

SECTORAL ACTIVITIES PROGRAMME
WORKING PAPER (WP.168)

Safety & health in small-scale surface mines

A handbook

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Preface

Occupational safety and health (OSH) are important issues for the world's 13 million or so small-scale miners — many of whom work in surface mines — and their communities.

Progress in dealing with diseases and accidents affecting small-scale miners will require a better understanding of the risks and hazards and of the practices and behaviour to prevent them. Better data will also be required for improvement programmes to be targeted. This will mean having a simple form for reporting accidents and disease — something recommended in this handbook.

OSH regulations might need to be revised to ensure that the special requirements of small-scale miners are adequately covered. This handbook sets out some basic principles for use in the absence of specific regulations, or in conjunction with them.

Mines' inspectorates can play an important role in overseeing OSH in small-scale mines and in providing advice, as well as policing regulations. We hope that this handbook will be of use to them in their important task.

Both mine owners/concession holders and mineworkers must be helped to realize that accident prevention and improved occupational health are worth obtaining and worth keeping. Education, training, demonstration and surveillance are the keys to improving OSH in small-scale mining. But this is well known. The purpose of this handbook is to make a practical contribution to this process.

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Oscar de Vries Reilingh
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1. Objectives, scope and definitions

Objectives

The objectives of this handbook are:

- To protect workers in small-scale surface (open-pit) mines from safety and health hazards and risks in their work.
- To prevent or reduce the incidence and severity of illness and injury in small-scale surface mines.
- To promote training and consultation in improving safety and health in small-scale surface mines.

Good standards of safety and health can only be achieved if everyone is competent for the work they have to do and all work together, effectively, as a team.

Scope

The following guidelines apply to any situation or operation that affects the safety and health of those involved in small-scale surface mines. They are for mining operators, supervisors and mineworkers.

The guidelines set out the basic requirements for protecting workers' safety and health and contain recommendations on good mining practices to be followed in order to protect safety and health.

This handbook is not intended to replace applicable laws, regulations or accepted standards that set out higher requirements.

Definitions

Surface mine means an excavation in the earth conducted above ground (open-pit mine) for the purpose of opening-up, proving or producing any mineral from a natural deposit. It includes all facilities belonging to or used in connection with the mine.

Mining authority means a government institution that is responsible for all or any part of occupational safety and health in mining.

Mine operator means any individual or organization who operates, controls or supervises a mine, as an owner or lessee.

Competent person means a person who, in the opinion of the mine operator and the mining authority, has adequate qualifications, such as suitable training and sufficient knowledge and skill, for the design, organization, supervision and safe performance of the duties for which he or she is appointed.

Hazard means the potential to cause injury or damage to the health of people.

Risk means the likelihood that something will occur causing injury or damage to the health of people.

2. General principles

The application of these guidelines should take into account the following steps, ***in order of priority***:

- Eliminating the risk.
- Controlling the risk at source.
- Minimizing the risk.
- Using personal protective equipment.

Safety inspections should be carried out at regular intervals.

Convention on Safety and Health in Mines

The ILO's Convention on Safety and Health in Mines, 1995 (No. 176) covers *all* mines. It provides a floor — the minimum safety requirement against which all changes to mine operations should be measured. The accompanying Recommendation (No. 183) — which is advisory — provides more specific guidance on the different sections of the Convention.

The Convention sets out procedures for reporting and investigating accidents and dangerous occurrences in mines. Governments that ratify it undertake to adopt legislation for its implementation, including the designation of the competent authority to monitor and regulate the various aspects of safety and health in mines.

More specific guidelines on safety and health in surface mines, mainly for larger scale operations, can be found in the ILO's *Code of practice on safety and health in opencast mines*.

3. General provisions

Duties of the mine operator

The mine operator should:

- Notify the mining authority before starting operations at any mine and before discontinuing or abandoning any existing mining activity.
- Provide all the equipment, apparatus, facilities and finance to ensure, as far as reasonably practicable, good mining practice and an appropriate standard of occupational safety and health at the mine.
- Make sure everyone understands their safety and health responsibilities.
- Appoint, depending upon the number of mineworkers employed and the nature and extent of mining operations, one or more competent persons — supervisor — to supervise and control the operations at the mine.
- Encourage the workforce to be actively involved in safety and health.

Requirements for employment in surface mines

Work in a surface mine often has to be performed in a hostile and dangerous environment. It can be made safe and productive by continual human effort. Such efforts cannot succeed unless all workers have certain skills and a good knowledge of possible hazards and risks.

It is therefore vital to have competent and experienced persons who should be constantly on the site of the mine to supervise and control the operations and carry out regular inspections.

Supervisors should have immediate charge of all persons employed within the mine area of operation and should be responsible for the safety, health and welfare of all persons assigned to them.

Each newly recruited mineworker should receive instructions, guidance and supervision in their respective work from the supervisor and

adequate on-the-job training before being starting work. This instruction should include :

- Introduction to the working environment.
- Health and safety aspects of the task to be assigned.
- Hazard recognition and avoidance.
- Hazards relating to explosives.
- Ground control and working in areas of high walls.
- Hazards of machinery and equipment.
- Basic knowledge of first aid.

No mineworker should be assigned to work alone in a remote place or where a hazard might exist.

Obligations of mineworkers

No mineworker should take any action at work which could cause danger to other workers, damage to mining equipment or obstruct production.

Every worker should fully comply with rules or instructions issued by the mine operator and should make proper use of and take reasonable care of any personal equipment provided for his protection.

Action to prevent danger

Every mineworker while at work should:

- Take reasonable care for the safety and health of himself or herself and of other persons who may be affected by their acts or omissions.

-
- Comply with instructions given for his own safety and health and those of others.
 - Report immediately to the supervisor any situation which he or she considers hazardous and which he or she cannot correct themselves. If this measure cannot be taken, the mineworker should immediately warn all workers who could be in danger.
 - Report any accident, injury or dangerous occurrence which arises in the course of or in connection with work.

Every mineworker should leave the area as soon as possible after being warned of danger, except for rescue or first-aid workers who may be required to assist in rescue work.

Mine facilities

As far as possible, at or near every site where mining is regularly carried out, there should be:

- A clearly marked storage facility for first-aid equipment.
- Somewhere to store safety and personal protection equipment.
- Secure storage for explosives and shot-firing equipment.
- Somewhere to store mining tools and equipment.
- Adequate washing, sanitary and changing facilities.
- Adequate accommodation for mineworkers when mining operations are located in remote areas.

Relations between the mine owner/operator and the workforce should be based on regular consultation, consensus, and fairness.

4. Mining accidents and dangerous occurrences

Definitions

Mining accident means any occupational injury to any person as a result of mining work within the area of mining activity, for which medical treatment is administered or which results in loss of consciousness or death.

Dangerous occurrence means any unplanned event at any mine that has the potential to cause an injury or disease to persons at work.

A dangerous occurrence could be an event that:

- Substantially affects regular mining activity, such as: land slides; collapse of the working face; major fall of rock; inrush of water into the mine; the unintentional ignition or detonation of explosives.
- Causes damage to or disrupts the operation of any vital mining machinery or equipment, such as: explosion; fire; bursting of a pressure vessel.
- Requires the withdrawal of miners or any other emergency action.
- Endangers any individual at the mine.

Response to mining accidents and dangerous occurrences

At any mine where an accident or dangerous occurrence takes place, the mine operator should ensure that:

- The necessary steps are taken to evacuate and treat injured mineworkers and immediate action is taken to prevent further danger arising from the event.
- An investigation into the cause of the mining accident or dangerous occurrence is carried out and preventive action is taken to avoid similar events in the future.

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- The result of the investigation is recorded in a book provided for that purpose and the mining authority is notified about the event.

After a mining accident or dangerous occurrence, the mining authority should assist the mine to ensure that improved practice will prevent it from happening again.

5. Hazards in the working environment

In the working environment of a surface mine airborne contaminants (such as rock dust and fumes), excessive noise, vibration, heat stress and ergonomic problems can create health risks to mineworkers who are subject to frequent and prolonged exposure to them.

Dust and fumes

Dust

Airborne contaminants, such as rock dust, are mainly produced during drilling operations, mineral getting, loading, crushing of rock or ore, and blasting. Persons exposed to excessive dust for prolonged periods may suffer from permanent lung diseases, such as silicosis.

As far as practicable, the escape of dust into the atmosphere should be prevented, particularly in stagnant zones.

Dust should be controlled or suppressed by:

- Using wet drilling techniques.
- Using water sprays during mineral getting, loading, crushing.

In general, any stone surface being worked should be kept moist to reduce the escape of dust into the atmosphere.

Where such dust control measures are not provided or have not been developed, mineworkers exposed to excessive dust concentrations in their working environment should always use personal protective equipment, such as dust masks, to prevent dust from being inhaled.



Use water to suppress dust and/or wear a dust mask.

Harmful fumes

Fumes, produced during shot-firing operations contain toxic gases (such as sulphur dioxide, nitrous oxide, nitric oxide, etc.) which, when inhaled, can lead to serious health damage.

Mineworkers should not approach a working face after shot-firing until the dust and gaseous products of the blast have completely dissipated.

The exhaust from diesel engines also contains harmful fumes, including very fine, respirable particles. Frequent and prolonged exposure to diesel exhaust is a health risk and should be prevented.

As far as practicable, stationary diesel equipment should not be operated in stagnant zones or close to workplaces.

Simple dust masks do not protect against toxic gases which are present in after-blast fumes or in diesel exhaust fumes.

Persons should not work or travel where hazards may be created as a result of impaired visibility due to dust or fumes.

Noise

Repeated or prolonged exposure to excessive noise levels will lead to hearing impairment.

Potential sources of noise emissions include compressors, drilling machines, pick-hammers or other mechanical equipment used at a mine.

Wherever possible, such noise sources should be muffled with an effective acoustic absorbing material so as to reduce noise emissions to tolerable levels. Increasing the distance between the noise source and the listener is often a practical method of noise control.

Where such noise control measures are not possible, comfortable and practical personal hearing protection devices, such as approved ear plugs or ear muffs, should be worn by every person exposed to noise levels exceeding 90 dbA.

Since the sound pressure of pick-hammers or drilling machines normally exceeds acceptable levels, every person working with or in the vicinity of such devices should always use ear protection.

Loud noise at work can damage hearing.



Use ear protection when near excessive noise levels.

Vibration

Workers operating hand-held machinery, especially pneumatic rock drills and pick-hammers — even for one hour a day — can suffer from the effects of vibration in their hands and arms.

Vibration White Finger (VWF) or “dead finger” starts when the fingers become numb.

VWF can lead to gangrene.

There is no cure for Vibration White Finger.

Prevention and control of Vibration White Finger

- Avoid long periods using equipment. Work in short bursts.
- Use modern, vibration-dampened equipment.
- Repair or replace old equipment or fit anti-vibration handles.
- Grip handles as lightly as possible.
- Support heavy tools so that a lighter grip can be used.
- Maintain vibrating tools to minimize vibration levels.

There is no personal protective equipment that has proved to be effective against hand and arm vibration syndrome.

Heat stress

Workers should be informed of the nature of heat stress and its adverse effects, as well as of protective measures. They should be taught that heat tolerance is very dependent on drinking enough water (not merely satisfying thirst (and eating a balanced diet.

Workers should also be taught the signs and symptoms of heat disorders (e.g. dizziness, faintness, breathlessness, palpitations, and extreme thirst).

Workers should have ready access to water or other appropriate drinks which encourage re-hydration. Carbonated drinks and drinks containing caffeine and heavy concentrations of sugar or salt should not be offered.

Safe, potable water should be located within close to each worker or brought to the worker every hour.

Clean cups should be provided and water containers should be shaded or cooled to 15-20°C.

Modified work practices can reduce the likelihood of heat stress — e.g. by reducing individual workload through the provision of tools or task-sharing, or by scheduling appropriate breaks.

Ergonomics

Many aspects of mining work carry risk of injury to the upper and lower limbs or spine, either because of the manual handling tasks involved or because of awkward postures.

Basic ergonomic requirements should be considered, including work-place layout, design of equipment and tools, working techniques, working time and rest patterns.

Patterns of movement

- Avoid crooked or twisted positions.
- Aim for rhythmical movements but avoid monotonous ones.
- Horizontal movements are easier to control than vertical ones.
- Avoid reaching out any further than necessary.
- Try to keep movements symmetrical when working with both hands.

Using strength

- Dynamic actions are preferable to static ones.
- Find a movement in which there is sufficient strength to carry out a task, or redesign the task.
- For each system of joints, bones, muscles and tendons, there is a range of movements which can be carried out most efficiently. Tasks should use this range of movements.
- The heavier the load that is carried in front of the body, the closer it should be to the body.

The main causes of injury are heavy loads, awkward working positions, repetition, working under pressure.

6. Health, welfare and hygiene of mineworkers

The mine operator should make such provisions as may be necessary to ensure appropriate health care, welfare and hygiene of mineworkers.

Health care

The health of mineworkers should be checked by a competent physician before being assigned to work in a mine for the first time. Periodic health examinations should also be arranged, especially for workers in places where the material handled or the process could be hazardous to health.

A mineworker who is ill or in any way incapable of normal activity should not be allowed to work.

Changing and bathing facilities

Where possible, the mine owner should provide adequate facilities at the mine site for the changing, storage and washing of clothes and for bathing by mineworkers. Water supplied for washing and bathing should be of sufficient purity and must not come from a sump that is part of the works, unless it has been suitably treated. Waste water should pass straight to a drainage system.

Sanitary facilities

The mine owner should ensure that surface mine works are equipped with latrines and urinals that are located and fitted out in such a way as not to spread odours.

They should be installed so that they do not pollute the working environment — such as in inactive workings.

Latrines and urinals should always be kept clean and disinfected. Other places than the latrines should not be used for such purposes.

Drinking water

A mineworker should never drink mine water.

An adequate supply of potable drinking water should be provided at all main work sites during working hours.

If it is safe to drink from wells on site, they should be located so that they will not be contaminated by waste water from the mine (e.g. outside the mining area, higher than the mine drainage level).

Drinking containers should be dust proof and kept closed when not in use. Drinking water should not be contaminated in any way.

Areas for food

Food should not be stored or consumed in any area that is exposed to hazardous material, vapour or dust.

Food should be stored and consumed in clean, sheltered places. Rest stations may be established for that purpose.

Intoxicating beverages and narcotics

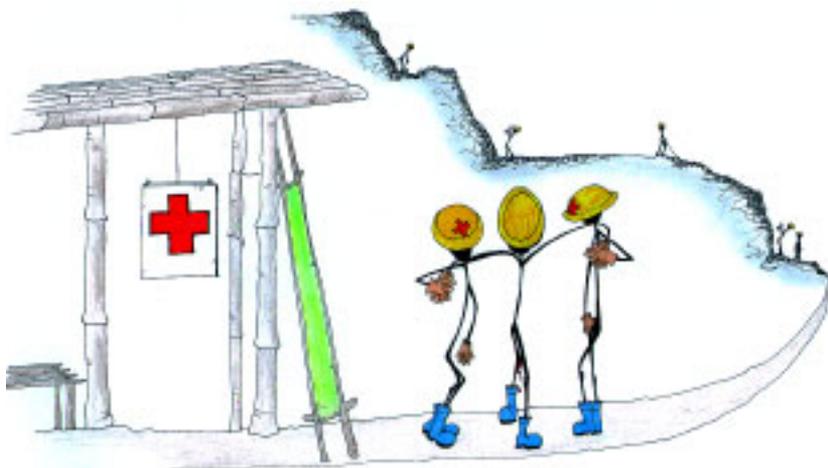
Intoxicating beverages and narcotics should not be permitted or used in or around mines. Persons appearing to be under the influence of alcohol or narcotics should not be allowed to work.

7. First aid

Workers and supervisors should be able to respond quickly to incidents and accidents and provide basic first aid and treatment to injured persons.

Rapid first-aid treatment can prevent further serious health damage or even loss of life to injured persons.

The mining operator should ensure that suitable, regularly replenished and properly maintained first-aid kit is provided at a strategic location where mining operations are performed. The first-aid kit should be easily accessible and ready for use at any time while any person is at work.



Have people trained in first aid.

The **minimum** equipment required to ensure adequate first-aid treatment should include:

- a stretcher for transporting persons unable to walk;
- a blanket for persons in shock;
- sufficient bandages and sterile dressings for open wounds on limbs, body and head;
- splints for fractures of limbs;
- disinfectants;
- any other first-aid material that may be required due to the nature of work and recommended by a competent physician.

Every effort should be made to ensure that at least one employee is trained in first-aid applications (the mining authority should provide first-aid training) who should be on site while mining activity is carried out.

Action following a mining accident

At any mine where there has been an accident, the necessary measures should be immediately taken to:

- Remove injured mineworkers to a safe place for first-aid treatment.
- Eliminate further danger arising from the event.

Any worker involved in rescue operations should take reasonable care for the safety and health of himself or herself and not endanger themselves by rash action where there are unknown risks.

No person should be allowed to enter the area where there has been an accident, except when it has been made safe and express permission is given by a competent person.

Every injury to a mineworker, however small, should be reported to the person in charge of first aid at the mine for checking up and treatment before the injured person returns to work or leaves the mine.

Arrangements should be made for transporting injured or sick persons to a hospital or other suitable medical facility, for example through cooperation between mine sites in close proximity.

8. Personal protective equipment

The mine operator should provide, free of charge, the personal protective equipment that is to be worn when hazards cannot be eliminated — and ensure that it is worn properly and maintained in good condition.

The basic personal protective equipment should be:



← *safety helmet* (hard hat) where falling objects might create a hazard.

← *protective gloves* when handling materials or performing work which might cause injury to the hands.

← *suitable protective footwear* (e.g. safety shoes or rubber boots) where there is a danger of slipping or of injury to the feet.

Hat, gloves, boots: wear them always.

This minimum standard protection should be worn at all times in and around the mine.

Additional protective equipment should be used as required.



← hearing protection where excessive noise levels are produced (e.g. where compressors, drilling machines or pick-hammers are used).



← *dust mask* where excessive airborne dust is produced (e.g. during drilling or rock-breaking).



← *safety glasses/goggles* where there is a danger from flying particles that may cause injury to the eyes (e.g. where hard rock is to be broken).

Other personal protection may also be required, such as:

- *closely-fitting clothes* when working with or around moving machinery or equipment;
- *safety belts and lines* where there is a danger of falling.

9. Safety when mining

Posting warning signs and barriers

A surface mine often consists of deep trenches or large holes. There is a high risk that a mineworker or member of the public could fall in. Such workings should be surrounded by a secure fence or otherwise securely barricaded. Suitable warning signs to forbid unauthorized entry and subsequent fall of any person should be posted.



Fence pits; post warnings.

Ground conditions or any other dangerous condition in the mine that creates a hazard to persons should be corrected before other work or travel is permitted in the affected area. Until corrective work is completed a warning sign against entry should be posted. When left unattended, a barrier should be installed to prevent unauthorized entry.



Isolate unstable ground until it is fixed

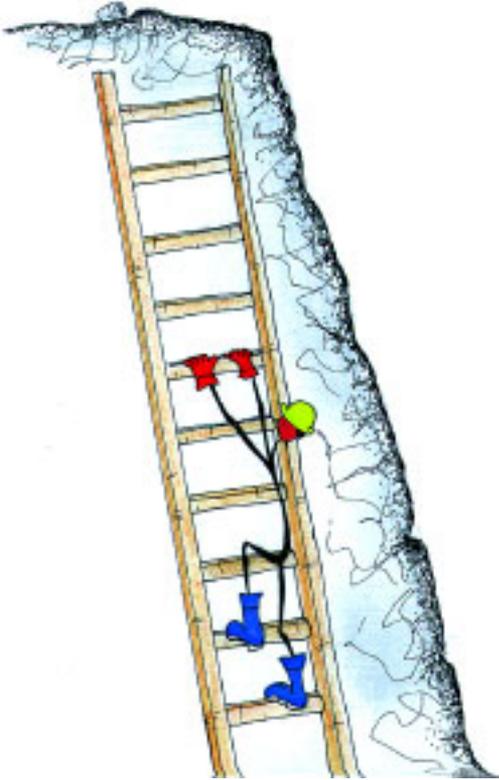
Travel ways and safe means of access

Mineworkers often have to use difficult terrain to travel to and from their work places within the mine (e.g. climbing or walking along steep pit walls and excavations where there may be a danger of slipping or falling, a slide of material, rock fall, etc.).

To reduce these hazards, the stability of any pit wall, bench or slope where persons normally travel to and from their assigned work places should be regularly examined and properly maintained.

Each place in the mine where any person normally works should be provided with appropriate travel ways.

Any access exceeding an inclination of 50 degrees from the horizontal should be provided with fixed stairs or a ladder.



For access via steep grades, use a secured ladder.

Stripping of overburden

Surface mining activities generally start with the removal of overburden, typically loose ground or decomposed rock. This material is potentially unstable and could easily collapse or slide, especially when wet.

Any excavation of loose ground should therefore not be done by undercutting or by forming steep slopes. The slope of loose ground or decomposed rock should be kept at an angle (not more than 45 degrees) that ensures stability.

Vegetation, such as large bushes and trees, should be removed from the overburden before stripping reaches the roots to prevent hazards due to falling trees.

To prevent loose soil from sliding back into the mine:

- pit or wall perimeters consisting of soil or unconsolidated material which could create a fall-of-material hazard, should be stripped back for at least 3 metres from the top of the pit or quarry wall; and
- all material from the stripping of overburden should be removed to a safe distance from the working edge of the mine excavation and be shaped to a safe angle of repose (30 - 40 degrees from the horizontal).



Overburden stripped back and removed to a safe distance from the working edge.

Working on walls and benches

Falls of rock at the working face, the collapse of the working face and landslides are major risks in the production areas of surface mines. They are often the cause of serious mining accidents. The design and layout of the working faces should therefore be such that the danger of material fall is minimized.

This can be done by applying a benching (terraced) system instead of having a steep pit wall.



Unsafe steep pit wall.

Stable benching system.

Any wall, slope or bench, where work is to be performed should be regularly examined for cracks or other signs of stress or weakness, in particular:

- prior to commencing any work;
- after blasting;
- after heavy rainfall; and
- as ground conditions warrant.

Under no circumstances should any face, side or bench be worked in a way that causes unsupported overhanging or undercutting.



Beware of undercutting.

Where the undercutting of a working face is essential, a sufficient means of support (e.g. sturdy wooden props) should be properly installed to prevent overhanging material from collapsing.

In any alluvial layer, consisting of sand, clay, pebbles or similar loose material, a single bench for manual working should normally not exceed 2.5 metres in height. Also the maximum slope should be less than 45 degrees.

When working in solid material or hard, rock the height of a single bench should not exceed 6 metres for manual working. Also, the slope angle should be less than 60 degrees from the horizontal.

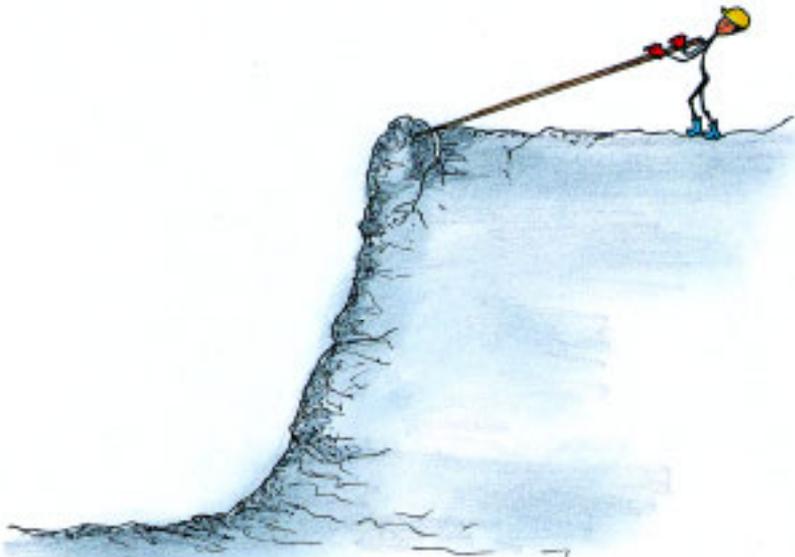
Each terrace floor of a multi-bench system should be wide enough to allow persons to work and travel freely and safely. A bench width of at least 3 metres is recommended; this also provides some protection against rock fall.

Scaling

Wherever loose rock or soil at any working face could create danger to persons. It should be scaled down or supported in a safe manner before other work or travel is permitted in the affected area.

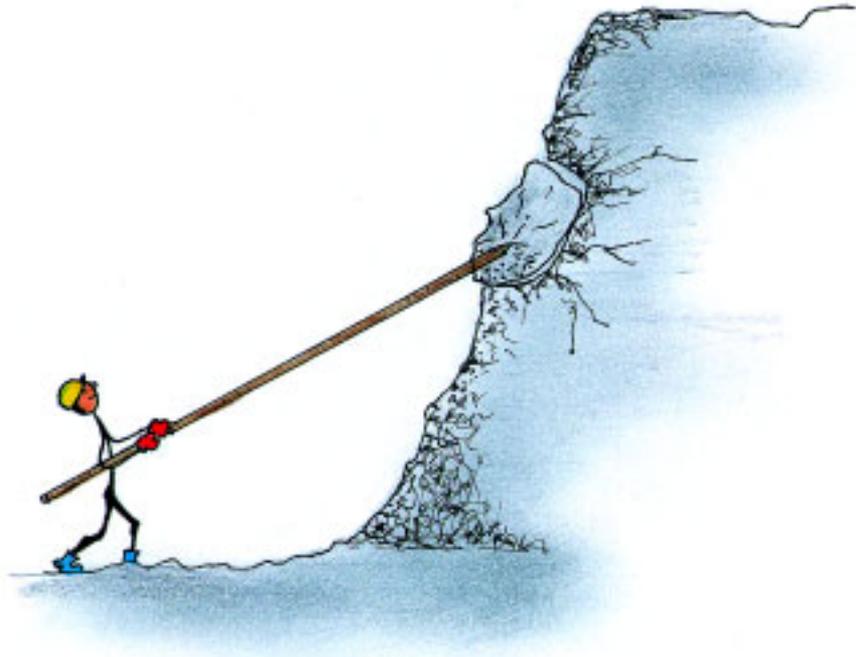
If possible, scaling should be done from the top of the working face downward. All persons should be removed from below the scaling area.

Scaling should be carried out from a location which will not expose persons to injury from falling material.



Keep clear when scaling.

If scaling is performed from below the face, the scaling bar should be of a length and design that will allow the removal of loose material without exposing the person performing this work to injury.



When scaling from below, use a long bar.

Other work

When digging pits, trenches or other such works, any face or side wall over 1.5 metres high should be securely supported (e.g. by installing struts) to prevent any falls or slips of the wall material back into the excavation.

When using water monitors to dislodge rock or earth from a vertical wall, make sure the hose and nozzle are firmly fixed. Stand well back from the wall an well clear of the debris as it falls and washes away to the pump or sump.

If any work has to be done manually on a face that is more than 2.5 metres above the ground, the workers should wear a safety harness or rope that is fastened to a secure anchor well clear of the top of the face.



When off the ground be well supported

Any tunnel or adit being driven into the face for exploration, drainage or any other purpose should be securely supported as ground conditions warrant.

Where such underground adits exceed a length of 6 metres, arrangements should be made to ensure an adequate supply of fresh air, either by artificial or natural ventilation.



Support the roof; check the air.

Inadequate ventilation in underground workings may result in a lack of oxygen and high levels of carbon dioxide. Thus the atmosphere therein should be regularly checked for O_2 and CO_2 concentrations. The level of O_2 should not fall below 19.5%; the level of CO_2 should not exceed 0.5%.

Unventilated areas underground should be barricaded and signs posted to prevent entry.

Mine drainage

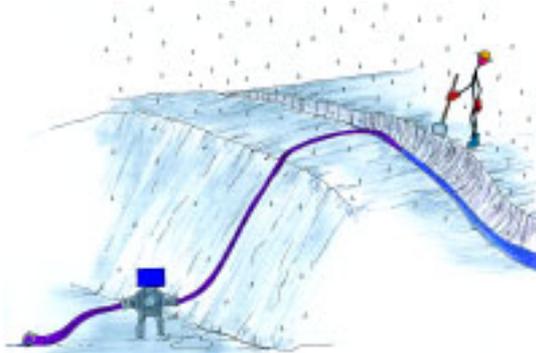
Most small mines do not encounter strong groundwater inflow, unless they are close to and below the level of a river. But they often have problems in dealing with surface water during and after heavy rainfall. Such surface water can adversely affect the stability of the pit strata, wash out slopes and terraces, and even flood the mine. Heavy mudflow and slope failure are often consequences of surface water entering the mine.

Whenever possible, surface water should be prevented from entering mine workings by digging ditches to trap the water and conduct it away from the pit.

Drainage channels should be well away from the edge of the excavation and constructed as to minimize storm runoff entering the pit.

As far as possible mine workings should be arranged so that water is discharged naturally (e.g. into lower abandoned workings).

Channelling incoming water down the slopes to collection points could also be an effective way to protect the slopes of surface mines. Where necessary, water pumps should be installed at such collection points.



Keep water out of the pit as far as possible.

10. Mechanical equipment

General requirements

All machinery and apparatus that is used in surface mines should be robust, fitted with appropriate protective safety devices and maintained in good condition.

Where the location of a mine site makes it difficult to get spare parts, it is even more important to keep machinery in good working order by regular servicing and maintenance. Servicing and maintenance should be carried out according to a scheme prepared by the mine operator, or to the manufacturer's specifications.

As a safety measure, any power tool for hand-held use should be fail-safe, i.e. operated with controls that require constant hand or finger pressure.

Only a competent person should undertake any work on machinery where technical knowledge or experience is required.

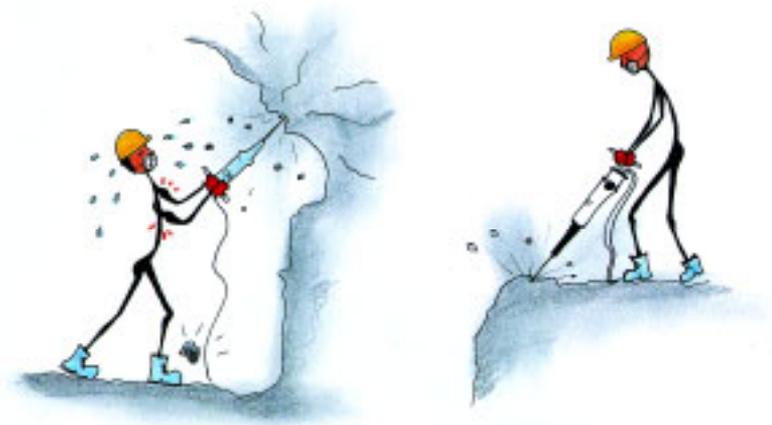
Operation of pneumatic pick-hammers

Any mechanical part affecting the safe operation of pneumatic pick-hammers, such as hose connections, pick retainer and the state of pick, should be checked for any defect by the equipment operator before being put into operation. The same applies to pneumatic drills.



Check hoses and connections before starting work.

Extraction operations by pick-hammer should be performed from a position which will not expose the operator to injury from falling material.



Not like this!

Like this.

Use pick-hammers from a safe position.

Lubricating oil should be used before a pick-hammer is started and at intervals as required during operation.

Material that is to be broken by pick-hammers (secondary breakage) should be positioned or blocked to prevent any movement which could endanger persons in the work area.

Before pneumatic pick-hammers are moved from one working place to another, the air compressor should be turned off and air bled from the hose.

Pick-hammers should not be used for breaking material that could contain misfired explosives or detonators.

See also pages 13-14 on noise and vibration.

Drilling operations

Drilling equipment should be inspected and any defects corrected before it is used.

The drilling area should be inspected for hazards before starting drilling operations.

Drill crews and others should stay well clear of rotating augers or drill stems. Persons should not pass under or step over a rotating drill stem or auger.

Drills should be attended at all times while they are in operation.

Persons should not hold the drill steel while collaring holes, nor rest their hands on the chuck while drilling.

Persons should not drill when their footing is not secure or when standing on staging or equipment that is not suitable for drilling.

Before drills are moved from one place to another the air compressor should be turned off and air bled from the hose.

Holes should not be drilled where there is a danger of intersecting a misfired hole or a hole containing explosive material.

See also pages 13-14 on noise and vibration.

Compressors and related equipment

Compressed air vessels should have a safety certificate in accordance with regulations. Normally they should withstand at least five times the maximum design operating pressure.

All pipe/hose constructions and connections should be able to withstand the operating air pressure and flow. Suitable locking devices should be used at connections between machines and high pressure hose lines, particularly where a connection failure could create a hazard to the operator or other persons.

On any compressor or pressure storage vessel, safety equipment should be installed that is suitable for working constantly under the maximum permissible operating pressure. The equipment should include:

- pressure gauge;
- temperature gauge;
- safety valve to release excess pressure.

The temperature inside a compressor should not exceed 40 °C below the flash point of the lubricating oil used (i.e. not more than 160 °C). Whenever the compressed air temperature exceeds the limit, or some defect is found in the cooler, the compressor should be stopped.

The compressor lubricating oil should have a flash point higher than 200 °C. Animal or vegetable oil should not be used for lubrication.

Compressor air intakes should be as clean and dry as possible. Air filters should be used to ensure that only uncontaminated air enters the compressor.

The compressed air flow from the compressor to the point of use should be kept as dry and as cool as possible.

**Never direct compressed air towards a person.
Take all necessary precautions to protect persons using
compressed air tools & equipment from injury.**

11. Explosives and blasting

Definitions

Explosive material means explosives, blasting agents and detonators.

Explosives means any chemical compound, mixture, or device that is made, manufactured or used to produce an explosion by sustained chemical reaction in itself, such as black powder, nitro glycerine, dynamite, etc.

Detonator means any device containing a detonating charge that is used to initiate an explosive, such as non-electric blasting caps and electric blasting caps.

Blasting agent means a chemical substance which becomes an explosive when mixed with a hydrocarbon (e.g. ammonium nitrate).

Blast area means the area in which concussion, flying material or gases from an explosion may cause injury to persons.

General requirements

Blasting operations should not take place without the approval of the mining authority.

Only explosives and detonators approved by the mining authority and provided by the mine operator should be used at a mine.

Only persons who are trained, certified and experienced in the handling and use of explosive material should direct blasting operations and related activities.

The operator of every mine at which explosives are used should provide the equipment and materials necessary to enable blasting operations to be carried out safely.

Storage of explosive material

Explosive material should be stored in magazines which, as far as possible, should meet the following requirements:

- be structurally sound;
- be made of non-combustible material, or the exterior covered with fire-resistant material;
- be lined with non-sparking material;
- have ventilation holes at the upper and lower part of the building to control dampness and excessive heating;
- have appropriate warning signs that indicate the contents;
- be kept clean and dry inside;
- be locked when unattended;
- be used exclusively for the storage of explosive material;
- be electrically grounded when made of metal.

Areas surrounding storage facilities for explosive material should be clear of rubbish, brush, dry grass and trees for 10 metres in all directions. Other combustible material (e.g. gasoline; diesel) should not be stored or allowed to accumulate within 20 metres of explosive material.



Be very careful in storing, transporting and using explosives.

Detonators should not be stored in the same magazine as other explosives, unless they are kept in a separate compartment.

When stored in the same magazine, blasting agents should be kept separate from explosives, safety fuses and detonating cords to prevent contamination.

A suitable person should be appointed by the mine operator to be in charge of explosives at the mine. This person should be over 21 years of age and competent in the storage, handling and use of explosive material.

Conveying explosives

Explosive material should be transported without undue delay to the blast site.

Closed, non-conductive containers should be used to carry explosives and detonators to and from blast sites.

Separate containers should be used for explosives and detonators.

Explosive containers should be clearly marked, indicating their content.

Charging and shot-firing operations

Explosives should not be taken to the blast site until the blast holes are ready to be charged.

Explosives and blasting agents should be kept separated from detonators until charging begins.

Explosive material should be protected from impact and from temperatures in excess of 65 °C when taken to the blast site.

No person should smoke, have a naked light or any other appliance that could generate heat or sparks in the vicinity of holes that are being charged with explosives.

Charges should be made up only at the time of use and as close to the blast site as conditions allow.

Once charging begins, the only activity permitted within the blast site should be that which is directly related to the blasting operation.

Before charging, blast holes should be checked for obstructions which should, as far as possible, be cleared.

Explosives should not be forcibly pressed into a blast hole for any reason. Tamping (compressing the explosive in the hole to reduce air spaces) should only be done with non-sparking equipment, such as bamboo-type charging rods.

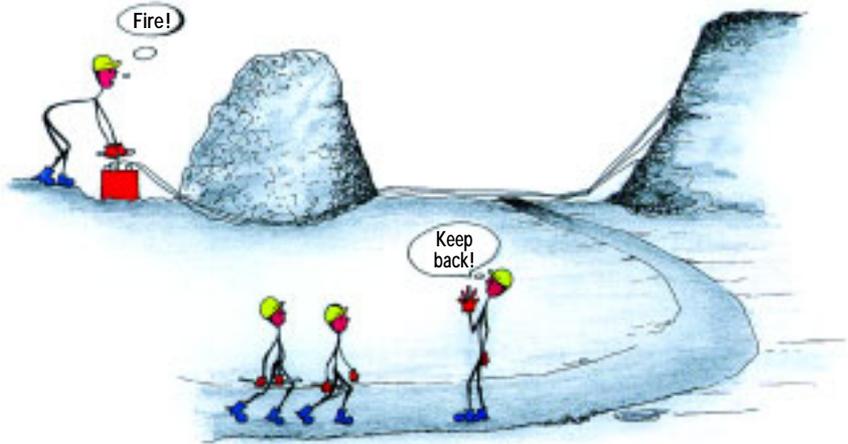
After a blast hole has been charged, it should be stemmed by using fine sand in small paper packets or clay “noodles”.

Unused explosive material should be transferred to a protected location, as soon as practicable after charging is completed.

Once charging is completed and the circuits have been connected, the firing of shot holes should take place without undue delay.

Before firing a shot hole the responsible person should:

- Check the completed circuit to ensure that the components are properly connected.
- Give ample warning to allow all persons to be evacuated from the blasting area.
- Guard or barricade all access routes to the blast area to prevent the passage of persons.



Give warnings; stay well clear before blasting.

No work should resume in the blast area until it is free of after-blast fumes and a post-blast examination by the person in charge has verified that there are no potential blast-related hazards.

Handling of misfires

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.

Faces and muck piles should be examined for any misfire.

Only work necessary to remove misfires should be permitted in the affected area until the misfire is disposed of safely.

12. Cessation of mining / mine closure

No small-scale surface mine or mine site should be abandoned without any rehabilitation. Nor should it be left in a condition that could lead potential hazards to the public or damage to the environment. The mining authority should ensure that its requirements for abandonment are met.

Every mine operator should ensure that the necessary steps are taken to meet the requirements of the mining authority to prevent any danger arising from abandoned mine sites, either by progressive rehabilitation during ongoing mining operations or after the completion of mining activities.

Rehabilitation measures should include, but not be limited to:

- Removal of any harmful or toxic substances, machinery, mine structure and any other left-over material likely to be harmful to persons or nature.
- Refilling and levelling of deep excavations or holes that may create a danger of fall to persons. Where this is not possible, such danger areas should be provided with secure fencing or otherwise barricaded.
- Re-contouring (e.g. by trimming slopes to a safe angle), stabilizing (e.g. by revegetation) of potentially unstable faces, pit walls, benches or waste dumps to reduce erosion or potential slope failure.