Department of Natural Resources, Mines and Energy

Opal and gem miners' handbook

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Queensland Government

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1. Objective

This handbook provides operational advice that if followed can lower the risk of injury associated with small scale opal and gem mining.

2. Obligations

In many cases opal and gemstone miners work alone and may be the Holder, the Operator and the Site Senior Executive (SSE) combined. However, they must still ensure that the way they mine and the equipment they use does not pose an unacceptable level of risk to themselves or other people.

3. Risk management

Preparation and planning is the key to a safe and successful venture.

A simple way of identifying hazards is by asking yourself:

- What am I about to do?
- What could go wrong or how could I or someone else get hurt?

The answer to these questions will reveal the hazards and the risks.

Once hazards and risks have been identified, ask yourself:

- What do I need to do to stop this happening?

The answer to this question will be the control measures you must implement to prevent anyone, including yourself, from being hurt.

4. Operational advice from experienced miners

4.1. Access

Gem and opal mining often occurs in isolated places. Consider the following.

- Have a survival contingency plan in place in case of emergency.
- Know what to do if your vehicle breaks down.
- Know where to source fresh water and have sufficient water supply for an extended period.
- Have appropriate communication (two-way radio, satellite phones, etc) and a back up communication plan in case your main communication method fails, e.g. EPIRB.
- Ensure someone knows where you are and when you are expected to be back. Have a regular call in process in place, so someone knows when to raise the alarm if you do not call in within a certain time frame.
- Know your exact location. There can be a maze of dirt tracks which can be very disorientating even for the most experienced prospector. A tracking device such as a GPS can assist.
- Despite mining taking place in generally arid areas, consider the hazard of flash flooding from storm events. Creeks can rise quickly, rain may fall upstream and you can lose access.

5. Geology

An important aspect of mining safety is to have an understanding of the geology of the ground you are going to work in. It is advisable to ask local miners what the ground is like where you are considering digging.

The most productive opal deposits are often found in or near faults or joints. Even small excavations in these areas can unwittingly unlock the foot foundation of an angled fault plane which may be supporting entire sections of a pit face.

On the gemfields, there are localised areas supporting slippery backs which when dipping into the excavation are potentially very unstable.

Understanding and respecting the physical nature of the ground you are working can prevent major disasters. Slope stability in large excavations requires constant consideration and ongoing preparation.

Underground mining requires diligent inspection of roof and side walls for signs of movement and/or ground separation.

6. Surface mining

Plan your excavation. Dove tail into a wall rather than slotting and never undermine a trench or work under over hanging material.

If material is identified in a side wall you should either bench it back or batter the wall to reduce the height and increase stability.

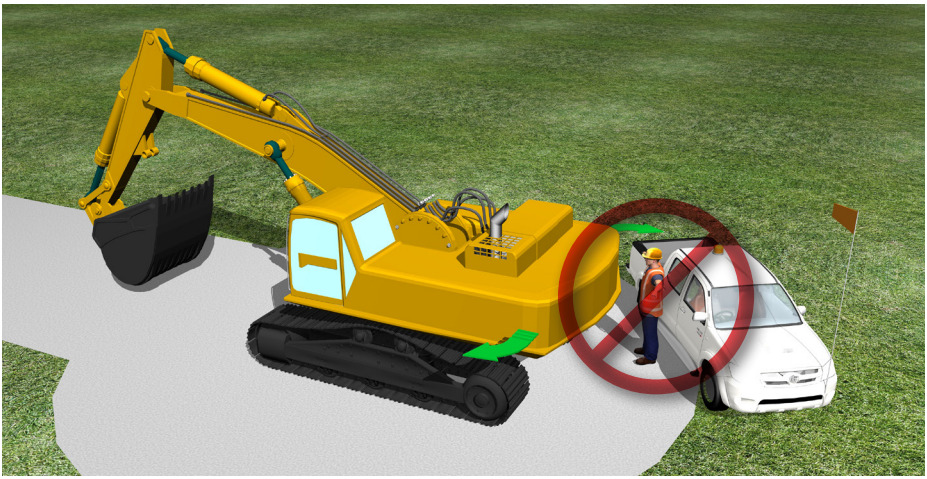
> In October 2016 an opal miner who had been working alone was found deceased in a collapsed trench at his remote mining claim. It is believed he was working with hand tools in the bottom of the trench mining into one side of the trench wall when part of the undercut section of the wall collapsed on him.

Slips are weak surfaces in the ground that may slip away. When working slips always drive up to the slip never drive along the slips.

Never trust the integrity of a standing free face, especially narrow exploration trenches.

The greatest potential for ground failure is caused by fault zones and changes in ground conditions causing instability in the ground.

Always appreciate the slew radius of an excavator, either as an operator or stone checker, to prevent crush injuries from heavy machinery. Never approach a working machine without making positive communication with the operator and being signalled into the work zone.



Stay clear of bulldozing operations. Bulldozers either ripping or pushing a full blade in a drive appear a slow as snails. However in 2nd or 3rd gear they can be quick and powerful with sharp corrections. Pedestrians and light vehicles do not mix with dozers.

Do not operate a machine with its track frame parallel to the pit face. Always approach and work perpendicular (at right angles) to the face. This keeps the operator back from the wall and provides a quick egress if necessary.

Barricade open edges.

> If working at heights above 2.4 metres or near vertical edges you must wear/use suitable fall prevention equipment.

Good housekeeping can reduce the risk of slips, trips and other incidents. Put tools and equipment back in their designated areas when you are finished with them. Clear the worksite of debris before starting work and regularly throughout operations. Clean up spills immediately, using a portable spill kit that contains materials to contain, absorb and dispose of oils, fuels and chemicals.

> A tidy miner is often the hallmark of a safe miner.

7. Underground mining

Example of a fall of ground on gemfields. Fall is from roof and sidewall contact.

For safety reasons you should have a partner when underground mining.

When first starting out in an opal or gem mining area, it is advisable to ask local miners what the ground is like where you are considering digging. Places to avoid may include:

- creeks that could cause flooding of shafts and drives
- ground that has been previously mined and has been backfilled leaving loose incompetent ground.
- areas where many old shafts/drives have been worked underground. These may have become unstable and or flooded out over the years.
- areas that are clay from the top of the ground.

If possible ask the locals if you can go underground and have a look at their mining methods and shafts/drives. This will give you a better understanding of the ground, what ground support may be required and how underground workings are ventilated.

When you have considered all of the above you will need to plan how you are going to mine.

Basic equipment may include:

- windlass
- electric/air jackhammer
- generator (kept well away from the shaft) to provide power for extension leads, lighting and mining equipment
- air compressor (for generator for air jack hammer)
- suitable ladders, etc.
- automatic hoist (up and over) for hoisting waste rock or wash.

All equipment must be checked both mechanically and electrically. Equipment should be in good working order and have been well maintained. Have a method of communications with persons on surface.

7.1. Digging the shaft

Safety helmets, steel capped boots, safety glasses and dust protection should be worn at all times.

Shafts can be dug by:

- hand, using jackhammers. The most preferred being a rectangle approximately 1m x 1.5m.
- a Caldwell drill that can drill various diameter shafts and depths. The most preferred diameter is 1m.

Drill additional shafts to allow for ventilation and emergency egress.

When the shaft is dug or drilled you need to install a collar that sits just above the surface and is deep enough to contain any loose material from falling down the shaft. The collar can also prevent the erosion of the shaft opening.

For drilled shafts, the collars are often lined with galvanised tanks with the top and bottom cut out. For hand dug shafts the collars are often made from roofing iron.

Make sure that the collars are far enough above ground to stop water going down the shaft during heavy rainfall. A good bund of dirt as a barrier around the collar can help with this.

If using a Caldwell drill rig (see photo on previous page) to excavate a secondary shaft, make sure it is drilled into virgin ground, offset from existing excavations. Drilling into an existing drive or tunnel will adversely affect ground conditions in the existing tunnels around the shaft.

7.2. Ladders

Ladders need to be safe and strong enough to support the weight of all persons going up and down the shaft, and have strength left in reserve to account for equipment being brought down the shaft and loads being hauled out of the shaft.

If the ladder styles or rungs bend during use and do not return to their original shape after the weight is taken off, the ladder design needs to be made stronger.

When removing dirt consider that the bucket may fall.

> In November 2016 an opal miner in NSW was fatally injured after being struck by a steel material hoist bucket that fell down the shaft.

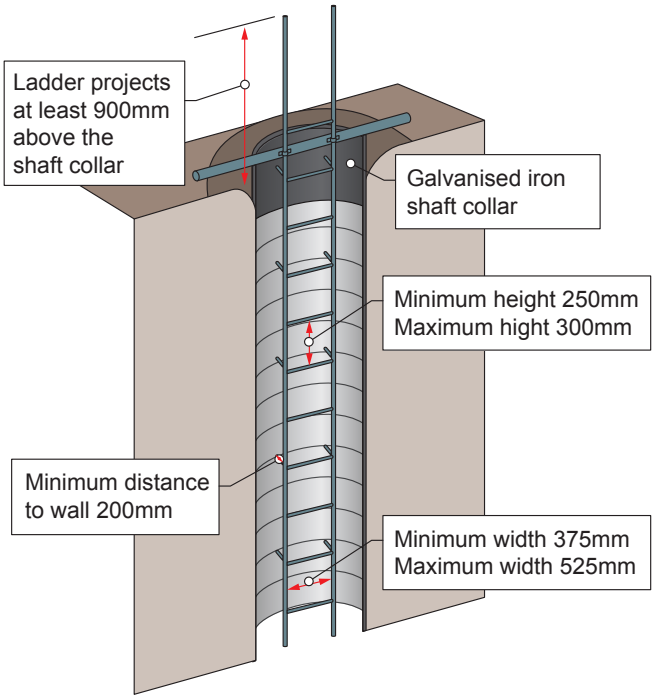
If digging by hand, you will need to attach ladders as you go. Ladders vary in length and width but all must have a suitable and fail-safe method of attachment.

If using a drill, ensure the ladders are securely pinned at regular intervals to the wall of the shaft. Ladders may be joined at the surface and then lowered into and secured to the shaft.

All persons working at the entrance to or entering the shaft must wear a safety harness securely attached to the surface.

Ensure that ladders are secure and fit for purpose. Observe the following ladder requirements:

- extend 900mm above collar of shaft
- off set and pinned 200mm off the wall
- rungs between 250mm – 300mm apart
- ladder between 375mm – 525mm wide.



Steel used for rungs and sides of ladder should have a minimum cross sectional area of 71mm³.

Rungs should be securely fastened to the stiles (sides) of the ladder.

The rocks in which gems are found often accelerate rusting, so the rungs should be completely sealed at the point where they enter into, or contact, the stiles.

The point of attachment to the stile should be smooth and free from projections liable to cause injury to the hands.

7.3. Ground conditions

You must be able to effectively ‘read’ the ground and know what ground conditions indicate the potential for ground failure.

Inspect diggings before starting operations. As you descend down the ladder you will be able to assess how stable the ground is at each level. Look for:

- movement or cracks
- loose ground may require scaling or further shoring
- any other major changes to the appearance of the ground
- water ingress after rain events.

Cracks may not always be obvious. Cracks may be very fine hairline structures that require a detailed inspection to be noticed. Once observed you must have knowledge of the ground to understand what effect the cracks may have on ground stability.

7.4. Mining a drive

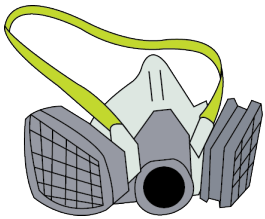
When mining underground ensure that before commencing a horizontal drive, the shaft is in consolidated competent ground.

- Establish a mine plan of the underground drives, using the centre of the access shaft as the reference for compass bearing and distance. The plan is to be kept on the surface in a visible location.
- The minimum depth from the surface to the roof of the drive is considered 4 metres when the ground is competent and less weathered.
- The width and height of a drive must allow reasonable access for a person at all times.
- A second means of egress should be available at all times when working underground.
- When mining out a drive wider than the normal width consideration must be given to the use of ground support (such as props with headboards, pillars, backfill) given the wider excavation span.

You will need to bring all tools and equipment for underground mining through the drive, including:

- extension leads
- suitable lighting
- fans to circulate the air
- potable water
- basic first aid kit
- mining equipment.

You will be breaking rock that is likely to be silica bearing, and creating dust that may not be visible to the naked eye. Therefore, wearing a suitable dust mask is essential.



It is critical to maintain a suitably sized pillar around the shaft and between drives at all times as this assists in stabilising the ground.

Always try and determine if there are any old workings in the area you're mining as mining into unconsolidated fill can result in engulfment.

Over mining can result in belling out or a ballroom developed. Ground support will be required when spans increase. Wider spans are more likely to fail. Appropriate ground support must be installed to prevent ground failure.

> If you have any concerns that the area you are working in is unsafe or unstable, pull out, reassess and make the working safe before going back in to work. It is "Better to be Safe than Sorry".

7.5. Ventilation

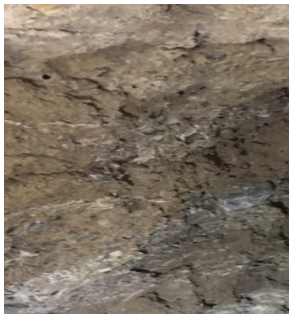
When working underground you will need to dig or drill another shaft, mainly for emergency egress and ventilation. The use of fans will aid in circulating air throughout the drives. Further holes can also help in this. You must ensure that the air is moved through the mine without re-circulation and that every part of the underground workings in supplied with fresh air.

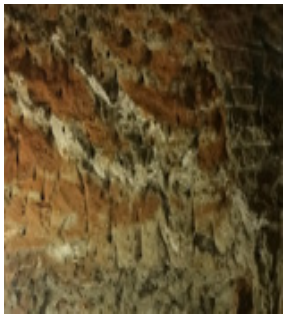
Flush out old workings, or working that have not been used for some time, with fresh air from the surface before entering.

7.6. Safety aspects to look for while digging drives

Whenever you are mining, you should conduct a thorough inspection to identify such things as:

- cracks appearing in the ceiling, these can be hairline or wider and if left unmanaged can become dangerous



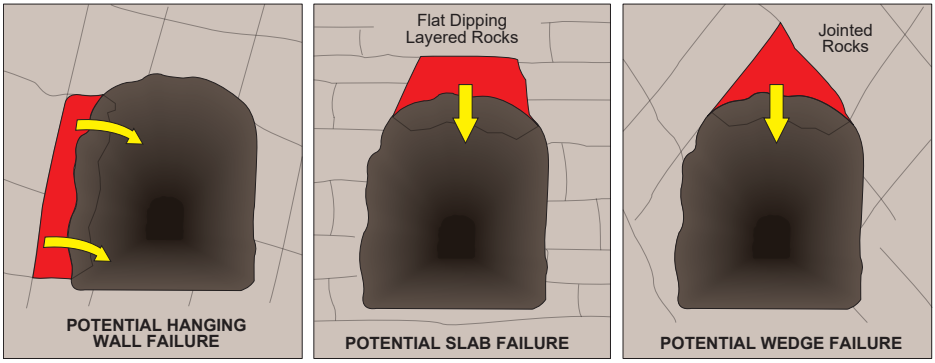


Cracks may be very fine and hard to see yet indicate the potential for a rock fall.

- slips or slides in the clay. These occur due to slight moisture and can result in large blocks of clay falling out from the wall of the drive. Gaps can sometimes appear between the clay and the ironstone horizon and can mean that a slip and/or slide is giving way or it is just the drying out of the clay. Using the jackhammer to dig some of the clay away will show whether it is drying out or there is clay about to give way

Example of exfoliating ground that needs to be brought down - gemfields.

- a weak layer such as clay or structure may be parallel to the wall or roof making it hard to recognise the potential for the rocks to fall



- a wedge of rock may fall when two weak surfaces intersect.
- moisture in the ground.
- undercutting of sidewalls that create a brow/overhang
- evidence of entry into workings by snakes
- thorough inspection of ground conditions following rain events.

7.7. Daily checks

Fully check the operation of all above ground equipment, including windlass/auto hoist and wire ropes (cables).

Run the generator and check wiring and leads. Check and test ladders before and as you descend, to ensure they are fully secured to the wall of the shaft.

When underground do a thorough check of mining equipment, drives and pillars for any noticeable changes, ventilation and moisture.

Check for cracks in the ground or areas of fallen rocks.

NOTE: Nip point guarding required

Most aspects of safety are common sense. If good practices are adhered to you should have a safe and rewarding experience.

8. Additional operational advice

8.1. Communication

- Establish and maintain a method of communication with the surface.
- Test communications regularly.

8.2. Accessing shafts

- Do not carry things while climbing ladders or accessing and egressing earthmoving equipment.
- Shafts should have barricades and edge protection and a method to securely cover and lock when not in use.

8.3. Flooding

- Install a collar ring that extends at least 500mm above the shaft entry.
- Profile the ground around all shafts so that water does not pool and is diverted away from the shaft.
- Make bund walls around the claim to stop flooding, where necessary.
- Be aware of the extent of surrounding workings and that these may contain water.
- Seek advice and information on the extent and locations of flooding that may occur in the area you are working.
- Avoid sinking shafts or excavating in water courses or flood prone areas.

8.4. Hydraulic pressure

- Turn off and bleed hydraulic lines before working on them.
- Isolate plant using locks and tags.
- Never use hands or fingers when looking for a hydraulic leak.
- Always wear eye protection when looking for a hydraulic leak.
- Ensure hoses and fittings are rated for the correct pressure.
- Never stand under an elevated boom or bucket.
- Always have the safety pins in place on quick hitch attachments.

8.5. Tyre pressure

- Always deflate tyres before working on them.
- Deflate both tyres if working on dual wheels.
- When inflating tyres, establish an exclusion zone and stand clear and to the side of the tyre. Think about where the pieces of rim and tyre might go if it bursts.
- Only suitably qualified personnel should conduct work on earthmover wheels tyres and rims.
- When removing a wheel always ensure there is a fail-safe jack/ support system in place.

8.6. Air pressure

- Maintain and check pressure gauges and relief valves.
- Never replace a relief valve with a bung or other blanking device, and never wind down the spring on a relief valve if it is leaking.
- Ensure hoses and fittings are correctly rated for the pressure.
- Regularly drain air receivers and tanks to get rid of water that causes corrosion.
- Before working on any air system components ensure they are turned off and depressurised.
- Isolate the plant using locks and tags.
- Ensure couplings and joiners are secure. Use pins or clips.

8.7. Gas cylinders

- Ensure gas cylinders are stored upright, secured and out of direct sunlight in a well ventilated area.
- Turn off when not in use.
- Check gauges, regulators and hoses regularly.
- Always use flash back arrestors on both the oxy and acetylene.
- Do not use or store LPG cylinders indoors.

8.8. Electricity

- Where possible use battery powered tools.
- Only qualified persons are to undertake work on electrical equipment.
- Ensure that earth leakage\safety switches are installed on all circuits.
- Regularly test safety switches.
- Run leads so that they are protected from damage, off the ground and away from water and wet areas.
- Check and inspect electrical equipment, leads and plugs prior to use. Replace any that are found to be damaged.
- Large generators that supply a switch board must have an earth stake.
- Smaller generators can have an earth stake or be bonded to main metal structures joining into the mine (ladder) and generator frame.

8.9. Mobile plant

Conduct a prestart check on equipment at least daily. Check and test (as applicable):

- brakes (including emergency brakes) using the OEM brake test procedure
- steering
- safety features
- emergency stops
- guards
- hoist/winch ropes
- attachment security and operations.

Do not use mobile plant unless the brakes and steering are operational and effective.

Ensure that any maintenance and repairs to plant and equipment is done to OEM standards and is recorded.

8.10. Winches and hoists

Never use winches and hoists for man riding unless they are specifically designed and engineered for that purpose.

If winches and hoists are used in the main access shaft, a second means of egress that is independent of this shaft must be established.

Only use wire rope grips (bulldog clamps) for temporary use on wire ropes. Better attachments are available and damage the rope less, such as wedge capels, wedge sockets and swaged fittings.

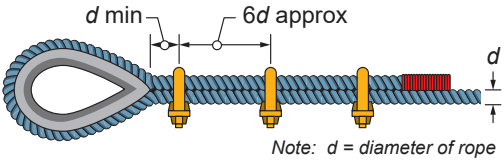
> For advice and examples of the most suitable equipment to use, talk to an experienced rigger and have a look at what is available from lifting equipment suppliers.

If you are using bulldog clamps on wire rope, use at least 3 installed 50mm apart. The clamp portion must be on the live rope and not the tail (refer diagram).

> Use a thimble to protect the end of the rope from damage at the connection as you are hoisting.

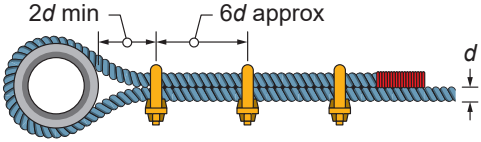
Ensure wire ropes are installed, inspected and maintained as per the manufacturer's recommendation.

Be careful when installing and cutting wire ropes – do not let them unravel. Use clamps or thin wire binding (seizing) to keep them together at the end when cutting or installing on a winch (see below)

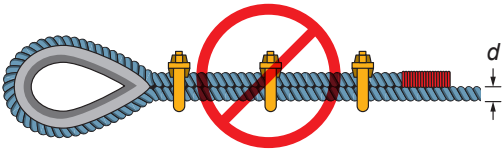


Note: d = diameter of rope

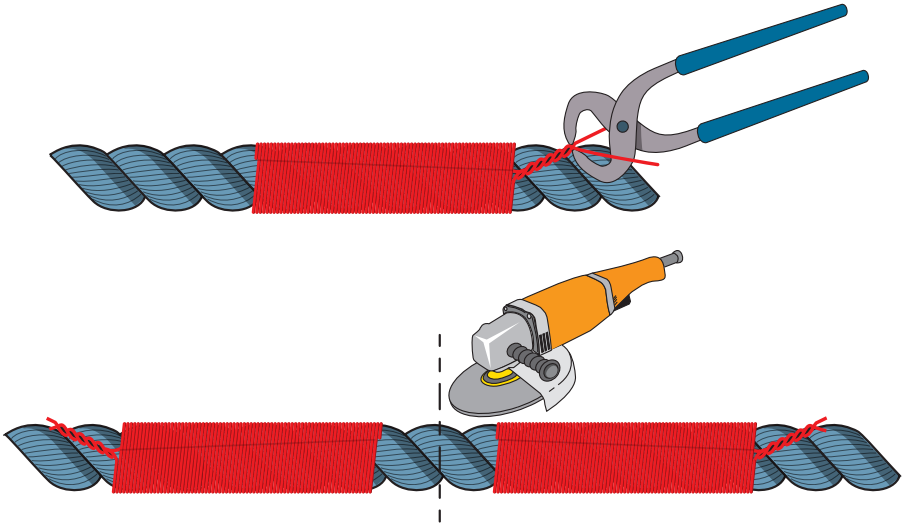
Correct method of fitting wire rope grips (normal thimble)



Correct method of fitting wire rope grips (rounded thimble)



Incorrect method of fitting wire rope grips



Stopping a rope unravelling when cutting - example using thin wire seizing wrapped tightly around the rope - taken from AS 2759-2004.

8.11. Load shifting using mobile plant

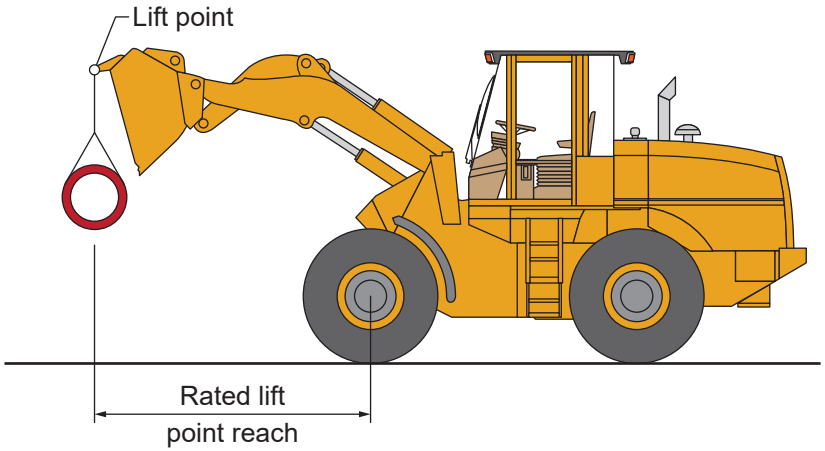
Lift points should only be fitted to ‘pinned’ front-end loader buckets. Lifting points should not be attached to quick-hitch buckets designed for excavators, front-end loaders or backhoes.

The rated capacity at each lifting point should be prominently marked at the lifting point.

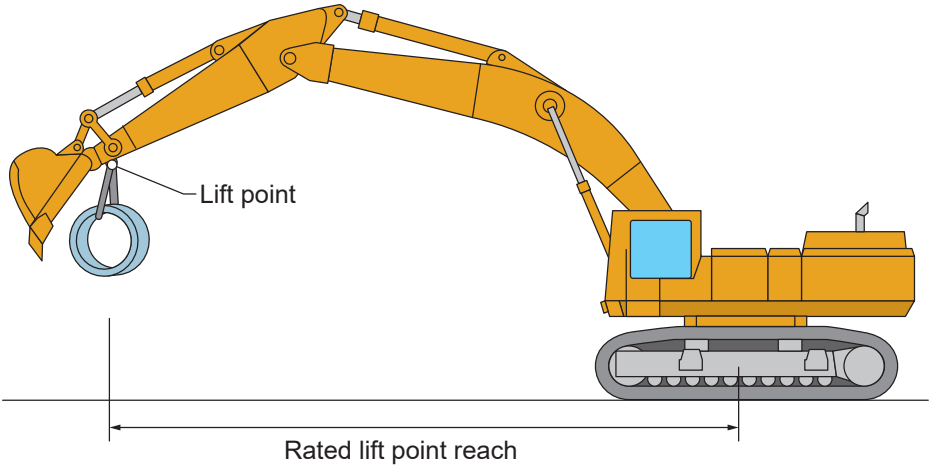
Lifting points on earthmoving plant should form a closed eye to which a load rated shackle may be attached. Do not use hooks.

Earthmoving equipment that is used to lift freely suspended loads should be fitted with a controlled lowering device (hose burst protection) on the raising boom cylinder/s.

Typical lifting points on mobile equipment are shown in the following diagrams.



Typical lift point reach diagram for non-slewing machine with bucket attached



Typical lift point reach diagram for slewing machine with bucket attached

8.12. Pedestrians near mobile plant

Never allow personnel to be on foot in areas where mobile equipment is operating.

If personnel do enter an area where equipment is operating, stop the equipment and lower all implements.

Operators and persons on foot must have a communication method or set of agreed signals between them. These are to be agreed upon and confirmed before operations start.

8.13. Rotating machinery

Ensure that guards are installed on all pulleys, flywheels and rotating equipment. If someone can access the rotating parts of a machine, they can get pinched or even dragged in.

Stop, isolate and lockout equipment before conducting any maintenance, repairs or adjustments.

8.14. Fumes

Fumes include equipment emissions, smoke and gaseous chemicals.

- Test the atmosphere before entering a confined space.
- Never use petrol motors underground or in confined spaces.
- Position petrol motor driven equipment well away from shafts and mine ventilation points.
- Establish and use mechanical ventilation devices to provide adequate ventilation flow in underground workings .
- Always ventilate old underground workings before entering them.

8.15. Dust and Respirable Crystalline Silica

Respirable dust is dust that is small enough to penetrate the very small breathing vessels within the lungs.

Respirable crystalline silica (RCS) is a type of respirable dust that contains crystalline silica.

The most predominant form of crystalline silica is quartz. In sufficient quantity, RCS can cause silicosis, an irreversible and progressive condition in which healthy lung tissue is replaced with fibrous scar tissue. Silicosis can be fatal.

The following actions can help to minimise the risks associated with dust and RCS.

- Ensure mobile plant cabins are well sealed.
- Have mobile plant air conditioner filters cleaned regularly.
- Never use compressed air to blow out filters, clean out vehicles or blow dust off clothes.
- Wear a well-fitting respirator (type P2 minimum).
- Install plant so prevailing winds blow dust away from work areas.
- Install dust extractors where possible.
- If water is available, use spays to suppress dust.
- In underground workings, keep ground that is to be worked damp or moist.

8.16. Heat and extreme weather

- Monitor weather conditions and plan work activities to suit the conditions.
- Understand the signs and symptoms of heat stress/stoke and take early action.
- Ensure that you have adequate water supplies and drink plenty of water. Australian National Health and Medical Research Council recommends that the average woman drinks 2.1 litres a day, while the average man should consume 2.6 litres a day. Increase your water consumption if you are working in hot and humid conditions.
- Pace your work according to the environmental conditions and how you are feeling.
- Ensure that you take regular breaks away from the hot environment.

8.17. Explosives

Only a licenced Shotfirer can transport, handle, use and store explosives

If firing on the surface:

- determine a safe exclusion area that considers the potential for fly rock
- notify neighbours of the intended blast
- ensure all accesses are guarded before, during and immediately after blasting (until the Shotfirer gives the all clear). Do not let anyone enter the exclusion area during this time
- check the exclusion zone is free of people and equipment immediately before blasting

If firing underground, ensure:

- no one is underground when blasting takes place
- underground workings are well ventilated prior to re-entry after blasting

When a misfire (i.e. a shot or any part of a round of shots fails to explode) is suspected, persons should not enter the blast area until at least 30 minutes after the time of firing.

9. Operational competency

Personnel who undertake mining activities must have adequate knowledge, skills and understanding of the mining methods for both surface and underground mining, handling of materials and operation of plant.

All personnel who use and operate mobile equipment must be trained and competent in its safe use.

Personnel who carry out repairs and maintenance must be competent to ensure that plant is serviced and maintained so it is capable of performing its intended function and is within the condition and performance limits of its specifications.

10. Emergencies

Even with proper planning, things can still go wrong. Are you prepared for an emergency situation?

Ask yourself the following questions.

- Who knows where you are what you are doing?
- Does someone know how long you will be there?
- How will someone know that you need assistance?
- Who will they tell if something goes wrong?
- How will someone find you or get to you in an emergency?

The following precautions are the minimum requirements to prepare yourself for an emergency.

- Have a contact person above ground, who knows enough information so that help can be sent to you if needed, including:
  - your intended activities and location/s
  - an up-to-date underground plan
  - how long you will be there
  - what to do and who to contact to initiate an emergency
- Establish a communication/contact schedule with your contact person
- Install a sign or notice at the surface if you are working underground.
- Have a reliable method of communication and a back up method in case the first one fails
- Carry and use an EPIRB
- Maintain a well-equipped first aid kit
- Undertake a first aid course
- Ensure that you have fire extinguishers in your mobile equipment and at your camp.

11. Incident and accident reporting

The *Mining and Quarrying Safety and Health Act 1999* (Qld) requires the Senior Site Executive to report fatalities, serious accidents (person had to go to hospital) and high potential incidents to an Inspector of Mines. The on call numbers and notification details are shown below.

Region/District	On call/Emergency Phone	Email for written notice
North Region: Townsville	(07) 4447 9282	tsvmines@dnrme.qld.gov.au
North West Region: Mount Isa	(07) 4747 2151	isamines@dnrme.qld.gov.au
South Region	(07) 3330 4273	sthmines@dnrme.qld.gov.au

If you are not sure if you should report something, call an Inspector of Mines on the on-call number and they will advise you.

12. Cessation of mining (seasonal) and mine closure

You must make your mine safe and secure when you are away from the site. This applies whether your absence is of short duration or for longer periods and when you have finished mining and will not come back to the mine.

Your method for making the site safe will need to take into account:

- people, including visitors, fossickers, tourists and station owners
- livestock and other animals
- securing shafts and voids.

The following requirements are the minimum for when you have finished mining and will not come back due to closure, surrender or abandonment:

- comply with requirements of the Environmental Authority
- backfill shafts, trenches and voids
- profile the walls of open cut workings
- establish bunding where there is a risk of falling more than 2.4 metres.

Notes

Notes

www.dnrme.qld.gov.au

13QGOV (13 74 68)

Queensland Government