

Guidance Note

QGN10

Handling Explosives in Surface Mines and Quarries

Explosives Act 1999

Mining and Quarrying Safety and Health Act 1999

Coal Mining Safety and Health Act 1999

October 2008, Version 4

GUIDANCE NOTE – QGN10

Handling Explosives In Surface Mines And Quarries

This Guidance Note has been issued by Safety and Health of the Department of Natural Resources and Mines to provide guidance in handling explosives in surface mines and quarries.

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

QGN10 - HANDLING EXPLOSIVES IN SURFACE MINES AND QUARRIES

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 Explosives in Surface Mines and Quarries*, covers an important aspect of safety and health in the mining and quarrying 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 and to advise of best practice, 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
- *Explosive Act 1999*.



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Chief Inspector of Mines



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Chief Inspector of Explosives

1 PURPOSE AND SCOPE

This Guidance Note QGN10 is provided to assist competent persons in the safe and secure storage, use and transport of explosives within the Queensland mining and quarrying industries. The note provides information to be considered during the risk management process to assist in determining acceptable surface 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 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 surface mining and quarrying operations using explosives. Persons responsible for the storage, transport and use of explosives at mining or quarrying operations should consider their site circumstances and their training and experience when assessing or reviewing safety standards using accepted 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 SURFACE MAGAZINES

2.1 LOCATION OF MAGAZINE

2.1.1 Public Risk

When siting a magazine the risk management process can be carried out to identify hazards that may arise from its proximity to public installations, facilities and roads. Risk acceptability should be evaluated based on the quantity of explosives stored in the magazine (magnitude of the hazard) and the possible consequences of an unplanned explosive incident.

2.1.2 Proximity to other Magazines

The separation distance of magazines in proximity to each other should be determined based on the quantity of explosives stored and the magazines used. Further guidance can be attained from AS2187.1 – Table 3.3.3.2 in relation to distances from protected works and separation distances from other explosive magazines and ammonium nitrate storage.

2.1.3 Proximity to Ignition Sources

When siting the magazine the risk management process can be carried out to identify hazards that may arise from its proximity to likely ignition sources. Such sources arise from proximity to refuelling depots, vegetation, rubbish or mineral matter. Magazines are required to have the immediate and adjacent area cleared of any substance likely to cause sparks or catch fire, and to establish an acceptable firebreak around the magazine. **Note:** Guidance on the width of the firebreak can be attained from local fire fighting authority, or Queensland Fire and Rescue Service.

2.1.4 Vehicle Access Routes

When siting the magazine a risk management process can be carried out to identify hazards that may arise from proximity to vehicular access routes and roadways used on site. The number of access routes to the magazine and the types of vehicles and the frequency of their proximity to the magazine should be considered (AS 2187.1). Best practice is ensuring that all vehicles perform at least one 90 degree turn to access a magazine location thus reducing the risk of an out of control vehicle having direct route into the storage area.

2.1.5 Activities within site

When siting the magazine a risk assessment can be carried out to identify hazards that may arise from proximity to other activities on site. Mining activities that involve employees and equipment should be at a safe distance in the event of an explosive incident occurring (AS 2187.1).

2.1.6 Weather Protection

When siting the magazine, it should be located as to provide all-weather access. This includes adequate drainage to prevent deterioration of the access roadway and prevent water entering into the magazine (AS 2187.1). In conditions where adequate drainage cannot be provided catchment tanks such as that shown below in Figure 1 can be utilised to protect the magazine from water ingress.



Figure 1: Water catchment on the side of a magazine

2.1.7 Use of Natural Ground Features

When siting the magazine, the use of natural ground features should be considered to enhance physical protection of employees and the public. Alternatively, mounds can be built around the magazine to provide additional protection (AS 2187.1).



Figure 2: Relocatable magazine protected by earth mounds

2.1.8 Security

When siting the magazine, do not make it easy for unauthorised personnel to locate or access the magazine. If possible it should be located on site in a position that is not viewable from outside the mine or quarry. Adequate security installations should be in place to prevent accidental or unauthorised disclosure of the magazine location (AS 2187.1).

2.1.9 Licences

A person is required to hold an authority to store explosives for a quantity of explosive of 10 kg or more.

Quantities of less than 10 kg are exempt from a license to store, however a person licensed to use explosives is the only person allowed to possess such explosives.

2.2 FABRICATION REQUIREMENTS

2.2.1 Portable Magazines

All portable magazines have to be constructed in accordance with specifications given in AS 2187.1, or with a system of at least equivalent safety and security approved by the Chief Inspector of Explosives.

2.2.2 Relocatable Magazines

Relocatable magazines have to be constructed in accordance with specifications given in AS 2187.1, or with a system of at least equivalent safety and security approved by the Chief Inspector of Explosives.

Explosives in excess of 10kg may only be stored in a relocatable magazine by a person who holds an authority to store and who stores the explosives in accordance with the licence, conditions imposed, and applicable regulations (*s44 Explosives Act 1999*).

2.2.3 Fixed or Permanent Magazines

Fixed or permanent (non-relocatable) magazines located above ground are to be constructed in accordance with specifications given in AS 2187.1, or with a system of at least equivalent safety and security approved by the Chief Inspector of Explosives.

Explosives in excess of 10kg may only be stored in permanent magazines by a person who holds an authority to store and who stores the explosives in accordance with the licence, conditions imposed, and applicable regulations (*s44 Explosives Act 1999*).

2.2.4 Bulk Explosive Storage

Storage tanks used for bulk explosives such as ANFO and bulk emulsions are to be constructed in accordance with specifications given in AS 2187.1 and the Australian Explosives Manufacturers Safety Committee (AEMSC) Code of Practice for the Precursors for Explosives, or with a system of at least equivalent safety and security approved by the Chief Inspector of Explosives.

All bulk explosive storage facilities require that a person holds an authority to store and stores the explosives in accordance with the licence, conditions imposed, and applicable regulations (*s44 Explosives Act 1999*). Security and safety considerations given to bulk explosive storage facilities need to be equivalent to that of explosive magazines.

2.2.5 Magazine Exteriors

Persons and machinery approaching any magazine should be able to clearly distinguish the magazine. Magazines should be painted in a light colour to maximise light reflectance and be protected against corrosion to prevent structural damage and deterioration (AS 2187.1).

2.2.6 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 SECURITY

2.3.1 Remote Security

To enhance the security of a surface 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 and camera fittings and installations inside the explosive storage area are required to comply with AS 3000 for electrical equipment in hazardous locations (refer to Section 1.6.2.2).

2.3.2 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 needs to 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.

2.3.3 Holding Down Bolts

Where there exists the possibility of the magazine being removed by unauthorised persons a provision should be made for holding-down bolts or another equivalent method to protect external portable and relocatable magazines (AS 2187.1).

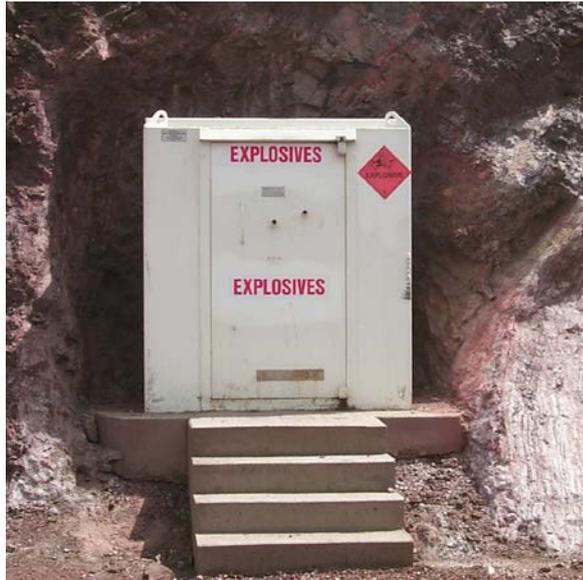


Figure 3: Relocatable magazine fixed in cement to prevent unauthorised removal

2.3.4 Perimeter Fences

A perimeter fence should be installed around the magazine for additional security purposes. In determining whether fencing is required, consideration should be given to the magazine's location and security requirements. It should be noted that a perimeter fence is not intended to provide complete security of explosives, but act as a deterrent to unauthorised access. Guidance on the fabrication of the fencing can be found in AS 2187.1.



Figure 4: Magazine with chain and barbed wire fencing

2.3.5 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.

2.4 MARKINGS

Every magazine is to be marked on the door or lid with either the word 'EXPLOSIVE' or 'DETONATOR,' as appropriate. The markings are required in red lettered characters on a white background and sized to make them clearly defined. 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 area.

A sign is also required at the entrance of the magazine to warn persons at the magazine of their liability to penalty for an offence if reasonable precautions and reasonable care is not taken to prevent an explosives incident at the magazine (*s48 Explosives Act 1999*).



Figure 5: Explosive hazard class diamond

2.5 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 and segregation 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.

2.6 UTILITY REQUIREMENTS

2.6.1 Water Installations

If water is required within the vicinity of the magazine, the location of the installation needs to be so as to prevent water coming into contact with the explosives. It should be positioned as to not cause erosion or degradation to the access or foundations of the magazine. If necessary, a sump should be used to prevent water from accumulating in areas.

2.6.2 Electrical Installations

2.6.2.1 Lighting

Lighting in magazines may be either natural or artificial. 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. 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.

2.6.2.2 Electrical Equipment

Electrical equipment and installations should be avoided if possible, due to the inherent risks associated with their presence. Electrical arcing of equipment can produce an ignition source that is capable of initiating certain explosives. If electrical wiring or installations are necessary inside the magazine it needs to be in accordance with electrical equipment for hazardous areas (AS 3000). Professional advice should be sought before installing electrical equipment in magazine areas.

2.7 ENVIRONMENTAL CONDITIONS

2.7.1 Ventilation

Ventilation should be adequate to ensure that with the magazine doors closed there is no accumulation of dangerous vapours or excessive heat build up (AS 2187.1). If inhaled certain explosives such as primers can be toxic to persons. There is additionally an explosive risk when explosives are exposed to high temperatures. Air vents should be suitably designed to provide sufficient fresh air circulation and protection from the weather as well as prevent access of persons and foreign objects.

2.7.2 Shade Roof

The magazine should be designed and 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 can be reduced for some explosives. Where the external environment conditions are likely to cause excessive internal temperature fluctuations, a shade roof or similar device should be provided (AS 2187.1).



Figure 6: Shade roof on a steel relocatable magazine

2.8 EMERGENCY INSTALLATIONS

2.8.1 Lightning Protection

2.8.1.1 Vertical Conductors

The need to protect structures and buildings containing explosives within the vicinity or inside the magazine from lightning, can be determined in accordance with AS 1768 – Section 2. Magazines or structures with explosive contents need to be protected from lightning.



Figure 7: Vertical conductor used to protect relocatable steel magazines

2.8.1.2 Earth Terminations

Where earthing terminations are required for lightning protection or the control of undesirable extraneous electricity they need to be in accordance with AS 2187.1.

The number of earthing termination for magazines is as follows:

- (a) For a portable magazine – one.
- (b) For a modular steel or concrete relocatable magazine – at least two at diagonally opposite corners
- (c) For a tank magazine – at least two at diagonally opposite corners.



Figure 8: Earthing terminations on a steel relocatable magazine

2.8.2 Fire Fighting Equipment

As required, fire hydrants and on site fire installations should be positioned at the magazine access or immediately inside the magazine. It should be noted that in the case of an actual explosive burning no attempt is to be made to fight the fire. Fire fighting equipment is located in the magazine to prevent the possible spreading of a fire to an explosive. Selection of suitable fire extinguishers and hydrants is dependent on the hazards present within the magazine area. The suitability of an extinguisher for uses on fires that involve paper, wood, liquids or electrical equipment can be determined in accordance with AS 1850 e.g. dry powder, water. Fire hydrants should be clearly marked and have a service tag. Best practice is to advise the local fire brigade and other emergency services of the magazine's location.



Figure 9: Fire fighting equipment clearly accessible inside the magazine perimeter

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, and in transit, 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, whilst the explosives are on this mine. 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 COMPETENCY OF PERSON

The person who accompanies or escorts the explosive suppliers vehicle to the magazine is obligated to identify the safest and most direct route to be travelled on the mine site. Best practice is for the person escorting the explosive suppliers vehicle to use a selected high frequency radio channel to broadcast to other personnel and mobile equipment the explosives vehicles selected route to the magazine. It is recommended that a vehicle carrying explosives should not come closer than three meters to any type of radio or radio- wave emitting source.

4.2 ROUTE SELECTED

The route selected should take into account the explosive vehicle's ability to travel on unsealed surfaces. Certain explosives are at a risk of explosion by friction, shock or impact. The road base should be suitable to ensure that the movement of the explosives within the vehicle is kept to a minimum.

4.3 ACCESS TO MINING AREA

The explosives should be promptly secured in the magazine and inventory confirmed unless the site safety and health management system or procedure provides otherwise.

In instances where delivery is to be made to the charge area the vehicle driver shall be accompanied or escorted by a competent person and given a direct and safe route and precise instructions of where unloading is to take place.

The vehicles used to transport the explosives are typically only for highway use. Consequently, such a vehicle attempting to access pit areas or steep gradients that mining equipment utilise presents an additional risk. Other vehicles, or equipment should never be used to push explosive trucks.

5 MANAGEMENT OF THE MAGAZINE

5.1 STOCK CONTROL

5.2 Person in Charge of Magazine

A person in charge of the magazine will 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 Section 4 of AS 2187.1 and include the following.

5.2.1.1 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 also 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).

5.2.1.2 Explosive Limits

The person appointed in charge of the magazine needs 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.

5.2.1.3 Stacking Packages

The person appointed in charge of the magazine is obligated to check that the packaging for the explosives, to be stored in the magazine, is of such construction strength and character that it cannot break or open accidentally and are required to be stacked to a height no greater than that 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 space is to be maintained between the explosives and the magazine walls and ceilings (AS 2187.1).

5.2.1.4 Rotation of Stock

The person appointed in charge of the magazine needs to 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).



Figure 10: Explosives stacked with their labelling towards the access way for easy identification.

5.2.1.5 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 the date of receipts and the quantities received, the date and quantity booked out and 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.

5.3 HOUSEKEEPING

5.3.1 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.

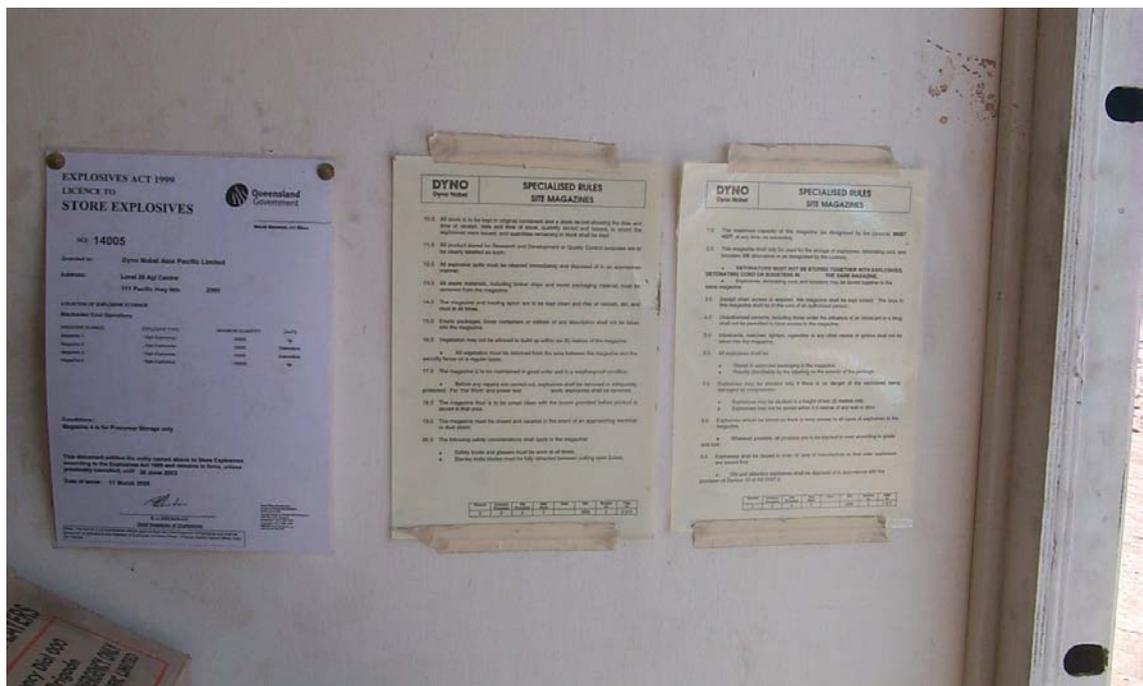


Figure 11: Magazine rules displayed in an easily viewable position inside the magazine

5.3.2 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 compound for discarding of such items before entering the magazine.

5.3.3 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 correct condition.

5.3.4 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 at risk of explosion by friction and packages should be open using non-sparking tools.

5.3.5 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 retardant clothing, eye protection and gloves. Appropriate personal protective equipment signs should be displayed at the magazine entrance.

5.4 PROCEDURES

5.4.1 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 person 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, district worker representative and the police (*s195 Mining and Quarrying Safety and Health Act 1999* and *s198 Coal Mining Safety and Health Act 1999*).

5.4.2 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.

5.4.3 Maintenance

A system or written procedure should be in place to inspect and maintain the magazine installations to the required standard. 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 system is required, that includes a fire watch to be conducted extending at least one hour after the completion of the maintenance work.

5.4.4 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 local emergency services should develop an emergency procedure.

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

5.4.5 Thunderstorm and Dust Storms

A system or written procedure should be in place to deal with atmospheric electrical activity or a dust storm approaching a magazine area. The procedure should include provision for all uncharged explosives to be placed in the magazine, the magazine secured and any mobile manufacturing units should be relocated to a area that has been predetermined for such an event. All personnel are to be withdrawn to a designated safe area and no person should return until an authorised person determines that it is safe to do so.

6 TRANSPORT OF EXPLOSIVES

6.1 GENERAL VEHICLE REQUIREMENTS

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

- be in sound mechanical condition and repair.
- 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 needs to be thoroughly cleaned, and inspected by a person who has the necessary competence and then certified in writing by that person to be free of explosive residues.

6.2 HIGHER RISK TRANSPORT OF EXPLOSIVES

The degree of risk and subsequent requirements for vehicles carrying explosives on a mine site 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:

Hazard – Fuel fire

- Use a diesel engine vehicle in preference to petrol since petrol has a very low flash point.

Hazard – Electrical fault

- 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 in a vehicle with a radio transmitter unless the radio is capable of being isolated, locked out 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.



Figure 12: Explosives vehicle at a mine site with separate explosives receptacles and fire extinguishers.

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.
- Where a vehicle is parked on a slope it should be suitably located to avoid the possibility of unplanned movement.

6.4 VEHICLE MARKINGS

Vehicles, that are used to carry explosives, need to be identifiable. This is to be achieved by 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.

6.5 COMPETENCY OF PERSONS

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

6.6 VEHICLE ACCESS TO EXPLOSIVE STORAGE SECTION

Where vehicles have access to the explosives storage section of the magazine (e.g. forklifts), 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.

6.6.1 Internal Combustion Engines

Every internal combustion engine that powers a 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 Section 5.1 and 5.2 of this Guidance Note.

6.6.2 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 (AS 1915). 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 Section 5.1 and 5.2 of this Guidance Note.

6.7 MATERIALS HANDLING EQUIPMENT

6.7.1 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 protected by conduit can largely control these hazards. Further guidance for the requirements of pumps in explosive areas can be attained from AS 2187.1.

6.7.2 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 for 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 be adequately designed for the selected drill pattern. Correct drilling of blast designs will ensure that safety hazards such as overbreak, fly or airblast overpressure are significantly reduced. 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 that 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 along the edge of the bench 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 edge the drill rig should be orientated so as to reduce the risk of the drill rig toppling.
- 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:

Current and valid shot firing ticket or licence applicable in the relevant State or Territory.

Currency with relevant competencies or qualification, attained through a national training package (i.e. endorsed by Australian National Training Authority).

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.”

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 current shotfirer’s 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.

For surface coalmines a shotfirer's licence under the *Explosives Act 1999*, is required for the person in charge whilst others involved in storage, handling or use of explosives are required to be competent in accordance with the relevant competencies in MNC04, the National Coal Training Package.

8.1.2 Blast Design

Blasts should be planned and designed by persons 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 Appendix A of 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. The potential risks should be identified and suitable equipment selected for the procedure. This may include personal protective equipment such as fire retarding clothing, gloves, goggles and in some instances, 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. Unauthorised personnel and machinery not involved in the blasting operation needs to be removed a safe distance from the area (AS 2187.2).

8.2.4 Mobile Equipment on Non-electric Blast

Where mobile equipment is used on non-electric blasts 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. Where charged holes are to be left to sleep over night suitable warning signs and lighting is to be utilised. Approaching machinery and person needs to be able to clearly identify the charge area. If further warning is required an overnight guard can be utilised to direct persons and mobile equipment around the shot area.

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, mobile telephones two ways, etc. Safe distances for electric detonators subject to radio frequency radiation can be determined from AS 2187.1 – Appendix I, however such devices should never be carried whilst holding or connecting electric explosives.

8.3 EXPLOSIVES SELECTION CRITERIA

8.3.1 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 the hole.

8.3.2 Blasting in Hot Material

Hot material is a substance that exhibits a temperature between 55°C and 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.

8.3.3 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.

Selection of the correct stemming for such conditions is most important; usually a clay-cock 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. All blastholes should have their depth measured and recorded immediately before charging. Short holes can lead to overcharging and digging problems, while overcharged blastholes can cause fly and airblast hazards.

8.4.2 Distribution of Pegs and Primers

The pegs should be positioned in a standardised pattern in relation to each hole so that when the hole is stemmed, the loader can work in a uniform manner. The peg needs to be securely placed in the drill cuttings so that down lines are not drawn into the hole. Explosive accessories should be distributed and placed along side the peg near the hole. They should not be placed in the drill cuttings or in a position where a vehicle could possibly run over a primer causing an unplanned explosion.

8.4.3 Priming

Primer cartridges should be handled carefully and the down line used to form the primer of suitable explosive strength (AS 2187.2). The primer should be located in the hole without using undue force and care taken to avoid the presence of extraneous matter between cartridges. The following general precautions should be taken whilst priming blastholes:

- Check explosives for damage.
- Any damaged explosive is to be disposed of appropriately and reported to the shotfirer (refer to Section 10).

- Down line securely tied to a peg to avoid primer being drawn into the hole (slumping).
- Ensure that the tails of the down lines are neatly placed at the base of the peg so that they are secure and away from any vehicle movements.
- If a down line or primer is lost down the hole the shotfirer should be notified and the loss recorded and the hole reprimed.
- Never remove a jammed primer by applying excessive force. Multiple priming should be used if original primer cannot be removed.

8.4.4 Bulk Explosives

Care is required in the loading of free flowing granular explosives and pumpable explosives to avoid damage to down lines or allowing them to be pulled into the hole (AS 2187.2). The following general precautions should be taken whilst using bulk explosives:

- The shot should be loaded such that the holes furthest from the access point are loaded first.
- Charging should be done as to prevent damage to the down lines and excessive spillage around the hole.
- The product should be regularly sampled for quality and density to avoid the possibility of desensitisation by compression (dead pressing).
- 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.

8.4.4.1 Mobile Manufacturing Vehicle

Where a mobile manufacturing unit 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 precaution should be taken while using bulk explosives vehicles:

- A pre start check needs to be conducted to ensure that the vehicle is in sound condition and repair.

- All personnel operating the mobile manufacturing unit need to be competent to monitor any support equipment associated with the delivery of the explosives e.g. pump pressure gauges, emergency shut off.
- The mixing and delivery system needs to be conducted so that the operator either has full view of explosives delivery points, or has adequate communication with another operator who does have such a view.
- Mobile vehicle access to the shot should be via clearly defined access routes designated by the shotfirer and a spotter used to control vehicle movements in areas of restricted visibility.
- When working near the edge of the bench a risk assessment should be performed to ascertain what types of hazard controlling mechanisms will be needed. From these results, it is then possible to determine if a secure harness system is needed to reduce the risk of falling.
- Before access to public roads, any explosive residue should be washed with water from pump hoses, explosive mixing receptacles etc.

8.4.4.2 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 operators to remove their gloves and earth themselves before touching any electric detonator.

8.4.5 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 or misfiring. 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. In the *Coal Mining Safety and Health Regulation 2001*, surface coal mining operations should include in their safety and health management system the stated allowable period for the explosives to remain in the ground before being detonated.

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 whilst stemming blastholes:

- A check should be conducted to ensure that the hole has been loaded with explosives and that the collar length 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.
- If loading with a front-end loader the operator should ensure that the bucket approaches the hole from the side opposite to the peg securing the initiating line (refer to section 7.5.2).

- Blastholes charged with gassed bulk explosives should be left unstemmed for the recommended time to allow for gas bubble expansion.
- All loaded holes should be stemmed prior to the end of the shift. In cases where this is not possible consideration should be given to blocking the hole with a gasbag or covering it with drill cuttings.

8.5.1 Tamping Rods

Only wooden or other non-metallic rods are to be used when tamping to prevent the possibility of an explosion from shock, friction or impact. Take care and 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.

8.5.2 Front-End Loaders

Where loaders are used for the loading of stemming into charged holes the vehicle is required to have the necessary modifications for operation within the vicinity of an explosive area (AS 2187.1). Stemming should be completed as soon as possible and care should be taken to ensure that down lines are not accidentally run over or caught up in the loader (snap, slap, shoot phenomenon). A spotter should be used to control vehicle movements in areas of restricted visibility.

8.6 INITIATION

The following procedures 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 have a tie-up plan.
- The tie-in 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-in and is obligated to personally check the tie-in before firing.

- In the event of a possible electrical storm developing during the tie-in the person in charge has to assess the immediacy of the storm and decide to fire or disconnect the control row and clear the blast area. **Note:** High-energy discharges of electricity are capable of detonating various forms of non-electric signal tube.

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 of explosives per metre) should be in accordance with manufacturers instructions (AS 2187.1).

8.6.2 Electric Firing

Electric detonators are susceptible to accidental initiation by sources of stray extraneous electricity (AS 2187.2). To reduce the risk of accidental ignition the following controls 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.
- Cease all surface charging operations if an electrical storm is imminent. Lightning detector devices can be used to track storms and lightning strikes giving greater determination of whether surface charging operations should be ceased. The type of detector selected should be appropriate for the type of charging operation, and use of a detector needs to be in accordance with site and manufacturers instructions
- 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. Exploder's are preferably 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 that when testing an explosion might occur and appropriate precautions are required to clear the blasting area and choose a safe location for testing. The shotfirer is responsible to ensure that the circuit tester used is 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 person who uses the cable should ensure the cable is adequately protected and insulated for the conditions under which the blasting is to be carried out. Adequate precautions are essential 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 is to 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 has 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 is the person who has to determine the exclusion zone and the location or distance from the shot of the guards. This should be determined from a risk assessment taking into consideration technical concerns or known hazards in the shot.

9.2 WARNING PROCEDURES

9.2.1 External Parties

It may necessary to pre-notify certain external parties before conducting blasts. This may be adjoining mines, residences or such things as warning air traffic controllers against low flying aircraft movements.

9.2.2 Withdraw of Personnel

Persons in the vicinity of the blasting area need to be warned and withdrawn to a safe area outside the exclusion zone 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

An audible warning device can be used to indicate that a blast is going to take place. The device should produce a sound that is clearly identifiable from any other sound, which might be used for warning or operational signals on the site (AS 2187.2). Signs should be provided indicating the audible warning device is a signal that blasting is taking place.

9.2.4 Radio Signal

Where a radio is used to give an audible signal all personnel onsite should clearly understand the implication of the signal. Whilst the signal is audible all personnel should maintain radio silence, except for extraordinary circumstances.

Where there is more than one radio channel used on a site, best practice is to select a blasting radio channel that is always used for this purpose.

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.

9.2.5 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.



Figure 13: Access guard with signage

9.2.5.1 Competency of Guard

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

9.2.5.2 Guard Location Sheet

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

9.3 BLASTPED FIRING

The BlastPED EXEL System allows remote, centralised blasting using a radio based link between the shot firer and blast site. Where a BlastPED is used for remote firing the user needs to ensure that the remote receiver is on and the signal tube connected to the 'sparker' only immediately prior to firing. Once the area has been cleared of personnel and permission to fire received, the master control operator can turn the controller on (from a remote and safe location), enter their PIN, and check the status of the receiver via the encoded radio link between the units. The 'arm and blast' commands can then be transmitted.

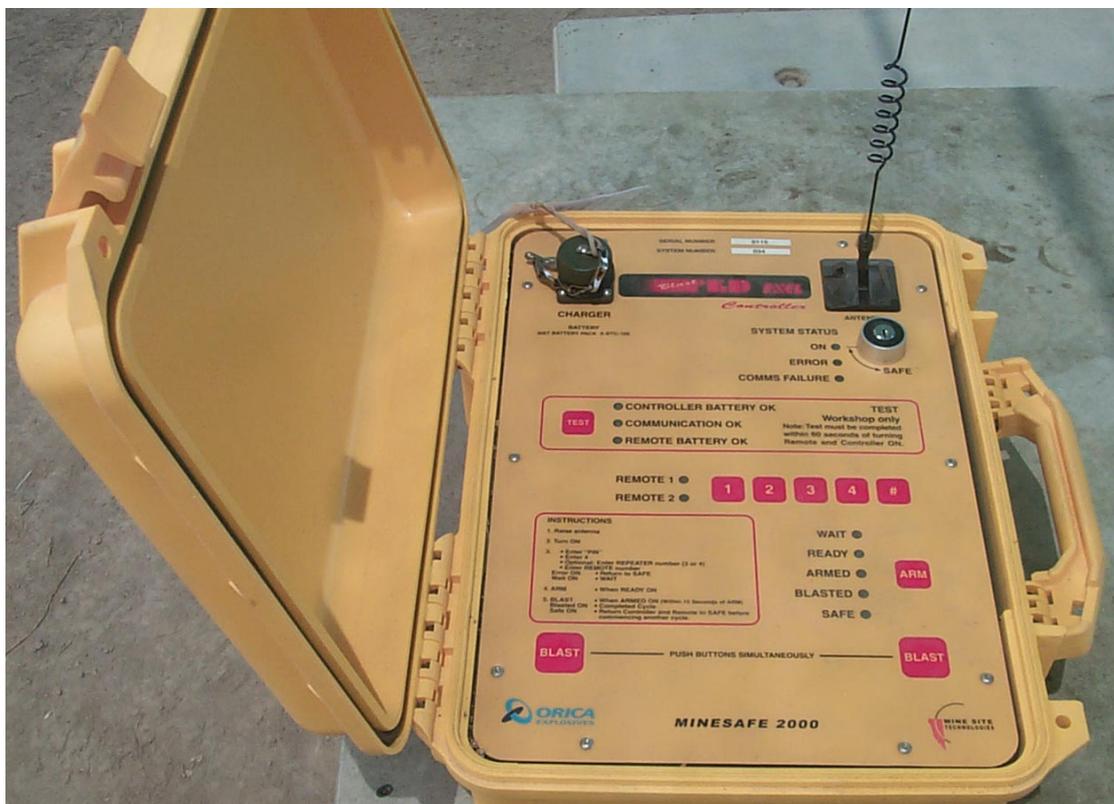


Figure 14: Master Control Unit used in BlastPED Excel remote firing

9.4 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 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 or additional hazards have been created and that it is suitable for work to commence again. Before examining the shot, consider the potential for hazards such as noxious fumes to be present and the ground integrity of the immediate and surrounding area. In surface blasting these hazards can be effectively controlled by using sight and smell for determination of risk acceptability. 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. It 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 persons or unexpected damage to property and as such is required to be reported to the Chief Inspector of Explosives (*s55 Explosives Act 1999*).

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 operating procedures 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 a risk assessment and a combination of other factors, including appropriate training, standard operating procedures 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-ferrous 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.
- (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.

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 packaging's 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 1768	Lightning protection
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 3000	Electrical equipment in hazardous locations
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