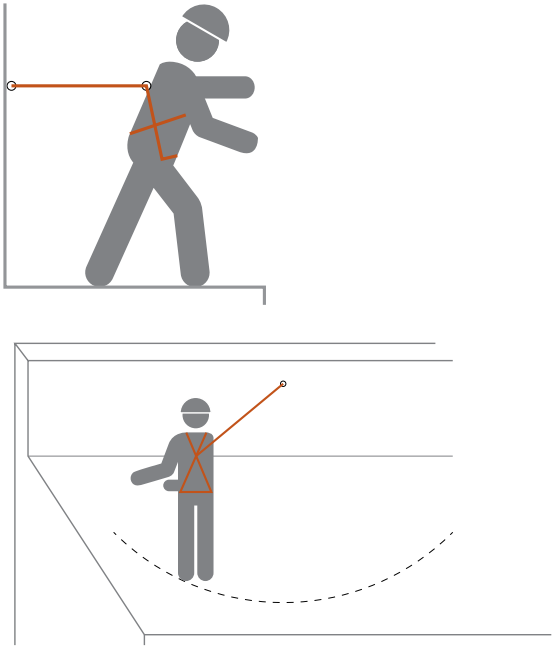

Figure 1 Examples of the restraint technique for preventing a person reaching the edge of an opening

9.2 Fall clearances

Fall clearances should be considered when selecting personal fall arrest equipment or any other working-at-height safety equipment.

The fall restraint technique requires operator competence, as well as clearly documented work procedures.

9.3 Pendulum effect

A fall may result in lateral movement or swinging, which can produce a pendulum effect, resulting in either

- the operator striking objects to one side of the fall path

  or
- snagging of the lanyard or anchorage line of a fall arrest device, reducing its effectiveness in arresting the fall.

9.4 Anchoring for fall protection

Anchorage points and the attachment method for fall protection should be selected and approved by a competent person.

Fixed anchorage points may be part of the physical environment in which a person is working, or within a designated work basket attached to a machine. All fixed anchorage points in a mine should be assessed and recorded by a competent person before being used.

However, the underground mining environment is constantly changing. Permanent and rated anchorage points (e.g. stope poles) may not be readily available, resulting in the use of adjustable, rather than fixed length lanyards. Adjustable lanyards allow workers to be correctly attached to suitable anchorage points but considerable judgement is required for their use.

A competent person should conduct a risk assessment when non-rated anchorage points are to be used (e.g. during an emergency).

An alternative to a fixed anchorage point is an anchored static line. This should be designed and installed by a licensed rigger or scaffolder because it introduces large horizontal forces that may cause the system to fail, or make rescue difficult.

Selection criteria

The choice of anchorage points depends on the working environment, how often the anchorage point will be used, and what is available or can be practically installed. The risk assessment for establishing the suitability of an anchorage point should consider:

- possible failure mechanisms that might result in a fall, including human factors
- likely distance of a fall
- swing mechanism (pendulum affect) that might apply to the anchorage point
- orientation and accessibility of the anchorage point
- physical characteristics of the worker
- potential for damage (e.g. rockfall)
- potential for deterioration (e.g. corrosion).

Correctly manufactured, rated, installed and maintained anchorage points should be used. All anchorage points should be inspected before use, with more frequent inspections for items being used under harsh conditions. Anchorage points should not be added to parts of plant that may be subject to fatigue loading or high stresses, such as rollover or falling objects protection system (i.e. ROPS or FOPS) structures.

Existing structures that may be used for anchorage points include:

- structural beams and girders
- other substantial objects.

Where mobile equipment is used for temporary anchorage points, workers should ensure:

- the equipment is fully isolated and braked, with the bucket lowered to bucket jacks if applicable and wheels chocked
- if possible, the equipment is parked into a wall or other structure to reduce the chance of it moving
- the actual point of anchor on the machine is sound and capable of withstanding the potential load.

If eye-bolts are used for anchorage points, they should be:

- installed by a competent person
- installed at an angle of at least 45° to the anticipated direction of pull – this reduces the potential for bolts to move
- inserted into the rock beyond a point where the rock strata will simply fall away – at least 600 mm depth is recommended.

The anchorage point should not damage the attachment or harness. This can be achieved using correctly sized holes with smooth edges, or holes that will not distort the attachment, which can lead to skewing of the intended load.

Potential improvised anchorage points that may be unsuitable include:

- ground reinforcement mesh – may be subject to degradation
- handrails and handrail posts – may be subject to rust degradation, lack structural strength or have unsuitable welding
- water pipes, cables, and poly pipe – may not be structurally sound or secured properly to walls
- bull bars and side rails of underground vehicles – may show signs of damage or inferior stability.

9.5 Attaching to anchorage points

The attachment is as important as selecting the anchorage point itself, and a competent person should inspect equipment to ensure that it is in a serviceable condition. This includes:

- anchorage slings that are in working condition, inspected prior to use and are rated for fall arrest
- snap-hooks that are rated for fall arrest
- lanyards that are rated for fall arrest
- karabiners that have double or triple action locking gates.

10 Training and competency

10.1 Overview

Training and competency assessment are important to ensure workers can effectively implement the site's safe systems of work. Training may be:

- formal industry-based with accredited and certificated courses
- undertaken on site while being supervised or mentored using competent trainers and assessors, with the trainer competent in the subject matter
- a combination of both approaches.

A training needs analysis will help identify the required competencies, training needs and skill gaps for the site and individual workers.

The training strategy adopted should take into account the functions of each worker, and provide them with the necessary skills and knowledge to enable them to do their work safely. Workers should understand that the prevention of falls may depend on their own actions when doing a particular work activity (e.g. using ladders, setting up equipment, using fall prevention systems).

It is essential that workers are:

- made fully aware, during their site induction, of the risks associated with working at height and the controls to be used
- regularly reminded of the risks, particularly when there are new developments or operating procedures are changed or revised.

In-house training should be specific for the mine, covering:

- the type of tasks and working environments likely to be encountered when working at height
- appropriate use of equipment provided, such as ladders and elevating work platforms
- correct use of fall prevention systems provided

as well as emphasising the importance of maintaining three points of contact when moving from one location at height to another.

Assessment of competency should be evidence based, recorded and verified before work commences.

10.2 Training in the use of fall protection systems

Where a fall protection system is used, the instruction and training given should include:

- the intended use of each piece of equipment, and how it works
- the correct selection, fitting, use, care, inspection, maintenance and storage of individual fall restraint and fall arrest components, their strengths and weaknesses, and the siting of temporary fall arrest systems
- the method to be used when carrying out a specified work task, including access and attachment method
- the risks associated with suspension trauma
- emergency rescue procedures.

11 Management and supervision

11.1 Accessing work areas

If workers are required to work in areas where there is the risk of falling, employers should provide a safe method to access and move around that work area. The tools and equipment that people will be required to carry to, from and around the work area, and areas where plant is being used, should also be considered.

Following a risk management process (see Chapter 2), management needs to establish a safe system of work for working at height underground. Matters to be considered include:

- provision of appropriate equipment and instructions for use
- assessment of competency to undertake tasks and use fall prevention systems where provided
- selection of anchorage points by a competent person in accordance with AS/NZS 1891
- securing of static lines at fixed positions for safety lanyard attachment
- installation of fixed work platforms and walkways in accordance with AS 1657
- provision of temporary work platforms
- installation of fall prevention systems
- supervision and regular inspections
- location and space required for any plant, equipment or materials used or temporarily stored
- work conditions (e.g. slippery surfaces, strong underground ventilation causing the loss of hand grip)
- assessment and management of access to and through the work area
- clearing obstructions to enable workers to move easily to and from the workplace
- adequate ventilation.

11.2 Use of fall protection systems

Where fall protection systems are used, the employer should ensure that:

- safe work practices have been adopted
- workers are trained and competent to use the system and regularly supervised in its use.

11.3 Inspection of fall arrest equipment

Each mine site should maintain a register of workers' fall arrest equipment and ensure the equipment complies with current Australian Standards. The equipment needs to be:

- inspected by a competent person trained in working at height equipment inspection in accordance with AS/NZS 1891
- assessed as fit for purpose (e.g. appropriately rated, has a current test tag)
- appropriately cleaned, maintained and stored between use.

The users of any fall arrest equipment should be competent to visually inspect the equipment before and after each use to check:

- harness stitching and webbing for signs of deterioration
- karabiners, snap hooks, lanyards and shock absorbers are in good condition
- fall indicators on the harness or fall arrest equipment are not visible (i.e. no indication of a fall)
- shock absorbers show no evidence of a fall involving the equipment.

12 Emergency response

12.1 Emergency procedures

A critical element of preparedness is the development of emergency response plans for identified emergency scenarios. Before entering the site, all workers should be familiar with the emergency response strategy to ensure they understand their responsibilities and what to do in an emergency.

To assist in the development of emergency response plans, workers should be involved in the identification and analysis of worst-case scenarios to ensure:

- engagement and commitment to managing risk
- allocation of appropriate resources and promotion of risk-reduction activities
- increased understanding of the risks associated with their work
- improved decision-making about risks and informed emergency response planning
- improved safety performance with a focus on prevention rather than response.

Useful information based on real-life emergencies may also be obtained from industry safety alerts.

Emergency procedures will vary based on the type of control measures that are used to address the fall hazard. When developing emergency procedures, consider the types of emergency and rescue worst-case scenarios that may arise. Information from risk assessments will assist with this task.

Appropriate emergency procedures and facilities, including first aid, should be available when workers are using a fall arrest system.

When establishing emergency procedures, consider:

- what emergency situations may arise
- how accessible the workplace is
- whether a person can be rescued immediately after an arrested fall

- what communication systems are available
- whether suitable rescue equipment (e.g. a rapid response kit) is immediately available
- competency of available rescuers
- what first aid equipment is available.

12.2 Training for rescues

Emergency response workers who may be part of any working-at-height rescue should be assessed as competent to the relevant national competency standards. They should be trained in the specialised rescue equipment being used, as well as appropriate first aid.

12.3 Suspension trauma

Suspension trauma, also known as orthostatic intolerance, may occur when a person has an arrested fall and is suspended in an upright position. The harness straps can put pressure on the leg veins and act like tourniquets. Blood circulation to the legs is reduced or stopped, with blood pooling in the lower legs. The decreased amount of blood returning to the heart increases the heart rate, which can lead to a heart attack. The oxygen content of the blood may decrease, leading to fainting or kidney failure or, in extreme cases, death. Heat and dehydration may exacerbate this condition. Susceptibility to suspension trauma may be unrelated to fitness or any other obvious physical conditions.

Workers and emergency response workers should be trained to recognise the risks of suspension trauma and importance of rescuing a person suspended in a full body harness as quickly as possible. For this reason, workers should be capable of conducting the rescue of a fallen worker and be familiar with the site's rescue equipment and procedures.

12.4 Reducing suspension trauma

The potential for suspension trauma as a result of an arrested fall can be reduced by ensuring that:

- the fall restraint configuration does not leave workers suspended in a harness
- workers use a harness that allows legs to be kept horizontal
- suspension after a fall is limited – there are foothold straps or some way of placing weight on the legs
- workers are trained to move their legs when hanging in a harness after a fall, including pushing against any footholds and moving their legs as high as possible
- harnesses are selected for specific applications, with consideration given to comfort, potential injuries and suspension trauma.

After ensuring that the area is safe to enter, the first priority for rescuers, even when dealing with suspected suspension trauma victims, should always be first aid techniques and requirements. The health of a fall victim should not be jeopardised by concentrating only on suspension trauma.

To minimise suspension trauma, the victim should only be moved in accordance with the latest edition of the Australian Resuscitation Council's Guideline 9.1.5 *Harness suspension trauma – First aid management*.

Emergency procedures need to be regularly tested to demonstrate their effectiveness.

Appendix 1 – Legislative provisions

The parts of the *Mines Safety and Inspection Act 1994* and Mines Safety and Inspection Regulations 1995 that are directly applicable to this guideline are listed below.

Mines Safety and Inspection Act 1994

Part 1 – Preliminary

s. 4 Terms used

Part 2, Division 2 – General duties

s. 9 Duties of employers

s. 10 Duties of employees

Mines Safety and Inspection Regulations 1995

Part 3, Division 3 – Inspection of workplaces

r. 3.21 Inspection of other underground workplaces

Part 4, Division 1 – General safety requirements

r. 4.1 Protective clothing and equipment

r. 4.4 Guards and handrails

r. 4.5 Fall arrest equipment

r. 4.10 Safety signs

r. 4.13 Induction and training of employees

r. 4.30 Preparation of emergency plan

Part 9 – Ventilation and control of dust and atmospheric contaminants

r. 9.11 Exposure standards
r. 9.12 Control of atmospheric contaminants
r. 9.14 Air in underground workplaces
r. 9.15 Air temperature
r. 9.16 Air sources
r. 9.22 Fumes from blasting
r. 9.23 Wetting down after blasting
r. 9.29 Monitoring of toxic, asphyxiant and explosive gases

Part 10 – Specific requirements for underground mines

r. 10.10 Means of entry and exit
r. 10.13 Excavations to be kept safe
r. 10.16 Levels to have safe entry
r. 10.17 Shaft entrances to be fenced
r. 10.20 Winze sinking operations
r. 10.21 Rise operations
r. 10.22 Travelling ways in shafts
r. 10.23 Travelling ways to be made safe
r. 10.25 Ladderways and footways
r. 10.26 Ladderways in shafts
r. 10.28 Geotechnical considerations
r. 10.35 Vertical opening procedure

Note: The only authorised versions of the Mines Safety and Inspection Act 1994 and regulations are those available from the State Law Publisher (www.slp.wa.gov.au), the official publisher of Western Australian legislation and statutory information.

Appendix 2 – Australian standards

AS/NZS 1418.10	*Cranes, hoists and winches – Mobile elevating work platforms*
AS 1418.17	*Cranes (including hoists and winches) – Design and construction of workboxes*
AS 1657	*Fixed platforms, walkways, stairways and ladders – Design, construction and installation*
AS/NZS 1891.1	*Industrial fall arrest systems and devices – Harnesses and ancillary equipment*
AS/NZS 1891.2	*Industrial fall arrest systems and devices – Horizontal lifeline and rail systems*
AS/NZS 1891.3	*Industrial fall arrest systems and devices – Fall arrest devices*
AS/NZS 1891.4	*Industrial fall arrest systems and devices – Selection, use and maintenance*
AS/NZS 1892.5	*Portable ladders – Selection, safe use and care*
AS 2317	*Collared eyebolts*
AS 2550.1	*Cranes, hoists and winches – Safe use – General requirements*
AS 2550.10	*Cranes, hoists and winches – Safe use – Mobile elevating work platforms*
AS 3868	*Earth-moving equipment – Design guide for access systems*
AS/NZS 4389	*Safety mesh*
AS/NZS 4488.2	*Industrial rope access systems – Selection, use and maintenance*
AS/NZS 4576	*Guidelines for scaffolding*
AS/NZS 4994	*Temporary edge protection*

AS/NZS 5532	*Manufacturing requirements for single-point anchor device used for harness-based work at height*
AS/NZS ISO 31000	*Risk management – Principles and guidelines*

Appendix 3 – Further information

Commission for Occupational Safety and Health,
www.commerce.wa.gov.au/WorkSafe

- *Prevention of falls at workplaces – code of practice*

Department of Mines and Petroleum,
www.dmp.wa.gov.au/ResourcesSafety

- *Vertical opening safety practice in underground mines – guideline*
- *Working at height – safety pamphlet*
- *Mines Safety Bulletin No. 39: Vertical opening development in underground mines (rise development)*
- *Mines Safety Significant Incident Report No. 171: Fatality after fall from cantilevered scaffold platform*
- *Mines Safety Significant Incident Report No. 166: Fall from height in a process vessel – fatal accident*
- *Mines Safety Significant Incident Report No. 164: Fall from height in an ore pass – fatal accident*
- *Mines Safety Significant Incident Report No. 159: Fall through grid mesh floor – fatal accident*
- *Mines Safety Significant Incident Report No. 158: Fall from workbasket in an underground decline*
- *Mines Safety Significant Incident Report No. 150: Failure of escape ladderway in underground rise*
- *Mines Safety Significant Incident Report No. 127: Operator tipped out of elevating work platform*

Australian Resuscitation Council,
www.resus.org.au

- *Guideline 9.1.5 Harness suspension trauma – First aid management*

National competency standards,
training.gov.au

- *RIIWHS204D – Work safely at heights (release 3)*
- *RIIUND202D – Operate from elevated work platform underground (release 1)*
- *PUASAR032A – Undertake vertical rescue (release 2)*

Safe Work Australia,
www.safeworkaustralia.gov.au

- *How to manage work health and safety risks – code of practice*
- *Managing the risk of falls at workplaces – code of practice*

Appendix 4 – Hierarchy of control

Working at height	
Elimination Eliminate the need for a person to work at height (e.g. relocate items requiring inspection or maintenance)	**Most effective control measure**
Substitution Provide alternative means of access to workplace (e.g. walkways)	
Isolation Barricade or enclose the fall risk area so that it cannot be accessed	
Other controls Where the hazard of working at height cannot be eliminated, substituted or isolated, provide safety controls to protect workers, including: • **engineering control** (e.g. fall restraint, dead-man's switch on EWP) • **administrative control** (e.g. measures to ensure that procedures, instruction, training and warning signs are in place to warn and protect workers exposed to falls) • **personal protective equipment (PPE)** (e.g. full body harness and fall arrest equipment)	**Least effective control measure**

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