Department of Natural Resources, Mines and Energy

Guidance Note QGN 11

Handling Explosives in Underground Mines

Explosives Act 1999
Mining and Quarrying Safety and Health Act 1999
Coal Mining Safety and Health Act 1999

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GUIDANCE NOTE – QGN11

Queensland Government

Handling Explosives In Underground Mines

This Guidance Note has been issued by Safety and Health of the Department of Natural Resources and Mines to provide guidance in the use of out of service procedures to manage the risk associated with unserviceable plant.

This Guidance Note is not a Guideline as defined in the *Mining and Quarrying Safety and Health Act 1999 and* the *Coal Mining Safety and Health Act 1999*. In some circumstances, compliance with this Guidance Note may not be sufficient to ensure compliance with the requirements in the legislation.

Guidance Notes may be updated from time to time. To ensure you have the latest version, either check the Department of Mines and Energy website or contact your local inspector of mines.

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FOREWORD

QGN11 - HANDLING EXPLOSIVES IN UNDERGROUND MINES

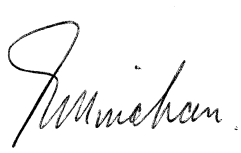
The Queensland mining and quarrying industries are Australia's largest users of commercial explosives at approximately 500 000 tonnes each year. Explosives have been the primary method of breaking and loosening rocks since the introduction of black powder. Today's wide range of commercial explosives are safer to use but still represent a major hazard due to the enormous amount of energy that can be rapidly converted into gases at high temperature and pressure.

This document, *Guidance Note for Handling of Explosives in Underground Mines*, covers an important aspect of safety and health in the mining industries. We have entered a new era with heightened international terrorist activity necessitating changes to our approach to explosive use. This component of our industry has been subject to extensive change to ensure appropriate standards exist for the safe handling and use of explosives. We have seen crucial changes to explosives in the way of increased security requirements for storage, transport and use.

These changes have been implemented to restrict explosives and explosives activities in the community to those authorised by the Chief Inspector of Explosives and of acceptable safety. Furthermore, it provides best practices as well as management and control of hazards associated with explosives. Many of these innovations bring advantages to the operator and worker alike, in the way of improved operating procedures and blast results.

This document was prepared to assist mines and quarries in identifying the hazards and implementing the necessary controls to ensure the safety and health of all persons involved in the processes of storage, use and transport of explosives, and provide information on the methods available to achieve an acceptable level of risk. Mines in Queensland should use this Guidance Note in conjunction with the relevant legislation dealing with explosives:

- *Mining and Quarrying Safety and Health Act 1999* or
- *Coal Mining Safety and Health Act 1999*, and the
- *Explosives Act 1999*



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1 PURPOSE AND SCOPE

This Guidance Note QGN11 is provided to assist competent persons in the safe and secure storage, use and transport of explosives by within the Queensland underground mining industry. The note provides information to be considered during the risk management process to assist in determining acceptable underground blasting practices. The information contained within is not merely limited to use in conducting job safety analyses but can be used when implementing safe operating procedures and safety and health management systems. The risk management process should be conducted with persons experienced and with content knowledge of explosives and risk assessment procedures. The risk management process should be conducted with persons experienced and with content knowledge of explosives and familiar with Australian Standards:

AS 2187. Explosives- Storage and use, and
AS/NZS 4360. Risk management

The principles stated in this document are intended as general guidance for the assistance of underground mining operations using explosives. Underground mining operations should consider their site circumstances and rely upon their own training and experience when assessing safety standards and risk management procedures.

This Guidance Note is aimed to promote consistency of best practice in safety and health in the mining industry. In addition the document provides information and reference for the identification, assessment and control of hazards associated with explosives storage, transport and use.

The State of Queensland and its agents will not be held liable for any loss or damage whatsoever (including liability for negligence and consequential losses) suffered by any person acting in reliance or purported reliance upon this Guidance Note.

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2 UNDERGROUND MAGAZINES

2.1 GENERAL DESIGN REQUIREMENTS

2.1.1 Location

When siting an underground magazine the risk management process can be carried out at the planning and design stage to identify a suitable location. The magazine should be located an acceptable distance from major service installations so the possible effects of an explosion will not adversely impact upon winders, electrical substations, pump stations, ventilation equipment or other important infrastructure (AS 2187.1). Risk acceptability should be evaluated based on the quantity of explosives stored in the magazine and the direct distance through rock and along openings. The more explosives stored the greater the distance needs to be to limit the consequences of an accidental explosion.

2.1.2 Ventilation

The magazine should ideally be located so that it exhausts directly into a return airway. This is to ensure that in the event of an explosion fumes travel away from where persons are working and escape routes. Where a direct connection to a return airway is not possible then auxiliary ventilation should be used in the magazine and turned on at all times. Auxiliary ventilation duct access into the magazine requires adequate security (e.g. fixed bars) to prevent unauthorised access to the magazine area.

Ventilation flow should be planned to provide for air movement of between 0.3 and 0.7 m/s, and with sufficient quantity to ensure fumes from any diesel engine in the magazine are diluted to an acceptable concentration. This should ensure that inside the magazine there is no accumulation of dangerous vapours or a build up of excessive heat.

Be aware that explosives need to be kept within the prescribed temperature storage range outlined by the explosives manufacturer. Explosives and initiators are at risk of burning or exploding at elevated temperatures as initiation sensitivity increases with temperature. Physical properties (firmness, plasticity, etc) may also change, and storage life/sleep time may also be reduced, with temperatures changes.

2.1.3 Proximity to Ignition Sources

When siting the magazine, consideration should be given to its proximity to likely ignition sources. These could include fuel sources such as refuelling depots, lubricant bays, oxy-acetylene equipment, rubbish or mineral matter. Location of magazines in high sulphide areas is to be considered in the risk analysis due to the hazard of a sulphide dust explosion. The magazine should be located a suitable distance from blasting conducted in sulphide areas to ensure in the event of an explosion the flame front does not propagate to the magazine area. An underground magazine should be a safe distance from accesses and main travel ways.

2.1.4 Vehicle Access

When designing the location of an underground magazine consideration should be given to hazards that may arise from proximity to vehicular access routes and roadways used on site. This includes the number of access routes to the magazine and the types of vehicles and the frequency of their proximity (AS 2187.1).

2.1.5 Ground Conditions

When designing the location of an underground magazine consideration should be given to the known in-situ ground conditions. Certain explosives can initiate through impact or friction caused by rock falls or ground control or reinforcements failures. The magazine should be sited in a region of competent rock to ensure possible damage caused by rock bolt failure, rock bursts and seismic activity is significantly reduced. The types of installations of ground support or reinforcement used needs to be properly engineered to minimise the risks involved.

2.1.6 Security

2.1.6.1 Remote Security

To enhance the security of an underground magazine consideration can be given to incorporating either a camera or alarm system with the required door and locking devices specified in this Guidance Note. All alarm, camera fittings and installations inside the magazine area are required to comply with AS 3000 for electrical equipment in hazardous locations (refer to Section 1.9.2.2).

2.1.6.2 Magazine Doors

The security requirements for underground magazines should be in accordance with AS 2187.1, or a system of at least equivalent safety and security. The doors of the magazine need to open outwards without causing an obstruction and be fitted with a restraining device so that accidental closing does not subject the explosives to jamming, pinching or impact.

2.1.6.3 Locking Devices

Locking devices for all magazine types are required to be in accordance with AS 2187.1, or with a system of at least equivalent security. As specified in AS 2187 the door or lid of every magazine is required be fitted with a six level ‘safe lock’. Where a padlock is used it shall have a hardened shackle and pad constructed to provide a high level of resistance to fracture and rupture. It shall also have a key system known as a ‘restricted system’ if the padlock is of the pin-tumbler type. Where the padlock is of the lever type, there shall be a minimum of five levers.

2.1.6.4 Door Hinges

It is important that the integrity of the door hinges and hinge lugs match the integrity of the lock provided. In the past illegal access to explosives has been gained through using a hacksaw blade on the hinges of the magazine. To prevent such access to the hinges the construction of the hinge lugs on the door should be in accordance with requirements in Australian Standard 2188. The integrity of the weld used to join the hinge lug to the door is also to be of a satisfactory standard to prevent the lug from detaching from the magazine, in the event of a forced entry. The strength of these welds should be monitored at each inspection or audit. Any non-compliance found during an audit or an inspection should be fixed as soon as practicable.

2.1.7 Markings

The magazine is to be marked at the entrance with either the word ‘EXPLOSIVE’ or ‘DETONATOR’, as appropriate. In addition an explosive hazard class diamond is required on the magazine door. A clearly defined ‘NO SMOKING’ or ‘NAKED FLAMES’ sign should be positioned at the entrance of the magazine to warn persons entering the magazine.

Figure 1: Signs to be marked: No Smoking sign, Explosive hazard class diamond, and Explosives sign.

2.1.8 Warning Devices

Persons should clearly be able to identify the location of an underground magazine. A flashing light or other warning device should be placed near each magazine. Employees should easily recognise the warning device used, and the warning devices should not be apparent when explosives are not present.

2.1.9 Segregation

Storage sites for the explosive magazine and detonator magazine shall be located as to reduce to acceptable levels the risk of sympathetic detonation between the different storages. The separation distances specified in AS 2187.1 are based on international testing and need to be observed as a minimum, however this minimum distance can be increased to further reduce the risk.

Where separation of detonators and explosives is not possible they need to be contained a safe distance, in a separate compartment defined by separating walls that are not in line of sight (AS 2187.1).

2.1.10 Fire Protection

For an underground magazine a fire fighting system that is either remotely or automatically operated is required. A sprinkler type system should be used where a diesel-powered vehicle can enter the magazine. It needs to have pipelines and control valves that are fire resistant and should be of a type recommended by the manufacturer for the type of explosives used (AS 2187.1). The system should be clearly identifiable, for example, paint pipes red and clearly mark control valves.

For a temporary storage area a fire extinguisher should be available in the vicinity of the magazine. Selection of suitable fire extinguishers and hydrants is dependent on the hazards present within the magazine area, for example electrical fires, liquid fires. This should be placed in the fresh airside of the magazine.

2.1.11 Earth Terminations

All exposed metal structures such as pipes, rails and doors that are inside or part of the magazine should be earthed to control undesirable extraneous electricity.

2.1.12 Water Installations

If water is required within the vicinity of the magazine, the installation needs to be set up to prevent water coming into contact with the explosives and ensure that the water does not cause erosion or degradation to the access or foundations of the magazine. If necessary, provide for drainage and a sump.

2.1.13 Electrical Installations

2.1.13.1 Lighting

Electrical fittings inside the magazine should be avoided, however if no alternative option is available, wiring should be suitable for electrical equipment in hazardous areas (AS 3000). Explosion protection for electrical equipment should be provided according to the classification of the hazardous area. However, the use of electricity in magazines is referenced in AS 2187 where it states:

"**2.1.4 Lighting**. Electrical fittings and wiring shall comply with AS 3000 for electrical equipment in hazardous locations and satisfy the requirements of the Hazardous Zone Classification".

Other Australian standards applicable to underground explosive magazines are:

- AS 2380, and
- AS 2381

A list of explosion-protection techniques and their applicable standards can be found in ESC-1 'Electrical Installations and Equipment in Hazardous Areas at Explosives Manufacturing Facilities and Storage Areas.' Alternatively, lighting can be located outside the magazine and arranged to shine into the magazine.

2.1.13.2 Electrical Equipment

Electrical equipment and installations, like pumps or explosive mixers should be avoided if possible, due to the inherent risks associated with their presence. Electrical arcing of equipment can result in an accidental ignition of explosive or an explosive atmosphere. If electrical wiring is necessary inside the magazine, all electrical installations should be suitable for operation in hazardous areas (AS 3000). Professional advice should be sought before installing electrical equipment in magazine areas.

2.2 PORTABLE / RELOCATABLE MAGAZINES

All portable and relocatable magazines, including converted freight containers, used underground have to be constructed in accordance with specifications given in AS 2187.1, or with a system of at least equivalent safety and security determined by risk management process.

2.2.1 Magazine Exteriors

Persons and machinery approaching the magazine need to be able to clearly distinguish and identify that it is a magazine. Portable and relocatable magazines should be painted white to improve light reflection and be protected against corrosion to prevent structural damage (AS 2187.1).

2.2.2 Magazine Interiors

Certain explosives are susceptible to initiation from friction and sparks caused by metal installations. Where exposed metal is present in the interior of the magazine an inner lining should be utilised. The inner lining should be free of iron or steel and be of close jointed construction (AS 2187.1).

2.3 PERMANENT MAGAZINES

Fixed or permanent (non-relocatable) magazines located underground are to be constructed in accordance with specifications given in AS 2187.1, or with a system of at least equivalent safety and security determined by risk management process.

2.3.1 Backs and Walls

The backs and walls of the magazine should be in a condition as to prevent a rock fall from impacting an explosive. The backs and walls should be free from loose or protruding rocks or alternatively, meshed and bottled to secure from possible rock falls. The magazine area should be kept free from water and as necessary be sealed to prevent water seepage. All intersecting boreholes have to be sealed off and any butts washed and cleaned to ensure they are free of residual explosives. The interior and surrounds should be preferably painted white and always kept clean (AS 2187.1).

2.3.2 Access

The access should be inclined or similar to provide adequate drainage to prevent deterioration of the access roadway and prevent water entering into the magazine. Vehicles should have to make at least one 90-degree turn to access a magazine to minimise hazards of an out of control vehicle. For rail access, a suitable derailer or equivalent should be adjacent to the magazine to prevent entry of a run away locomotive.

2.3.3 Elevated Storage

Where vehicles have access to the magazine the explosives should be stored in elevated bays to prevent an out of control vehicle or a reversing vehicle coming into contact with the explosives. Where detonators are stored in the same magazine as bulk explosives, a suitable safety distance needs to be provided as well as barriers or elevated storage bays to prevent access to the detonator area by a powered vehicle.

2.4 UNDERGROUND TEMPORARY STORAGE

The location of underground temporary storage (working party magazines) should be carefully and strategically selected using a risk management process that considers the following potential hazards (this list is not totally inclusive):

- To effectively control the temporary storage area it should be located as near as practicable to where the explosives are to be used.

- To warn others of the presence of explosives the containers in which the explosives are stored and the surrounding area should be adequately signed. Where mobile equipment is in the vicinity a warning device such as a flashing light can be used. Warning devices should not be apparent when explosives are not present.
- The larger the quantity of explosives stored the greater the consequences of an unplanned ignition. Explosives in the storage area should be kept to a minimum quantity, preferably not exceeding two days requirements and not exceeding the quantity needed for the designated operations.
- Explosives need to be suitably protected to guard against an unplanned ignition caused by friction, impact, shock or heat. Containers in which explosives are stored should be constructed to protect against these hazards and regularly cleaned of residual explosives.
- Detonators in the storage area are stored in locked containers to guard against theft and adequately segregated from other explosives to reduce the risk of sympathetic detonation.
- Floor of the temporary storage is elevated above roadway level and the storage level established to prevent water deterioration and so that a runaway or reversing vehicle is unlikely to contact the explosives.
- Plan to ensure that all explosives are removed from the storage area and the storage area closed when blasting operations for which the explosives were stored cease.

3 EXPLOSIVES ARRIVAL ON SITE

3.1 ARRIVAL POINT OF EXPLOSIVES

A risk assessment is to be carried out to identify hazards that may arise with the arrival of an explosives vehicle onsite. Explosives vehicles should arrive on site in a location that ensures the magnitude of the hazard and nature of the consequences are reduced to an acceptable level. Safe allocated stopping areas are required to reduce the vehicles proximity to populated areas, ignition sources and staff working areas. The requirements for the transport of explosives by road and rail can be attained from the Australian Explosives Code 2000.

3.2 EXCESS EXPLOSIVES

The carrier bringing explosives to the site may have explosives onboard that are to be delivered to other mine sites. These excess explosives represent an additional hazard and the site senior executive is responsible for the additional risk. Best practice is for an exact record of all explosives in the consignment to be provided to the site senior executive before entry to the mine site is authorised.

4 TRANSPORT TO THE MAGAZINE

4.1 TRANSFER UNDERGROUND

Where possible regularly utilised travel ways such as service shafts or declines should be avoided for the transfer of explosives from the surface to the underground. If the only means of access is a decline or service shaft then the explosives should be transferred at a time as to avoid employees and materials. All employees should be made aware either through appropriate signage or using a selected radio channel to broadcast that explosives are to be transferred to the underground storage section.

4.1.1 Transport in a Shaft

The site senior executive should ensure that there is a standard work instruction where a mine uses a shaft to lower explosive underground. The following general precautions should be taken to ensure the safety and security of explosives during transport in a shaft:

- Ensure that the shaft and cage are in sound mechanical condition and repair
- Ensure that explosives travel without other equipment and persons.
- Ensure that explosives are secured to prevent pinching, impact or friction.
- Maintain segregation and transport large quantities of detonators separate to detonator sensitive explosives.
- Ensure that a competent person controls the transit of the explosive
- Explosives should be transferred to the shaft and underground storage in an efficient manner to minimise explosives storage in inappropriate places.

4.1.2 Segregation

Transfer of detonators and explosives underground should be completed separately as to reduce to acceptable levels the risk of communication of explosion. If transferred together the materials handling equipment should be suited for the transport of explosives (refer to Section 5).

4.1.3 Security

The explosives should be promptly transferred to the magazine and not temporarily stored or delivered to other sections of the mine. The person in charge of the transfer of the explosives should ensure that explosives are not left unattended or left on rail carriages or vehicles unless suitably secured.

5 MANAGEMENT OF THE MAGAZINE

5.1 STOCK CONTROL

5.1.1 Person in Charge of Magazine

A person in charge of the magazine has to demonstrate competency and be assessed in the storage and handling of explosives before being appointed. The duties of the person appointed to be in charge of a magazine are given in AS 2187.1 and include the following.

5.1.1.1 Access to Magazine

The person appointed in charge of the magazine is obligated to ensure that only authorised persons have access to the magazine. The person needs to ensure that the magazine is secured at all times and the magazine key is in the care of an authorised person or locked in a secure location (AS 2187.1).

5.1.1.2 Explosive Limits

The person appointed in charge of the magazine has to ensure that the explosives stock levels in the magazine are within the licensing limits. For determining the quantity of explosives that can be held within a specific magazine refer to AS 2187.1. Best practice is for a record of the licence to store to be kept at the magazine location. This will ensure that all authorised personnel with access to the magazine are aware of the explosive capacity of the magazine.

5.1.1.3 Stacking Packages

The person appointed in charge of the magazine is obligated to check that packaging for the explosives to be stored in the magazine is of such construction strength and character that it cannot break or open accidentally. Stacking heights are not to exceed those recommended by the explosives manufacturer.

If the person in charge of the magazine is not satisfied with the condition of packaging supplied there is no obligation to store the product in the magazine.

To ensure adequate ventilation, an air gap is to be maintained between the explosives and the magazine walls and ceilings. (AS 2187.1)

5.1.1.4 Rotation of Stock

The person appointed in charge of the magazine will ensure that the explosives stock is rotated on a regular basis and that the explosives are within the expiration dates indicated by the manufacturer. Explosives that are more than one year old should not be used without first contacting the explosives manufacturer (source: Orica Explosives).

5.1.1.5 Record Keeping

The person appointed in charge of the magazine is required to keep a record of incoming and outgoing stocks. These records need to be kept for a period of not less than five years (AS 2187.1). The record is to include a balance of all explosives stored at the magazine. Every attempt has to be made to account for individual explosive items that are distributed collectively. Best practice is for a second record of the explosive stock levels to be kept in a separate location. An audit and inspection of the magazine, its contents and surrounds needs to be conducted and recorded frequently, preferably monthly and usually not more than every three months.

5.1.1.6 Record of Underground Storages

The site senior executive needs to ensure an up-to-date record of the number and location of underground magazines and temporary storage is kept at the mine and made available to an inspector at the inspector's request.

5.2 HOUSEKEEPING

5.2.1 Magazine Rules

Magazine rules for the operation of the magazine are to be displayed inside the magazine in a prominent position (AS 2187.1 – Appendix J). These rules should include explosives quantities and segregation requirements for correct storage, security procedures, housekeeping rules and whom to contact for maintenance work approval.

5.2.2 Prohibited Articles

Articles that are likely to cause fire or explosion such as cigarettes, matches, radio transmitters, mobile phones or rubbish of any description shall not be taken into the magazine (AS 2187.1). A receptacle should be provided at the magazine entrance for discarding of such items before entering the magazine.

5.2.3 General Tidiness

The floor of the magazine should be kept clean of dirt, empty packaging and explosives. Floor mats, dustpans and brooms should be provided in the magazine to clean up. Spillages of explosives should be cleaned up and properly disposed of immediately (AS 2187.1). It is the responsibility of the magazine keeper to maintain the magazine in exact condition.

Rubbish bins, waste packaging and other refuge should not be stored inside magazines.

5.2.4 Opening Packages

Free flowing or friction/impact sensitive explosives should not be opened or left in the magazine in a condition that could instigate premature ignition. Only suitable tools appropriate for the opening of explosives shall be used to open packages (AS 2187.1). Explosives such as detonating cord and primers are sensitive and packages should be open using non-metallic objects.

5.2.5 Safety Equipment

Where appropriate safety equipment should be provided for all persons entering the magazine. This may include personal protective equipment such as anti-static footwear, fire retarding clothing, eye protection and gloves. Appropriate personal protective equipment signs should be displayed at the magazine entrance.

5.3 PROCEDURES

5.3.1 Theft or Loss of an Explosive

A system or written procedure is required to manage the situation following any attempted forced entry, theft or unaccountable shortage of an explosive (AS 2187.1). On detecting a theft or loss of an explosive, the authority holder, who is the persons licensed to use or store explosives, is required to immediately give the Chief Inspector of Explosives written notice of the loss (*s55 Explosives Act 1999).* The site senior executive then needs to further notify an inspector of mines and the police *(s195 Mining and Quarrying Safety and Health Act 1999* and *s198 Coal Mining Safety and Health Act 1999)*

5.3.2 Accountability of Explosives

Sections 79 and 79A of the *Mining and Quarrying Safety and Health Regulation 2001* detail the regulatory requirements for dealing with the theft or loss of explosives and for personal accountabilities.

Every person who has immediate custody or control of any explosives, or a mine, has an obligation to account for and accurately detail what happens to the explosive when it leaves that person's custody or control.

5.3.3 Maintenance

A system or written procedure should be in place to maintain the magazine installations. Any maintenance work is to be authorised in writing by the person appointed in charge of the magazine. Where any activity that is likely to generate heat is to be undertaken inside or on the outside of a magazine the contents of the magazine are to be emptied and cleaned (AS 2187.1). For hot work, a permit is required be attained to work, and a fire watch needs to be conducted that extends at least one hour after the completion of the maintenance.

5.3.4 Fire

An appropriate fire emergency procedure should be in place to deal with fire at or near the magazine. It should address evacuation of all personnel to a safe location and securing access to the magazine. The person in charge of the magazine in conjunction with the mine's rescue team should develop an emergency procedure.

In case of a magazine fire, if the explosive is not burning, carefully remove as much of the explosive as possible. However, if the explosive is burning, evacuate. the area and do not attempt to fight the fire.

6 UNDERGROUND TRANSPORT OF EXPLOSIVES

6.1 GENERAL VEHICLE REQUIREMENTS

For the safe and secure transport of explosives underground all vehicles should adhere to the following general requirements:

- be in sound mechanical condition and repair.
- be powered by diesel fuel.
- provide adequate segregation of detonators from other explosives.
- all explosives to be transported in a safe and secure manner either in securely attached containers or other fit for purpose means.
- where packaged explosives may be in contact with interior surfaces , the surfaces should be kept in a clean condition and free from any projections that are likely to cause damage.
- before vehicles are serviced they need to be thoroughly cleaned, and inspected by a person who has the necessary competence and also be certified to be free of explosive residues.

6.2 HIGHER RISK TRANSPORT OF EXPLOSIVES

The degree of risk and subsequent requirements for vehicles carrying explosives underground should be managed based on the types and quantities of explosives carried and the suitability and condition of the vehicle. Where large quantities of explosives are transported together there exists the possibility of sympathetic detonation. For the safe and secure transport of explosives, the vehicles used can reduce the risk associated with the function by implementing the following controls:

<u>Hazard- Fuel Fire</u>

- Use a diesel engine vehicle with diesel fuel that meets AS 3570: Automotive Diesel Fuel.

<u>Hazard – Electrical fault</u>

- Have electrical wiring protected with conduit and also have a battery isolation switch located in an accessible position.

Hazard – Exhaust flames/sparks

- The vehicle should be fitted with a spark arrestor in accordance with AS 1019.

Hazard – Stray radio current

- Electrical detonators should not be transported close to a radio transmitter in a vehicle unless the radio is turned off or the radio wattage is sufficiently below the required initiation power. This is to prevent blasting circuit being energized by the electric field produced by radio transmitters.

Hazard – Vehicle fire

- The vehicle should be fitted with a dry-powder fire extinguisher with a rating not less than 40 B(E), as specified in AS 1850. Alternatively, or in addition, an automatically operated AFFF (Aqueous Film Forming Foam) system can be utilised, for a fire under the bonnet. Fire extinguishers are to fight a fire on the vehicle. However, in the event of the explosive on fire do not attempt to extinguish the fire, retreat a safe distance from the vehicle.

6.3 SECURITY AND SAFETY WHILE IN TRANSPORT

The following general precautions should be taken to ensure the security and safety of explosives during transport:

- Before leaving the magazine, the vehicle operator needs to ensure that all explosives are securely stowed and the quantity and type of explosives recorded.
- Explosives should be kept in their original boxes where possible to facilitate ready identification and containment.
- The transport route between the magazine and shot area should be pre-planned and all relevant mine personnel notified.
- No smoking or naked flames allowed within the vicinity of the vehicle. If any ignition sources are required they should be carried in a sealed container in an appropriate section of the vehicle.
- If the vehicle is unavoidably left unattended (e.g. emergency), it should be parked in an appropriate area with all receptacles and the vehicle locked.
- All vehicles should be parked facing into the walls of the drive to avoid the hazard of a runaway vehicle.

6.4 TRANSPORT BY RAIL

The site senior executive needs to ensure that there is a standard work instruction where rail is used for the transport of explosives underground. The following general precautions should be taken to ensure the safety and security of explosives during transport by rail:

- Rail cars should have specially designed receptacles to protect sensitive explosives from pinching, impact and friction.
- Segregation between detonators and bulk explosives as well as initiating systems should be maintained.
- Ensure that explosives are not exposed to extraneous electricity from batteries or overhead trolley wires.
- Transport large quantities of explosives on a separate rake from other material.
- Utilise splashguards to ensure that sparks from wheels or brakes cannot cause ignition.

Figure 2: Charge car with kettles clearly labelled and blue flashing light mounted on drivers cabin

6.5 VEHICLE MARKINGS

Vehicles that are used to carry explosives need to be easily identifiable. This includes being fitted with appropriate signs. Additionally, vehicles carrying explosives at mine sites are to be easily identified other than by signs, for example a flashing light of a distinctive colour is required, and this enables, in the underground environment, to show that explosives are being transported on the vehicle.

Similarly, when vehicles are not carrying explosives the warning signage or light needs to be inconspicuous, or have signage indicating the vehicle is explosive free.

6.6 COMPETENCY OF PERSONS

Every person required to transport explosives should be authorised. The *Mining and Quarrying Safety and Health Regulation 2001* require that such persons be authorised in writing by the site senior executive.

6.7 TRANSPORT ON FOOT

Where explosives are transported on foot protective carry containers are to be provided. These can be fabricated from metal, wood, canvas or other material that offers some protection to the contents. Ordinary carry bags do not provide adequate protection to detonators and should not be used. The containers need to be labelled clearly and segregation of detonators from high explosives maintained.

6.8 TRANSPORT USING A LOADER BUCKET

The transport of explosives using a loader bucket should be limited to bulk explosives only and when it is not practicable to use any other means. The site senior executive is required to ensure that there is a standard work instruction for the transport of explosives using loader buckets. This procedure should include the following precautions:

- A method of securing the explosives and preventing explosives falling out of the loader bucket.
- An outline of the circumstances when a loader bucket may be used for the transport of explosives.
- A method to ensure that no residual explosives remain on the loader after it is finished transporting.

6.9 VEHICLE ACCESS TO EXPLOSIVE STORAGE SECTION

Where vehicles have access to the explosives storage section of the magazine (e.g. forklifts, charge vehicles), they need to have the necessary modifications for operation within the vicinity of an explosive area. The following requirements are specified in AS 2187.1 and are applicable to all powered vehicles:

- The vehicle shall not be started inside the explosive storage section of the magazine.
- The vehicle shall not be stored in the explosive storage section of the magazine.
- The vehicle shall not be refuelled, maintained or left running unattended within the vicinity of the magazine.

6.9.1 Internal Combustion Engines

If an internal combustion engine powers the vehicle that accesses the explosive storage section is required to be equipped with suitable safety modifications for operation within an explosive area (AS 2187.1). The vehicle should be designed to protect the explosives against accidental ignition from heat, friction, pressure, incompatible materials, sparks and extraneous electricity. These hazards can be controlled as outlined in Sections 5.1 and 5.2 of this Guidance Note.

6.9.2 Electric Motors

Every electric engine that powers a vehicle that accesses the explosive storage section is required by AS 1915, to be designed to the specifications for electrical equipment used in explosive atmospheres. This requirement is to protect the explosives against accidental ignition from heat, friction, pressure, incompatible materials, sparks and extraneous electricity. These hazards can be controlled as outlined in Sections 5.1 and 5.2 of this Guidance Note.

6.10 MATERIALS HANDLING EQUIPMENT

6.10.1 Pumps

Where pumps are used for the transfer of bulk explosives there is a potential risk of an explosion initiated from heat, friction, sparks or electricity. The pump being fabricated from non-ferrous and non-combustible materials and electrical wiring being conducted can largely control these hazards. Further guidance for the requirements of pumps in explosive areas can be attained from AS 2187.1.

6.10.2 Miscellaneous Equipment

Where miscellaneous equipment such as pallet trucks, trolleys or lifting appliances is used in the magazine there is a potential risk of an explosion initiated from heat or sparks. The equipment should be fabricated from non-ferrous and non-combustible materials and suitable for use within an explosive environment. Further guidance of miscellaneous equipment in explosive areas can be attained from AS 2187.1.

7 DRILLING BLASTHOLES

The main explosives risks associated with the drilling of blastholes are residual explosives from previous blast being initiated and poorly drilled holes creating an unsafe situation during firing. Blast geometry and design is imperative to create safe discharges and blast results required for mine operating parameters. Blasthole diameter, angle and length are required to be adequately designed for the selected drill pattern.. The following standards and procedures should be in place to ensure holes are drilled safely and create a safe discharge:

- The drilling site is prepared and drill holes marked out prior to drilling.
- Drilling is not carried out on any face or bench until it has been examined for misfires and suitably treated (refer to Section 9 of this Guidance Note for the treatment of misfires).
- The driller is provided with a drill design specifying hole and collar lengths, direction and any expected geotechnical conditions.
- The driller records any unusual events during the drilling, for example cavities, soft rock, or an inability to drill designated holes.
- When positioning the drill rig to drill holes along the edge of the bench or stope the drill rig should be positioned so that the operator has a clear view of the edge at all times and is protected from falling.
- Whilst drilling near the bench or stope edge the drill rig should be orientated so as to reduce the risk of the drill rig toppling.
- Whilst drilling is in progress, explosives being transported or stored in the area should be kept at a safe distance from the drilling activity.
- Drilling is not carried out in a hole where any part of it is considered within an unacceptable distance from a hole containing explosives.

Note: If it is essential to drill in, or relatively close to, an old hole or butt, it should be carried out only with remote-controlled drilling equipment (AS 2187.2). The operator and all personnel need to be withdrawn a safe distance from the old hole or butt.

8 EXPLOSIVES USE

8.1 RECORDS

8.1.1 Authority to Use Explosives

In the "Foreword" to AS 2187.2 it states "it is a fundamental requirement that persons are competent and authorized by their employer to handle and use explosives. Competence, with respect to handling and use of explosives, is recognized through compliance with relevant legislation and by having documentation confirming one or both of the following:

1. Current and valid shot firing ticket or licence applicable in the relevant State or Territory.
2. Currency with relevant competencies or qualification, attained through a national training package (i.e., endorsed by Australian National Training Authority or the Department of Education, Science and Training).

Employers of persons who handle and use explosives also have responsibilities with regard to the safe and secure management of explosives by ensuring that systems are in place through legislation and their management plan (if required) to provide a safe place of work. From a security viewpoint, the presence and security of explosives on a worksite is the ultimate responsibility of the employer."

8.1.1.1 Mining and Quarrying

Under section 64 of the *Mining and Quarrying Safety and Health Regulation 2001*, the appointment should be authorised by the site senior executive and recorded in the mine record. Note that a person is considered competent if:

1. That person holds a shotfirers license under the *Explosives Act 1999* that is applicable to the mine's operations; or

2. The authorising person is satisfied the person has the competency accepted by the Advisory Council as qualifying the person to carry out the handling activity or has satisfactorily completed a competency based training program for carrying out the handling activity and is competent to carry it out.

8.1.2 Blast Design

Blasts should be planned and designed, by a person qualified or deemed competent to ensure required blast results. A suitable blast design should be provided to the shot firer or produced by the shot firer before charging. The blast timing should be designed to ensure a suitable explosive weight per delay to minimise vibration and fly and produce the required blast results.

8.1.3 Blast Parameters

Blasting records including all key parameters such as hole specification, burden and spacing, quantities of explosives used, tie-in pattern and number of delays should be documented in a manner consistent with AS 2187.2.

8.1.4 Charging Over Shifts

Where charging is conducted over several shifts, there needs to be a written procedure in place for communication between shifts. This should include communicating from one shift to another, information about charging and blasted locations, holes loaded and any unique hazards or unusual circumstances associated with the shot.

There are many recorded incidents of persons driving both heavy equipment and other vehicles over unattended charged blastholes, both on surface and underground. There are many ways to control this hazard, but an exclusion barricade with signposting is usually effective.

8.2 SAFETY PRECAUTIONS

8.2.1 Safety Equipment

As required safety equipment is to be utilised whilst using explosives. This may include personal protective equipment such as fire retarding clothing, gloves, goggles and anti-static footwear.

8.2.2 Handling of Explosives

Explosives are to be handled in a manner that prevents operations that could lead to ignition or initiation of explosives. Mishandling of explosives such as throwing of primers can result in ignition caused by impact with the ground.

8.2.3 Activities in Proximity

There should not be any activity undertaken within the proximity of the shot that could generate heat or sparks. This includes smoking, naked flames or operation of machinery (AS 2187.2). Any activity or operation that has the potential to produce such a hazard could unexpectedly initiate an explosive.

8.2.4 Mobile Equipment on Non-electric Blast

Where mobile equipment is used on non-electric blast there is a premature explosion hazard or misfire hazard due to running over of detonators. In addition a premature explosion hazard due to tensile (pulling) failure of signal tube resulting in “Snap, Slap and Shoot” phenomenon. Mobile vehicle access to the shot should be via clearly defined access routes and a spotter should be used to control vehicle movements in areas of restricted visibility.

8.2.5 Signage

Charging areas shall be clearly marked by appropriate warning signs. All possible approach roads to the shot should be fenced to prevent persons inadvertently entering the shot. A danger board displaying the words “Danger – Charged Holes” together with the name and date of the shotfirer or a similar procedure is to be used.

8.2.6 Communication Devices

When using electric initiation, there is a possibility of the blasting circuit being energized by the electric field produced by radio transmitters. Safe distances for electric detonators subject to radio frequency radiation can be determined from AS 2187.1, however such devices should never be carried whilst holding or connecting electric explosives.

8.2.7 Flammable Gas Areas

Where explosives are used in underground mines where there is a significant presence of flammable gas, the concentration of the gas should be checked prior to charging. If the concentration of flammable gas exceeds the stated legislative limit then charging should not occur. After charging the shot the area should be checked again to determine whether the shot should be fired. Examinations for the detection of flammable gas are to be carried out using certified and calibrated gas detectors. All persons involved in a suspected flammable gas zone need to be made aware of the hazards associated with varying concentrations of the gas.

8.3 EXPLOSIVE SELECTION CRITERIA

8.3.1 Underground Coal Mines

Explosives used in underground coal mines present a major hazard due to the presence of methane or coal dust and accidental ignition. Explosives used in underground coal mines need to be specifically manufactured for this purpose. It is the responsibility of the site senior executive to ensure that the supplier or manufacturer is providing explosives that are of the acceptable criteria.

The shotfirer in an underground coal mine needs to ensure the following hazards are identified and controls put in place:

- The concentrations of flammable gas or gases are below the required legislative requirements.
- In areas where the safe concentration of methane is exceeded the shotfirer should ensure that the time from firing the first detonator to firing the last detonator is within prescribed tolerance, for example 250 ms.
- All exposed coal surfaces within the vicinity of the shot are to be thoroughly saturated with water or treated with stone dust to ensure an incombustible coal dust concentration.

8.3.2 Ground Conditions

When selecting a combination of explosives to be used for the ground conditions present, the objective is to ensure reliability and safety. Each blasthole that contains water should be carefully measured and recorded for specific treatment. To avoid the risk of a misfire wet blastholes should be charged with an explosive with the appropriate water resistant properties. Before using ANFO in damp blastholes the effect of water on the explosive column should be considered. If damp blastholes are required to sleep, an explosive with some water resistant properties is required. A clear identification system is required to ensure appropriate priming and charging of wet blastholes, for example spray painting the depth of water next to hole.

8.3.3 Blasting in Hot Material

Hot material is when its temperature is 55°C or more, but less than 100°C. Explosives may detonate prematurely if exposed to high temperatures. Temperature measurements should be taken where hole temperatures are expected to exceed 55°C. It is not possible to recommend a safe exposure time for explosives at various temperatures, because of the wide range of products available and ground conditions encountered. There needs to be a written procedure for blasting in hot ground and guidance for this procedure should be sought from the explosives manufacturer and reference to AS 2187.2.

8.3.4 Blasting in Oxidizing / Reactive Ground

Both sulphide minerals and coal oxidise rapidly when broken and exposed to air. In operations where such minerals become dispersed as dusts, sparks or heat flash from blasting can initiate an explosion. The explosives to be used and the charging practices to be adopted should be developed in consultation with explosive manufacturers. There needs to be a written procedure for blasting in oxidising or reactive ground and guidance for this procedure should be sought from the explosives manufacturer and the following general precautions should be considered:

- Sheathing of ANFO explosives to inhibit exothermic reaction between the explosives and the material to be blasted.
- Wash down all exposed surfaces within the blast vicinity to make fuel unavailable for a secondary explosion.

- Use adequate stemming in all blastholes to inhibit the development of a flame front at the collar of a blasthole.
- Detonating cord is capable of raising and igniting a dust therefore low explosive strength detonating cord that is not in contact with rocks or dust should be used.
- Remote firing, preferably from the surface with the mine evacuated.
- Selection of the correct stemming for such conditions is most important; usually a clay-rock stemming is preferred.

8.4 CHARGING OPERATIONS

8.4.1 Clearing and Measuring Blastholes

All blastholes should be checked prior to loading to ensure they are clear and drilled to the correct depth. Any blocked holes should be cleared with a charging pole or steel bar. Blastholes should have their depth measured and recorded before charging.

8.4.2 Priming

Primer cartridges should be handled carefully and the initiating medium used to form the primer of suitable explosive strength. The primer should be placed in the hole without using undue force and care taken to avoid the presence of extraneous matter between cartridges (AS 2187.2). The following general precautions should be taken when using primers:

- Check that none of the explosives are damaged
- Any damaged explosives are to be disposed of appropriately and reported to the shotfirer (refer Section 10).
- Ensure that the tails of the initiating medium are neatly placed at the base of the hole so that they are secure and away from charging vehicles movements.
- If initiating line or primer is lost down the hole the shotfirer should be notified and the loss recorded and the hole reprimed.

8.4.3 Bulk Explosives

Care is required in the loading of free-flowing granular explosives and pumpable explosives to avoid damage to signal tube or allowing them to be pulled into the hole. The following general precautions should be taken when using bulk explosives:

- The shot should be loaded such that the holes furthermost from the access point are loaded first.
- Charging should be done as to prevent damage to the signal tube and excessive spillage around the hole.
- Care should be taken to ensure continuity of the charge.
- The rate of delivery needs to be such that overfilling of the hole does not occur.
- Where the truck empties during the charging of a particular hole, the hole should be suitably identified to ensure that the loading is completed prior to firing.

8.4.3.1 Pneumatic Charging

Where pneumatic charging devices are used, they shall be effectively earthed. All charging hose are required to be semi-conductive and have a resistance of not less than 15000 ohms/m and not more than 2 mega ohms for its total length (AS 2187.2). Best practice for operation of a pneumatic charging is for antistatic footwear to be used and for the operator to remove their gloves and earth themselves before touching any electric detonator.

8.4.3.2 Charge Vehicles

When charging of explosives is conducted using a charge vehicle and basket, the vehicle needs to have the necessary specifications as outlined in AS 2187.2 and Section 5 of this Guidance Note. It should be noted that charging off the boom of a development jumbo is strongly discouraged due to the numerous hazards present in this practice. The following general precautions should be taken while using purpose built charge vehicles:

- A pre-start check should be conducted to ensure that the vehicle is in sound condition and repair.
- The operator is required to ensure that the tails of the initiating medium are neatly placed at the base of the hole so that they are secure and away from the baskets movements (refer to Section 7.2.4 of this Guidance Note).

- Explosive receptacles should be located on the basket so that explosives are firmly secured. No explosives are to be stored in the articulation region beneath the boom of charge vehicles if there exists the possibility of impacting the explosives.
- The basket should have suitably designed explosive receptacles to reduce the risk of an explosive impacting the ground or getting caught in the basket.
- All personnel operating the charge car need to be competent to monitor any support equipment associated with the delivery of the explosives e.g. pump pressure gauges, emergency stop.
- All personnel working in the basket should use a lanyard to reduce the risk of falling.

Figure 3: Charge car basket with receptacles for explosives

8.4.3.3 Emulsion Loading Vehicles

Where a bulk emulsion vehicle is used to pump the explosive into the borehole, the vehicle is required to have the necessary specifications as outlined in AS 2187.2 and Section 5 (Transport of Explosives) of this Guidance Note. The following general precautions should be taken while using bulk explosives vehicles:

- A pre start check should be conducted to ensure that the vehicle is in sound condition and repair.
- All personnel operating the emulsion-loading vehicle need to be competent to monitor any support equipment associated with the delivery of the explosives, for example the pump pressure gauges or the emergency stop.

- Vehicle access to the shot should be via clearly defined routes designated by the shotfirer and a spotter used to control vehicle movements in areas of restricted visibility (refer to Section 7.2.4 of this Guidance Note).
- The mixing and delivery system should be conducted so that the operator either has full view of explosives deliver point, or has adequate communication with another operator who does have such a view.
- The product should be regularly sampled for quality and density to avoid the possibility of desensitisation by compression (dead pressing).
- When working near the edge of a stope or bench a secure harness system should be considered to reduce the risk of falling.

Figure 4: Underground emulsion vehicles with control operator and observer.

8.4.4 Sleep Time in Blastholes

Sleep time is defined as the time between charging and firing the shot. The sleep time of an explosive is important because explosive can often deteriorate under unfavourable conditions. Conditions such as heat, cold, humidity and water cause the explosive to deteriorate possibly causing failure of the explosives. Product deterioration may result in a charge, or part of a charge, failing to explode (misfire).

Best practice is for explosives to be charged and fired at the earliest practicable time. In large shots load-and-shoot firing eliminates a number of possible processes of deterioration.

8.5 STEMMING

Care should be taken to ensure that the down line connected to the primer is not damaged during the placing of stemming material (AS 2187.2). The following general precautions should be taken when stemming holes:

- A check should be conducted to ensure that the hole has been loaded with explosives and that the collar height is correct.
- The tension on the down lines should be checked to determine whether the primers are in the product.
- Ensure that the stemming material is of a suitable quality and does not contain large fragments of rock that may cause damage to down lines.
- Blastholes charged with gassed bulk explosives should be left unstemmed for the recommended time to allow for gas bubble expansion.

8.5.1 Tamping Rods

Only wooden or other non-metallic tamping rods are to be used when tamping to prevent the possibility of an explosion from shock, friction or impact. Care needs to be taken to ensure that the safety fuse, lead wires, detonating cord or signal tube connected to the primer are not damaged during the tamping process (AS 2187.2).
Note: A primer should never be tamped due to the risk of explosion caused by impact.

8.6 INITIATION

The following general procedure should be considered as hazard controls whilst tying up of shots using non-electric, detonating cord or electric initiated systems:

- Initiation tie-in should not commence until all operating equipment has completed operations in that section of the blast area and the section to be tied-in has been clearly isolated and defined.
- Personnel carrying out the tie-up should either have a tie-up plan or have the necessary experience to determine the required tie-up.
- The tie-up should be conducted in a planned methodical and approved manner.
- After tying up the shot, the tie-up should be checked to confirm that it is correct. The shotfirer is ultimately responsible for the tie-up and is obligated to personally check the tie-up before firing.

8.6.1 Non-Electric Firing

A procedure should be in place that provides a safe system of hook-up of non-electric explosives. Connections and detonating cord charge weight (grams per explosive metre) should be in accordance with manufacturers instructions (AS 2187.2).

8.6.2 Electric Firing

Electric detonators are susceptible to accidental initiation by sources of stray extraneous electricity (AS 2187.2). The following precautions need to be addressed and maintained:

- Keep wire ends, connectors and fittings, shorted (twisted) until immediately prior to use.
- Do not use electric detonators near power lines or other potential sources of electric current.
- If underground the firing is controlled from surface by means of a direct firing cable and an electrical storm is such as to constitute a danger, work in connection with charging and firing should cease.
- Lightning strikes can cause a potential difference underground that can cause possible premature detonation. In the event of an electrical storm the shotfirer is required to assess the immediacy of the storm and decide to fire or disconnect the control row and clear the blast area.
- Keep detonators clear of the ground until charging commences.
- Never hold an electronic delay detonator while it is being tested or programmed.
- Do not use plastic liners in blastholes unless they are genuinely and permanently conductive.

8.6.2.1 Exploders

Only exploders suited to the task should be selected by the shotfirer. Exploders need to be stored in a clean dry place and the shotfirer is required to ensure that exploders are maintained in correct working order (AS 2187.2).

8.6.2.2 Circuit Testers

Before connecting the firing circuit, the detonating circuit and firing circuit shall be checked to ensure continuity of the circuit. It should be assumed when testing that an explosion might occur and appropriate precautions are required to clear the blasting area and choose a safe location for testing. A system should be in place that ensures that circuit testers are maintained in correct working order (AS 2187.2).

8.6.2.3 Electric Firing Circuits

Where a shot firing cable is used to initiate a blast, the shotfirer should ensure the cable is adequately protected and insulated for the conditions under which the blasting is to be carried out. Adequate precautions need to be taken to prevent the cable from coming into contact with electrical installations, metal object and areas where possible damage can be caused to the insulating cover.

The cable should be kept short circuited at each end during the charging operation and at the power end while the leads from the detonators are being connected to each other or to the firing cables. The short circuit at the power end should not be opened for connection to the source power until all persons have been withdrawn from the blasting area. As soon as the blast has been fired the short circuit needs to be re-established by physical disconnection from the exploder.

9 FIRING

9.1 BLAST PERIMETER

The person responsible for the firing of the shot needs to determine the location or distance from the shot of the guarded perimeter. This should be determined from a risk assessment taking into consideration technical concerns or known hazards in the shot. In some instances it may be required that all personnel are removed to the surface before firing.

9.2 WARNING PROCEDURES

9.2.1 External Parties

It may necessary to pre-notify certain external parties before conducting blasts. This may be personnel on the surface, adjoining mines or residences.

9.2.2 Withdraw of Personnel

Persons in the vicinity of the blasting area and adjacent workings need to be warned and withdrawn to a safe area before firing the shot. They should not return until the 'all clear' signal is given (AS 2187.2). Each person involved in firing the blast has to be able to reach a predetermined safe position, by walking at normal pace, before the blasting happens.

9.2.3 Audible Warning Device

Audible warning devices for firing are required for use in underground mines in continuous secondary blasting situations, as apposed to firing at crib time or end of shift. Such devices are usually compressed air driven, and in a grizzley and track haulage situation tied in to warn persons on adjacent levels or sublevels of the imminent blasting.

9.3 Radio Communication

When underground development blasting can occur during the shift and discrete isolation of the hazards associated with such firings can be achieved without evacuation, then effective in-mine communications are essential.

Where a radio channel is used to warn of a firing underground, best practice is to select a blasting radio channel that is always used. This channel should be the most commonly used in the particular field locality of the blasting activities. Where there are likely to be users of other channel in the blast locality, then the firing warning should be broadcast simultaneously on all those channels.

9.3.1 Access Guards

Adequate roadblocks or warning signs or, where necessary guards shall be placed along drives to prevent unauthorised machinery or people entering the blast area or exclusion zone (AS 2187.2). All means of entry to the blasting area need to have guards to prevent unauthorised access or effective barricades erected across each place of entry.

The shot should not be fired unless persons have been removed to the ventilation intake side of the place where firing is to take place and where the resultant fumes and dust will not affect them.

9.3.1.1 Competency of Guard

The blast guard is required to understand where their location is and the sequence of events that will take place while the shot is being fired. They should park their vehicle at 90 degrees to the flow of traffic and have suitable markings. If someone does drive past the blast area they shall notify the shotfirer immediately so that the blast is stopped.

9.3.1.2 Guard Location Sheet

Where there are numerous guards required, say three or more, best practice is for a guard location and radio procedure record to be kept with persons who perform the duty of blast guard and the shotfirer. This document can include such things as blast guard's names and responsibilities. A pre-firing security check is then to be undertaken by the shotfirer using the radio and a map of the blast area to confirm the guard's locations. This alleviates the possibility of a blast guard not being involved in the final check by the shot firer prior to firing.

9.4 BLASTPED FIRING

The underground BlastPED uses the PED Transmission System to communicate with remotely installed receiver/exploders to remotely initiate electric detonators or starters. Where a BlastPED is used for remote firing the firing cable should be shorted (twisted) together until ready to connect up to the terminals of the receiver. The user connecting the cable should ensure that the BlastPED is not synchronised or the key turned to the firing position until immediately prior to firing. It is then up to the PED call operator to enter the 'arm and blast' command from security disk and transmit the messages, once the area has been cleared of personnel and permission received to fire.

Figure 5: Underground remote blasting using BlastPED system.

9.5 BLAST MONITORING

Where blasting is conducted in close proximity to buildings or structures, ground vibration and airblast overpressure needs to be monitored to record the blast characteristics and in the longer term provide help to ensure that the probability of damage or human discomfort is kept to a minimum. Where vibration is of concern the explosive weight per delay should be limited. Where protection from fly is necessary, precautions such as the use of blasting mats or other suitable cover and limiting the explosive weight per delay can be used.

10 POST FIRING

10.1 EXAMINATION OF SHOT

The shot firer is responsible for examining the site to ensure that no unfired explosives remains and that it is suitable for work to commence again. Before examining the shot, consideration should be given to the noxious fumes present and integrity of surrounding areas (AS 2187.1). Fumes and toxic gases arising from the explosion should have been effectively dispersed before re-entry of any persons. Senses of sight and smell should be sufficient for most determination, but oxygen deficiency is a real risk and caution is advised in small headings. In these instances the mine atmosphere should be sampled. If no misfires are evident, the 'all clear' signal can be given and the blast guards dismissed.

10.2 MISFIRES

A written procedure or standard work instruction is required that provides a safe system of entry and inspection for misfires and their treatment. This is to include the method used for the detection of a misfire. The precautionary interval allowed before the shotfirer can conduct an examination of the site and the recording and treatment of misfires. A written record of the location and details of the misfired shot is to be kept. By definition in the Explosives *Act 1999* an "explosive incident" is an event, including a misfire, with the potential to cause death or injury to a persons or unexpected damage to property and as such is required to be reported to the Chief Inspector of Explosives

10.2.1 Determination of Misfires

Every hole that has been charged with explosives is considered a misfire until proven otherwise. Methods used to determine if a misfire has occurred are based on many factors, including appropriate training, standard work instructions and guidance from AS 2187.2. There are certain events that indicate a misfire has occurred, these include:

(a) If using safety fuse, the number of shots counted is less than the number of holes fired or a disagreement on the count of shots fired.
(b) If damaged safety fuse, detonating cord, lead wires or unfired signal tube is exposed in a hole that has been fired.

(c) Evidence of cutoffs, butts or remaining portions of holes (e.g. boulders with drill holes) that are suspected of containing explosives has been shown to be free of explosives.

(d) Holes that have slumped between charging and firing due to dispersion of the explosive from water ingress or through joints and fissures.

(e) If during the normal excavation of the blasted ground, uninitiated or residual explosives are found or the load out machine encounters poor 'diggability' of the blasted ground.

The shotfirer should conduct a careful examination amongst the debris for explosives, which if present shall be removed to a safe place and disposed of in accordance with Section 10.1 of this Guidance Note.

10.2.2 Treatment of Misfires

The method used to treat a misfire should be based on risk assessment and a combination of other factors, including appropriate training, standard work instructions and information in AS 2187.2. The following methods can be utilised for the treatment of potential and determined misfires:

(a) To remove the hazard of residual explosives and blasting gases trapped within the blast it is best practice to use water sprinklers on the shot area immediately after firing.

(b) Stemming may be removed by applying water under pressure, compressed air, or a mixture of water and compressed air through a non-ferous blowpipe. After removal a fresh primer can be inserted and the blasthole stemmed and fired. **Note:** The use of compressed air alone is not encouraged. Where it is used, special precautions should be taken to minimise the dangers from static electricity and impact (AS 2187.2)

(c) If the down lines are considered to be in good condition, an attempt may be made to refire. Drilling a relieving hole parallel to the original blasthole and charging and firing.

(d) Drilling a relieving hole parallel to the original blasthole and charging and firing.

(e) If a misfire is suspected at any time during mining operations, the operations have to cease and a detailed inspection conducted by a shotfirer, or competent person, should commence.

11 DISPOSAL OF SURPLUS AND DEFECTIVE EXPLOSIVES

11.1 EXPLOSIVES

Explosives that are considered unsafe to transport or for storage are required to be destroyed in a safe manner in compliance with AS2187.1 – Section 8. Explosives are not to be thrown away, buried or placed with garbage but treated in the following approach:

(a) Explosives other than detonators can be disposed of by burning, detonating (providing a fresh charge is used and no detonators are inserted into deteriorated explosives) and by dissolving in water.

(b) Detonators and detonating relays may be disposed of by either detonation or burning in a furnace specially constructed and approved for the purpose.

11.2 EXPLOSIVE PACKAGING

Best Practice for the disposal of explosives is for a system to be in place so that empty explosive packaging is double checked by independent people before disposal. In instances where explosive packaging is to be used for other applications the labels should be clearly marked as to not create uncertainty of the packagings contents. Disposing of the explosives in a separate container from normal waste will ensure that discrepancies resulting from accidental disposal can possibly be traced.

12 LIST OF REFERENCED DOCUMENTS

Australian Standards

AS 1019	Internal combustion engines – Spark emission control devices
AS 1850	Portable fire extinguishers – Classification, rating and performance testing
AS 1915	Electrical equipment for explosive atmospheres – Battery-operated vehicles
AS 2187.0	Explosives – Storage, transport and use Part 0: Terminology
AS 2187.1	Explosives – Storage, transport and use Part 1: Storage
AS 2187.2	Explosives – Storage and use Part 2: Use of explosives
AS 2188	Relocatable magazines for storage
AS 2380.1	Electrical equipment for explosive atmospheres – Explosive protection techniques – General requirements
AS 2381	Classification of hazardous areas – Explosive gas atmospheres
AS 3000	Electrical Installations
AS 3570	Automotive Diesel Fuel
HB13	Electrical equipment in hazardous areas - Handbook
AS 4360	A basic introduction to managing risk

Other Publications

1) Australian Explosives Code 2000 – Australian Code for the Transport of Explosives by Road and Rail
2) ESC-1 Electrical Installations and Equipment in Hazardous Areas at Explosives Manufacturing Facilities and Storage Areas

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