

GUIDELINES



MDG 1012

DRAFT

“Guidelines on the Use of Explosives in Underground Coal Mines”

Prepared by:

A.A. Ryan
R. Gibbons
Dr. A. Green
S. Lott
B. McKinnon
Prof. Gour Sen
R. Stothard
B. Woolnough

July 1999

Author: A.A. Ryan
Production: P.G. Walker
Word processing: A.A. Ryan
Editing: R.A. Facer & P.G. Walker
Layout:

DRAFT

Recommended citation

Department of Mineral Resources, 1999. *Guidelines on the Use of Explosives in Underground Coal Mining*. MDG **1012**, New South Wales Department of Mineral Resources, Sydney, xxpp.

Copyright

? Disclaimer

? ISBN or ISSN

FOREWORD

Safety in mines, including underground coal mines, is a matter of utmost importance for all direct and indirect participants in the industry. These *Guidelines on the Use of Explosives in Underground Coal Mines* have been prepared to provide information and suggestions about the safe procedures concerning explosives and shotfiring. There is at present only limited use of explosives in underground coal mines in Australia, but that may enhance the need for awareness of safe procedures.

These Guidelines have been prepared to complement the *Coal Mines (Underground) Regulation 1999* under the *Coal Mines Regulation Act 1982*. The new Regulation is one of three new Regulations to replace the existing 35 sets of Regulations. (Both the existing and the planned Regulations are under the *Coal Mines Regulation Act 1982*.) The complementary new Regulation is to be known as the *Coal Mines (Underground) Regulation 1999*. (The other two new Regulations are the *Coal Mines (General) Regulation 1999* and the *Coal Mines (Open Cut) Regulation 1999*.)

These Guidelines have drawn extensively on the existing Regulation. In part this is because the new Regulation will provide fewer details about specific aspects of explosives, detonators and shotfiring. Reference should still be made to Part 10 of the *Coal Mines (Underground) Regulation 1999*.

DRAFT

The new Regulation, however, provides for important initiatives for underground coal mines in New South Wales. These Guidelines have been specifically designed as a supporting document for the Regulation. For example, mine managers are encouraged to develop and implement systems or management structures for the safe handling and use of explosives and detonators and for safety duties and procedures of shotfirers and shotfiring operations.

These Guidelines provide practical advice to New South Wales coal mine employers and employees regarding safe explosives practice and use in underground coal mines. It is anticipated that all managers of such mines will work with "stakeholders" in reviewing and, if necessary, modifying and improving safe explosives and shotfiring practices.

There are several pieces of legislation about health, safety and dangerous goods which must be considered with the *Coal Mines Regulation Act 1982*, and Regulations thereunder. A selection of those Acts, a selection of relevant Australian Standards, and of certain other Codes, is listed in the introduction to these Guidelines.

These Guidelines will be reviewed as required, especially after the new Regulations are introduced and after discussions with industry.

ACKNOWLEDGMENTS

These Guidelines were prepared by A.A. Ryan, District Inspector of Coal Mines, New South Wales Department of Mineral Resources. Compilation was greatly assisted by contributions from a committee of industry representatives. The members of that committee also included university representatives.

A.A. Ryan	(Chairman)
R. Gibbons	Former Colliery Manager, Cooranbong Colliery
Dr A. Green	Department Safety Science, University of New South Wales
S. Lott	Senior Sales Consultant, ORICA Explosives) (formerly ICI Australia)
B. McKinnon	Colliery Manager, Myuna Colliery
Professor Gour Sen	Blasting Consultant, Professor, School of Mining, University of New South Wales
R. Stothard	District Check Inspector, Construction, Forestry, Mining and Energy Union
B. Woolnough	Managing Director, Colrok Mining Services

DRAFT

Acknowledgment is made to the Health and Safety Commission, England for their assistance — especially the Health and Safety Laboratory in Buxton, Derbyshire, for the Technical information provided.

More than forty underground coal mines in New South Wales and Queensland participated in a survey into the consumption and use of explosives. This provided valuable information and reinforced the need for Guidelines covering the use of explosives in underground coal mines. The managements of those mines are thanked for this assistance.

CONTENTS

FOREWORD

ACKNOWLEDGMENTS

GLOSSARY

1 INTRODUCTION

- 1.1 Purpose and status of the Guidelines
- 1.2 How to use these Guidelines
- 1.3 A risk management approach to shotfiring

2 LEGISLATIVE AND COMPLEMENTARY FRAMEWORK

- 2.1 Coal Mines Regulation Act of 1982
- 2.2 Other Acts
- 2.3 Standards and Codes

DRAFT

3 SHOTFIRING SAFETY

- 3.1 The shotfirer
- 3.2 Training and qualifications of shotfirers
 - 3.2.1 Education for shotfirers
- 3.3 Shotfiring management process

4 THE SHOTFIRING PROCESS

- 4.1 Setting up management systems
 - 4.1.1 Steps to be taken in the event of a misfire — the need for a management plan
 - 4.1.2 Preparation of management plans for handling misfires
 - 4.1.3 Misfire revealed while loading out
- 4.2 Purchase correct materials and equipment with appropriate labelling
 - 4.2.1 Supplier's duties
 - 4.2.2 Employer's duties
- 4.3 Storage of materials and equipment, and transport and use
 - 4.3.1 Manager's duties in respect of storage, handling, use, issue and return of explosives and detonators
 - 4.3.2 Storage, issue and use of explosives and detonators
 - 4.3.3 Procedures for the movement or conveyance of explosives and detonators
 - 4.3.4 Control of explosives and containers of explosives
 - 4.3.5 Control of detonators and containers of detonators
 - 4.3.6 Locked containers and check sheets of explosives and detonators
 - 4.3.7 Action on finding explosives
 - 4.3.8 Maintenance of materials and equipment
 - 4.3.9 Maintenance and testing of exploders
 - 4.3.10 Maintenance and testing records for exploders

4.4	Planning the shotfiring process	
4.4.1	Handling and use of explosives and detonators	
4.4.2	Safe job procedures and practices	
4.4.3	Stray electrical currents and voltages	
4.4.4	Shotfiring fumes	
4.4.5	Misfires	
4.4.6	Special shotfiring applications in underground coal mines	
4.5	Firing of shots	
4.5.1	Drilling, placement and charging of shotholes	
4.5.2	Delay periods	
4.5.3	Stemming	
4.5.4	Safety precautions prior to shotfiring	
4.5.5	Stray electrical currents and voltages	
4.5.6	Priming cartridges	
4.5.7	Security of primed cartridges	
4.5.8	Shotfiring cable	
4.5.9	Danger zones and withdrawal of persons	
4.5.10	Steps to be taken before a shot or round of shots is fired	
4.5.11	Operation of exploder	
4.5.12	Sentry's duties	
4.5.13	Duty to comply with sentry's orders and with notices	
4.6	Precautions to be taken after firing	
4.7	Steps to be taken by the shotfirer in the event of a misfire	
4.8	Shotfirer's records	
APPENDIX 1	Explosives, Detonators, Exploders, Circuit Testers and Exploder Test Apparatus	
APPENDIX 2	Design of Shotfiring Equipment and Containers	

DRAFT

INDEX

Not yet compiled.

GLOSSARY (AND DEFINITIONS)

Act — *Coal Mines Regulation Act 1982*.

appoint — appointed by the mine manager in writing with a written statement summarising the authority and responsibilities in respect of the person appointed.

approved — has the meaning in the *Coal Mines Regulation Act 1982* (approved by the Chief Inspector). (This could apply to use of non-permitted explosives).

butt or socket — that portion of the shothole left in a face after blasting which could still retain explosive.

canister — any canister designed to hold explosives — but does not include the reserve station.

competent — means having appropriate experience, knowledge, skills and capability.

danger zone — an area in which a person may be injured or machinery may sustain damage as a result of shotfiring activities.

designated — designated in writing by the mine manager.

detonator — see Appendix 1.

DRAFT

detonator case — a case capable of being securely fastened, designed for the transport of detonators.

dust (dangerous) — means any coal dust which has not been treated.

exploder — any electrical apparatus approved for the purpose of initiating detonators in a mine.

explosive — see Appendix 1. **Explosive** includes detonating cord, detonators, relays, signal tubes, signal tube starters or similar devices.

explosives store or explosives magazine — any place situated above ground being an external magazine licensed and constructed under the *Dangerous Goods Act 1975*.

face — refers to unbroken coal where the seam is being worked.

flammable gas — any flammable gas or mixture of flammable gases — especially (for these Guidelines) gas occurring naturally in a mine. (In the *Coal Mines Regulation Act 1982*, clause 5 defines flammable gas as meaning methane, carbon monoxide or hydrogen, where methane is defined as including ethane, propane or similar hydrocarbon gases.

goaf — refers to the part of a coal mine where the coal has been removed and the void has been partly to fully filled up (eg, with broken rock).

maintained — maintained in an efficient state, in efficient working order and in good repair.

manager — in relation to a mine, means the person appointed or nominated under section 36 of the *Coal Mines Regulation Act 1982*. In relation to a mine, this means the mine manager.

mine — has the meaning in the *Coal Mines Regulation Act 1982*.

mine — when used as a noun, this refers to any excavation, structure or facility used in connection with the extraction of coal (or rock).

or

mine — when used as a verb, this refers to any act or activity associated with the extraction of coal (or rock), but generally does not refer to exploration (especially from the surface).

misfire — an occurrence where:

- (a) testing before firing a shot reveals broken continuity which cannot be rectified; or
- (b) any shot, or whole or part of a round, fails to explode when an attempt is made to fire it.

MSDS — Material Safety Data Sheet(s). An **MSDS** (for a substance) means a document that describes the properties and uses of a substance — that is, its identity, chemical and physical properties, health hazard information, precautions for use and safe handling information.

notice — a notice in writing.

DRAFT

owner — has the meaning in the *Coal Mines Regulation Act 1982*.

permitted detonator — approved detonator by the Chief Inspector (according to the Coal Mines (Underground) Regulation 1999.

(cf non-permitted. Also see Appendix 1).

permitted explosive — approved explosive by the Chief Inspector (according to the Coal Mines (Underground) Regulation 1999.

(cf non permitted. Also see Appendix 1).

primed cartridge — a cartridge of explosives into which a detonator has been inserted.

round of shots — a number of shots fired in one operation by means of instantaneous or delay detonators.

rules of transit — rules made by the manager of a mine, under the Coal Mines (Underground) Regulation 1999, specifying the procedures to be adopted for the conveyance of explosives underground.

shot — a charge of explosive (in a cartridge) placed in a shothole in coal or other rock (or stone) for the purpose of breaking the coal or rock (or stone).

shothole — a bored hole which is to be charged with explosives for blasting purposes.

shotfirer — a person appointed in accordance with Part 10 of the Coal Mines (Underground) Regulation 1999 [formerly, according to clause 12 of the Coal Mines Regulation (Explosives and Shotfiring — Underground Mines) Regulation 1984].

shotfiring operations include:

- (a) priming a cartridge;
- (b) charging and stemming a hole;
- (c) linking or connecting the detonator into a round of shots;
- (d) coupling a shotfiring cable or lead-in line into a detonator circuit, circuit tester or exploder;
- (e) testing a shotfiring circuit; and
- (f) firing a shot or round of shots.

DRAFT

socket or butt — that portion of the shothole left in a face after blasting which could still retain explosive.

stemming — means material used to fill a shothole after placement of an explosives cartridge to prevent the explosive blowing out along the shothole.

underground mine — means a mine in which persons are employed underground when the mine is being worked.

"5 metre limit" — within five metres of a seam, goaf or waste in any direction.

DRAFT

1 INTRODUCTION

1.1 Purpose and status of these Guidelines

These Guidelines may be cited as the *Guidelines on the Use of Explosives in Underground Coal Mining*.

DRAFT

These Guidelines have been prepared as a guide for safe operations in mining — in this case, shotfiring (use of explosives) in underground coal mining. Hence the Guidelines will assist in the development of a safe mining environment and improved working conditions.

Risk management is an important phase of planning for safe mining (Section 1.3). The Guidelines should be read in conjunction with the present Coal Mines (Underground) Regulation 1999. The Guidelines are to specifically support Part 10 of the Coal Mines (Underground) Regulation 1999. Use of the Guidelines will thus provide practical guidance and set minimum safety standards for all users of explosives at underground coal mines in New South Wales.

1.2 How to use these Guidelines

These Guidelines provide advice about safe practices for:

- the purchase of explosives and detonators;
- storage of explosives and detonators;
- transportation of explosives and detonators; and
- use of explosives and detonators

in underground coal mines, and of related practices. The Guidelines also describe the qualifications and role of shotfirers. Further, guidelines about good record keeping are also included.

To assist in efficient use of these Guidelines the information has been arranged in the order of the points listed above (purchase; storage; transportation; and use of explosives), as well as education expectations of shotfirers. Additional hints are given about misfires, and about the collection of observations to assist all workers in the mine. Hopefully answers will be found to all frequently asked questions, and suggestions about finding further answers are also given. In addition, valuable assistance can be obtained by contacting the Department.

It is expected that all personnel in a mine will be familiar with these Guidelines, and any related management plans. That expectation is, perhaps, a requirement for shotfirers — who should also participate in developing the management plan.

Many important terms or phrases have been presented in bold text, and such terms or procedures have also been highlighted in other ways. An index will also help to find key words, and a glossary also provides definitions of a range of terms.

Commencement Date

These Guidelines take effect from the date of commencement of the Coal Mines (Underground) Regulation 1999.

Authority

These Guidelines has been prepared and published under the direction of the Chief Inspector of Coal Mines.

1.3 A risk management approach to shotfiring

Risk Management

Use of these Guidelines can assist in reducing risks associated with coal mining. Use of explosives in underground coal mining is less common than in other types of mining, but the risks are important and, in some aspects, different. It is intended that these Guidelines can form an integral component of risk management in underground coal mining. The Guidelines identify a range of important factors in recognising risks, handling of explosives, planning for and carrying out shotfiring.

Hence each mine should have a clear risk management plan in place that recognises the risks associated with shotfiring, the role of shotfirers and procedures for the minimisation of risk. Further guidelines about good record keeping are also included.

DRAFT

To assist in efficient use of these Guidelines the information has been arranged in the order of the points listed above (purchase, storage, transportation and use of explosives). Additional hints are given about misfires and the collection of observations to assist all workers in the mine. Hopefully answers will be found to all frequently asked questions, and suggestions about finding further answers are also given. In addition to contacting the Department, the references and other sources of information (see Section 2).listed can provide valuable assistance.

It is expected that all personnel in a mine will be familiar with the Guidelines, and any related management plans. That expectation is, perhaps, a requirement for shotfirers — who should also participate in developing the management plan. The role of the manager is, naturally, of particular importance in the development and maintenance of a safe working environment in the mine.

The evaluation of risk and reduction of risk are important for the coal mining industry — and indeed all walks of life. For assistance in how to conduct an assessment of the risk (of mine operations and equipment), and with how to analyse and manage the risks that are identified, reference can be made to MDG 1010. While not specific to explosives, that publication offers a range of suggestions and guidelines for risk management that can be directly applied to risk and safety matters associated with shotfiring.

Reference

Department of Mineral Resources, 1997. *Risk Management Handbook for the Mining Industry: How to Conduct a Risk Assessment of Mine Operations and Equipment and How to Manage the Risks. MDG 1010*, New South Wales Department of Mineral Resources, Sydney, 96pp.

2 LEGISLATIVE AND COMPLEMENTARY FRAMEWORK

2.1 *Coal Mines Regulation Act 1982*

Any provisions or requirements of the *Coal Mines Regulation Act 1982* and Regulations thereunder must be complied with for all operations associated with explosives, explosive devices and procedures (including shotfiring). In particular, this includes the Coal Mines (Underground) Regulation 1999.

2.2 Other Acts

Acts other than that noted in Section 2.1 are also of direct application to the safety issues described in these Guidelines. Two of the most applicable Acts are listed here:

- *Dangerous Goods Act 1975*; and
- *Occupational Health and Safety Act 1983*.

2.3 Standards and Codes

There is a range of **Australian Standards** that can assist in the safe use of explosives. Similarly, additional **Codes** are also useful. These Standards and Codes help in maintaining safe operating procedures. Selected relevant Standards and Codes are noted here.

Standards

AS 1768 — 1991

Lightning Protection
(also NZS1768:1991)

AS 2187

Explosives — Storage, Transport and Use
(known as the SAA Explosives Code)

AS 2187.1 — 1984

Storage and Land Transport

AS 2187.2 — 1993

Use of Explosives

AS 2188 — 1988

Explosives — Relocatable Magazines for Storage

AS 2189 — 1983

Explosives — Glossary of Terms

Codes

Code of Practice — Transport of Dangerous Goods

National Code of Practice for the Preparation of Material Safety Data Sheets
[NOHSC:2011 (1994)]

(Australian Government Publishing Service)

National Code of Practice for the Preparation of Material Safety Data Sheets
[NOHSC:2012 (1994)]

(Australian Government Publishing Service)

National Code of Practice for the Labelling of Workplace Substances
[NOHSC:2012 (1994)]

(Australian Government Publishing Service)

DRAFT

Reference can also be made to:

Department of Mineral Resources 1996. *Guidelines for safe mining for the metalliferous mining, quarrying and extractive industries*. New South Wales Department of Mineral Resources, Sydney xxvi +362 pp.

That “Guideline” has useful and general information, as does the national Safe Mining handbook. However, special conditions apply to coal mines.

Similarly, the Department of Mineral Resources has published an extensive series of *Mine Development Guidelines* (“MDGs”). Many of the MDGs are directly concerned with (underground) coal mines.

It should be noted that, naturally, these Standards and Codes are subject to update and change. Hence regular checks should be made with the appropriate issuing authority. That is also the case with Acts and Regulations.

DRAFT

3 SHOTFIRING SAFETY

3.1 The shotfirer

Explosives and shotfiring should always be under the control of a **shotfirer** — with responsibility to the manager of the mine. Part 10 (Shotfiring and explosives) [of the Coal Mines (Underground) Regulation 1999] summarises aspects of the qualifications and appointment of shotfirers and their medical suitability in mines.

A shotfirer should be qualified and hold a **shotfirers' certificate** (see next subsection) — in this case, approved for a coal mining operation in New South Wales.

3.1.1 Appointment of shotfirers and trainee shotfirers

DRAFT

There is a range of factors that a manager needs to consider when planning the shotfiring requirements of a mine.

1. The manager must appoint a sufficient number of suitably qualified and competent persons to carry out shotfiring operations and any such appointee should be referred to as a **shotfirer**.
2. The manager may appoint such number of persons as considered appropriate to undergo training in shotfiring operations under the close personal supervision of a shotfirer and any such appointee should be referred to as a **trainee shotfirer**.
3. The manager should arrange for **records** to be kept of every appointment (that takes place under paragraph 1 or 2).

It is suggested that these records should include the following information:

- (a) qualifications of shotfirers;
- (b) appointment of the shotfirers;
- (c) training of shotfirers; and
- (d) retraining and training in new techniques.

The records should be retained at the office of the mine and be readily available for inspection. The records for each shotfirer should be kept for a period of seven years after the shotfirer has left employment at the mine.

4. A person can be considered to be suitably qualified to be appointed as a shotfirer pursuant to paragraph 1 only if that person is at least 21 years of age and
 - (a) is qualified to be appointed as a Deputy for the purposes of Section 42 of the *Coal Mines Regulations Act 1982*, and
 - (b) has completed an approved course in shotfiring in underground coal mines and has been assessed as competent, or
 - (c) has been appointed and carried out the duties of a shotfirer in underground coal mines for a period of at least three years prior to December 1997, provided the manager is satisfied with the knowledge and competence of the person appointed as shotfirer.

5. A person newly appointed as a shotfirer must, within the period of three years immediately preceding the appointment, have obtained from a duly qualified medical practitioner, a medical certificate to the effect that:
- (i) the person's eyesight was such as to enable the person to make proper tests for methane;
 - (ii) the person's hearing was such as to enable the person to carry out the person's duties efficiently; and
 - (iii) the person has obtained an approved gas testing certificate within the preceding three years.

3.2 Training and qualifications of shotfirers

From time to time, the Chief Inspector of Coal Mines will publish details of qualifications which have been approved for shotfirers.

The manager should arrange appropriate training in any new shotfiring techniques which are to be introduced. This should include theoretical instruction and adequate practice under the close personal supervision of a person competent in the new technique. Where a person is to return to shotfiring duties after a break of more than three years, the manager should arrange an appropriate period of retraining.

3.2.1 Education for shotfirers

An indication of the range of topics that should be part of the education or training for shotfirers is summarised below. The listing of topics can also serve as a guide to the range of factors important for the planning of safe shotfiring in underground coal mines. Note that Appendix 1 contains information on explosives, detonators and equipment, and Appendix 2 contains, in summary, notes on the design of containers and equipment for shotfirers.

Recommended Theoretical Topics

1. Introduction to shotfiring in mines.
2. Detonators and explosives.
 - (a) Types of **permitted** and **non-permitted** explosives.
 - (b) Types of detonators.
3. **Shotfiring** equipment
 - (a) **Break detector, pricker, scraper, stemmer, explosives canisters, detonator cases.**
 - (b) **Exploder.**
 - (c) **Stemming** materials.
 - (d) Ohmmeter and test circuits.

Storage, issue, conveyance [transport], care and security of explosives and detonators;
current recording systems;
manager's scheme for bulk transport of explosives; and
recognition, handling and safe disposal of deteriorated explosives and detonators.

5. Drilling:
methods and equipment;
setting up alignment;
dust suppression;
arrangement of **drilling patterns** and firing patterns; and
recognition and significance of joints and breaks in the rock strata.
6. Safe shotfiring procedure — effects of shotfiring.
Determination of **danger zone**, **sentry posting**, warning and shelter; and
shotfiring curtains and shields.
Precautionary examinations, gas testing including use of **methanometer**.
Ventilation in headings, forcing and extracting, overlap systems. Prevention of
dust, noxious **fumes** and ignitions.
Stonedusting and barriers.
Examination procedure after shotfiring, including ventilation and fume dispersal.
7. Priming a cartridge and firing single shots, including single shot **misfires**.
8. Multi-shot exploders, circuit testers, cables and joint insulators.
Warning of high voltage.
Stray voltages and currents.
Current leakage.
9. Initiation method — multi-shotfiring;
the delay detonator, and detonator types (including transformer-coupled) and their
application; and
direct or inverse initiation.
10. Firing of rounds in coal headings, coal and stone driveages, shafts and cross-
measure drifts.
Priming cartridges in a priming station.
Special transport arrangements.
Coupling and testing of circuits (including calculation of resistance).
Misfires in a round with delay detonators (including transformer-coupled).
11. Parallel, series paralleled and paralleled series shotfiring circuits firing from
power (electricity) mains and generator sets.
12. As above, with transformer-coupled detonators.
13. Appointment, qualifications, duties and responsibilities of shotfirers.
Relevant safety, health and security legislation, records and reports.
Exemptions.

14. Case studies, with special emphasis on safety, health and security aspects of the relevant legislation.
15. Tests on theory covered in courses.

Practical Exercises

16. Preparation for Shotfiring (General)
 - (a) **Shotholes:** placing, drilling, diameter, depth marking, cleaning and testing for breaks.
 - (b) Testing for gas:
 - (i) in the vicinity of shotholes;
 - (ii) in the general body of air; and
 - (iii) at roof level in headings.
 - (c) **Charging** a shothole:
 - (i) assessing amount of explosives to be used;
 - (ii) handling explosives and detonators;
 - (iii) preparing a primer; and
 - (iv) direct and inverse initiation methods.
 - (d) Stemming a shothole.
 - (e) Checking for general safety, including the protection of mechanical, electrical and scientific equipment.
 - (f) Protection against stray electrical currents.
17. Firing single shots.
 - (a) Recap on preparations (as in paragraph 16).
 - (b) Safety aspects: shelter, danger zone, the posting of sentries, erecting fences and posting notices.
 - (c) Precautions after shotfiring.
 - (d) Dealing with single shot misfires.
 - (e) Protection against stray electrical currents.
18. Firing a round of shots.
 - (a) Recap on preparations (as in paragraph 16).
 - (b) Use of delay action detonators (or instantaneous, if appropriate) and transformer-coupled detonators.
 - (c) Circuit testing — special attention to be given to ohmmeter readings and circuit testers at the outbye end of the cables and not at the face of the working coupled directly to the detonators.
 - (d) Safety aspects: shelter; danger zone; sentry; instructions; posting notices; coupling up large rounds.
 - (e) Firing procedures.
 - (f) Precautions after shotfiring, including fume dispersal.
 - (g) Dealing with misfires, including transformer-coupled detonators.
19. Practical tests
Recap, and tests on practical exercises in the field.

3.4 Shotfiring management process

Use of these Guidelines will assist in design of a mine's shotfiring management process. The Guidelines will thus provide a basis for a self-audit process. It must be emphasised, however, that there is a great need for each mine to develop its own management program for shotfiring (across the full range of factors, risks and safety requirements). Clause 155 of the Coal Mines (Underground) Regulation 1999 refers to the development and implementation of a *shotfiring and explosives system* at each mine.

DRAFT

DRAFT

4 THE SHOTFIRING PROCESS

The shotfiring process starts with the purchase of the correct explosives, detonators and equipment — assuming the **mine development plan** is in place (including the planned role of shotfiring). Other important factors include storage, transport and use of materials, planning and shotfiring, and post-firing procedures.

4.1 Setting up management systems

These Guidelines are intended to provide guidance for the safe implementation of the shotfiring process (for underground coal mines). Hence the Guidelines can provide a checklist of matters which must be effectively and efficiently addressed in the design and setting up of shotfiring management systems.

Well-designed shotfiring management systems which are integrated into the overall operations of an underground coal mine can greatly enhance a safe working environment. It is important that all mine personnel are well-informed about the management system and are committed to incorporating it into the mine's daily operations. All personnel should thus have ready access to the **management system** and to these Guidelines. Clause 155 of the Coal Mines (Underground) Regulation 1999 refers to the importance of consultation with an appropriate employees' representative in the development and revision of a mine's shotfiring and explosives system.

Purchase of explosives, detonators and equipment should include awareness of obligations concerning the provision of useful warning information.

4.1.1 Steps to take if a misfire occurs — the need for a management plan

A **misfire** occurs when:

- (a) testing before firing a shot reveals **broken continuity** which cannot be rectified;
or
- (b) any shot, or whole or part of a **round** of shots, fails to explode when an attempt is made to fire it.

The mine manager should ensure that:

- 1. the circumstances of any misfire are reported and investigated; and
- 2. the shotfiring procedures are reviewed to reduce the likelihood of further misfires.

4.1.2 Preparation of management plans for handling misfires

Dangerous consequences might arise from a misfire. The potential for such potential means that management plans for handling misfires should be prepared.

The following is a guide for the preparation of procedures to deal with misfires.

- 1. If a misfire occurs, a shotfirer should take the following steps.
 - (a) Disconnect the **exploder**. (The shotfirer should retain possession of the key.)

- (b) Retest the circuit. If it is satisfactory, try to refire the round. If it is not satisfactory, join the ends to short circuit the shotfiring cable and notify sentries (if posted) of the situation.
- (c) Examine the wiring to the face, and then the face itself. If there is an obvious fault, repair it, then notify sentries, retest and fire the round. If there is no obvious fault, divide the circuit into half and retest. Continue dividing the circuit until the fault is located.

DRAFT

NOTE. The following precautions are recommended.

- (i) Take adequate precautions to prevent unauthorised persons gaining access to the misfire site.
 - (ii) No one should approach the misfire site until an interval of 10 minutes has elapsed.
- (d) Isolate the fault from the circuit and take any steps necessary to anchor the detonator leads of any identified misfired shot with (non-conductive) material to a secure place to help recover the charge after firing. **Do not pull forcibly on the detonator leads.**
- (e) It may be possible to wash out the **stemming**. If the explosives are rapidly destroyed by water, they may be sludged out through a non-ferrous blow-pipe or tube using water under pressure or a mixture of water and compressed air. A decision can then be made whether or not to recharge the hole. If the shot is to be refired, connect it into the circuit, test the circuit and refire the round. If the explosive is water-resistant, insert a fresh primer and stem, reconnect and fire the shothole in the normal way.

NOTE.

- (i) The use of compressed air alone is not encouraged. Where it is used, take special precautions to minimise the dangers from static electricity and impact.
 - (ii) Where water under pressure is not available, the stemming may be sludged out by using water and a wooden or non-ferrous implement.
 - (iii) When removing stemming, take care not to disturb any detonator or explosive which may be susceptible to detonation during the process of stemming removal.
- (f) If the faulty charge cannot be replaced, secure the detonator leads to aid recovery of the primer, reconnect the round (leaving the faulty charge in place), notify sentries, and retest and fire in the usual manner.
- (g) Where it is not possible or practical to remove a misfire by refiring the explosive or removing the stemming as described above, then a relieving hole may be drilled as parallel as possible to the original shothole, charged and fired as follows:
- (i) the collar of the misfired hole by inserting a suitable wooden plug, or be otherwise clearly marked.

- (ii) Where the misfired hole is less than 50 millimetres in diameter (as is the case in most holes used in underground coal mining) or is less than 4.5 metres in length, do not drill holes any closer than 450 millimetres to the nearest point of the misfired hole. Where such misfired holes are longer than 4.5 metres, then do not drill relieving holes any closer than 750 millimetres to such holes.
- (iii) With larger and longer holes, increase the distance between the misfired hole and the relieving hole as required by the management system.
- (iv) Electric detonator leads must be joined and thus short-circuited.

The relieving hole may then be charged and fired provided the usual precautions and testing are performed.

NOTE. Only detonate relieving holes if all other courses of action have been considered and judged to be ineffective. Following the firing of the above shot or shots, do not resume work at that location until the shotfirer has searched thoroughly and carefully for the detonator or any explosives from the misfired shot. If the misfired charge is not recovered, identify the debris and keep them separate for careful examination. Also notify the senior mining official on that shift of the circumstances. Regulations require that a management system is prepared for the recovery, transportation and safe disposal of the detonator and explosives recovered from the misfired shot or any material likely to contain a misfired shot.

4.1.3 Misfire revealed while loading out

The management plan must include a set of steps to be followed when a misfire is identified during loading out, that misfire having been previously obscured. Such an event is most important, and the steps must include concerns about safety for any personnel present, and for the safe procedures to be followed if loading out equipment is present.

4.2 Buy correct materials and equipment with appropriate labelling

It is important to buy only the correct detonators, explosives and related materials and equipment. This will help to ensure that only appropriate materials are brought onto and stored on site. Also, affix appropriate labels to all materials to identify their correct use and handling procedures.

4.2.1 Supplier's duties

Material Safety Data Sheets (MSDS)

To assist in safe handling of hazardous substances, including explosives, describe them using **Material Safety Data Sheets (MSDSs)**.

The purpose of MSDSs is to provide the information needed to allow the safe handling of hazardous substances used at work.

Production of Material Safety Data Sheet

Manufacturers and suppliers should produce an MSDS (or MSDSs) for all **hazardous substances** which they supply. Attention is drawn to the *National Code of Practice for the Preparation of Material Safety Data Sheets*. That National Code gives practical guidance on meeting the requirements for MSDSs. It also advises on acceptable formats, which include those of the National Commission, the European Community and the International Labour Office. Any overseas MSDS provided in Australia should include the relevant Australian information — eg, supplier contact details and any relevant exposure standard.

Articles or materials which produce hazardous substances during their use, such as welding rods or explosives, should also be accompanied by an MSDS (or MSDSs) or other equivalent information.

Provision of Material Safety Data Sheet on first supply

Suppliers should provide an MSDS on or before the first time that a hazardous substance is supplied to any purchaser. There is no need to include an MSDS with every delivery, provided one has been given with an earlier delivery of that particular article or substance. However, if the MSDS is revised, the manufacturer or supplier should send a copy to each purchaser of the substance.

Provision of Material Safety Data Sheet on request

Suppliers of hazardous articles or substances, or substances that produce hazardous substances, must provide an MSDS on request to purchasers and to prospective purchasers.

Labels for containers

Securely attach labels to containers of hazardous or potentially hazardous materials. The purpose of labelling is:

- to readily identify the contents of a container by product name; and
- to alert any person who is handling the container, or using a hazardous substance from the container, to the significant hazards involved.

Labelling of substances

Suppliers are responsible for the correct labelling of hazardous substances which they supply to others.

The National Code of Practice for the Labelling of Workplace Substances gives minimum standards on the labelling of hazardous substances.

Labelling of articles

Articles which produce hazardous substances during their use, such as welding rods, must also be appropriately labelled to indicate the conditions of use that can produce these hazardous substances.

4.2.2 Employer's duties

Obtaining Material Safety Data Sheets

An MSDS must accompany the first supply of the hazardous substances. Where an MSDS has not been provided at a subsequent supply, it may be requested from the manufacturer/supplier. The MSDS will allow users to assess the use of the hazardous substance and to establish any necessary controls in the workplace.

Access to Material Safety Data Sheets

At each workplace, employees and employee representatives must have ready access to MSDSs for the hazardous substances used. Copies must be readily accessible to employees who are required to use or handle any hazardous substance, as well as to employees who are supervising others working with the hazardous substance.

Access to MSDSs may be provided in a number of ways, including:

- paper copy collections of MSDS;
- microfiche copy collections of MSDS, with microfiche readers open to use by all employees; and
- computerised MSDS databases.

Depending on which access method is used, the employer should ensure that:

- the current MSDSs are available;
- any storage or retrieval equipment to read the information is kept in good working order;
- employees are trained in how to gain access to the information; and
- where information is displayed on a screen, there are means of obtaining a paper copy of that information.

Alteration of Material Safety Data Sheets and additional information

MSDSs obtained from a supplier must not be altered except where the MSDS is provided from overseas and is not available in one of the acceptable formats described in the *National Code of Practice for the Preparation of Material Safety Data Sheets*. An employer wishing to add additional information to the supplier's MSDS should append it to the MSDS. However, it must be clearly marked to indicate that the appended information is not part of the original MSDS. Specific workplace information may be added in this manner and is not considered to be an alteration to the MSDS.

Labels

All containers of hazardous substances supplied to, used in, or handled in, the workplace must be appropriately labelled to allow the substances to be used safely. Containers of hazardous substances should be labelled in accordance with *National Code of Practice for the Labelling of Workplace Substances*. Where appropriate, all hazardous articles or materials which can produce hazardous substances, should also be labelled.

4.3 Storage, transport and use of materials and equipment

4.3.1 Managers' duties on the storage, handling, use, issue and return of explosives and detonators

The mine manager should not let any explosive or detonator to be stored on the mine surface except in an external **magazine** or **explosives store** licensed and constructed according to the *Dangerous Goods Act 1975* and the Regulations under that Act. The manager may nominate as a **reserve station** a place on the surface and places underground suitable for the issue, return and temporary storage of explosives pending their use in connection with shotfiring operations. Reserve stations should not at any time contain between them more explosives than are expected to be used during the course of the next working days at the mine. If the mine will not be worked during the next five (5) days all explosives should be returned to the explosives store.

DRAFT

Explosives and detonators must not remain in the explosives store for longer intervals than those recommended by the manufacturer. The aim of every manager is to minimise the amount of explosives stored and, by appropriate cycling, to ensure that the "use by date" for any explosive is not exceeded.

The manager should specify the capacity of each reserve station and have its location, and the area of the mine workings which it serves, shown clearly on a suitable plan. A reserve station should be of substantial construction with separate lockable compartments, secure against unauthorised access, remote from any potential ignition source, and clearly marked by the words "**EXPLOSIVES**" and "**DANGER**". It is essential that adequate key/alarm security arrangements operate at all places where explosives are kept.

All persons handling explosives or detonators must be authorised and must be aware of their duties.

NOTE

Explosives and detonators that are damaged, deteriorated or appear abnormal in any way must be treated with great caution. If found, such explosives or detonators must be reported to the person in charge of the mine at the time who must assess the damage and its implications for safe handling. In rare cases, it may be dangerous to try to move the explosives or detonators (eg, corroded detonators or deteriorating explosives). Segregate damaged/deteriorated detonators or explosives from other explosives and detonators and seek expert advice from the supplier or manufacturer.

Take care when disposing of wrappings which have contained explosives and detonators. Ensure that no articles or materials are inadvertently enclosed in the wrappings.

4.3.2 Storage, issue, and use of explosives and detonators

The mine manager must develop, document and implement a system for the storage, transport and use of detonators and explosives at the mine in order to ensure effective control of the materials and to ensure the safety and health of all persons at the mine. (Refer to AS 2187, parts 1 & 2). Such a system must address the following issues.

1. The purchase and receipt procedures for explosives and detonators must ensure delivery of the correct type.
2. Storage of explosives (and detonators) other than in the main external magazine (explosives store) must be clearly explained.
3. The procedure for the issue and receipt of explosives and detonators must be ready for audit at any time.
4. Care of detonators and cases, and care of explosives and containers, must be clearly explained and correct procedures must be implemented.
5. There must be a clear system to describe the size and construction of canisters for transportation of detonators and explosives and their maintenance and use.
6. Proper storage and transport of detonators and explosives, as set out in Section 4.3.3, should include construction and location of reserve stations, quantities of explosives and detonators and control of reserve stations.
7. The security of explosives and detonators against accidental damage or loss or unauthorised access must be a prime factor in safety procedures.
8. At least one safe place, situated conveniently near the top of each shaft or near each outlet normally used by workers as a means of egress from the mine, should be nominated as a place for the deposit of explosives and detonators brought out of the mine.

4.3.3 Movement or conveyance of explosives and detonators

An explosive must not be taken into or used underground at a mine unless it is approved.

A **management system** must be developed for **the movement or conveyance of explosives and detonators** to ensure the safe and secure conduct and control of that movement. The important points in Section 4.3.2 must also be implemented. The system should cover the:

1. movement of explosives to and from an explosives store; and
2. movement of detonators to and from an explosives store.

The management system should include a description of the supervisory arrangements and precautions required for:

3. the movement of explosives and detonators between places on the surface; and
4. (for explosives only) movement to either a reserve station or the working face below ground, or for transfer from one reserve station to another and the emptying of reserve stations.

5. After loading onto suitable transport, explosives and detonators must be under the direct supervision of the shotfirer or a person appointed for the purpose of transporting the explosives and detonators.
6. If the explosives are not transported directly to the working face they must be placed in a reserve station which is to be securely locked when unattended by the shotfirer or the appointed person.

Detonators should not be stored underground but taken into the mine by the shotfirer on an “as needs” basis. Any detonators not used on that shift should be returned at the end of the shift to **a place nominated on the surface of the mine.**

7. Where a large amount of explosives is used in a round of shots at a working face, and unopened manufacturers’ boxes of explosives are taken to the face in accordance with a bulk movement scheme, they should be under the charge of a shotfirer or the person appointed for the purpose of transporting the explosives. Any explosives left unused should remain under the charge of the shotfirer or the appointed person until returned to the surface of the mine or securely locked in an underground reserve station.

4.3.4 Control of explosives and containers of explosives

DRAFT

These Guidelines are designed to assist safe control of the security and the movement of explosives to be used underground.

1. The manager should authorise in writing those personnel who are to open containers of explosives. Authorised personnel who are in control of explosives must only open a container immediately before use, and only for the purpose of carrying out authorised duties at the mine.
2. A shotfirer or trainee shotfirer should be authorised to be in control of containers of explosives while underground except where the mine manager authorises a person who is qualified and experienced to give technical and specialist advice or training to mine personnel while underground. No other persons except those authorised as above should assume control of such containers.
3. Keys for an explosives station underground must only be issued to the authorised person, who must only open the containers as required, as noted in paragraph 1 (above).
4. No person should try to open an explosives container by any means other than the use of the proper key. If at any time a container is found to have a faulty lock, that container must be immediately withdrawn from service.
5. An authorised person who is in control of a container of explosives should ensure that, unless the container remains in that person’s possession, the container must be placed in a suitably marked box located in a safe place near to the relevant working place. Unless the box remains in the personal possession of the

authorised person, the box is required to be locked and the key should be kept in the possession of the authorised person.

An authorised person who is in control of a container of explosives should ensure that, unless possession is retained at all times, the container must be returned to the explosives store or to the place on the surface nominated by the manager of the mine for the deposit of explosives. However, if the person received it from a reserve station established for the purpose of the rules of transit, the container should be returned to that reserve station or to a person and at a place nominated by the manager for the purpose of the transit rules.

6. Due to the hazardous nature of shaft sinking operations, explosives should not be taken into the shaft unless they are immediately required for charging a shothole.
7. **Return of unused explosives**

The manager may appoint a person to receive unused explosives at a place at the surface of the mine. The explosives should remain in the care of the appointed person until they are returned to the explosives store.

Procedures may allow the manager to designate a place for the temporary storage of explosives pending their return to the explosives store. Further guidance may be found in management procedures in relation to the storage, issue and use of explosives contained in these Guidelines.

4.3.5 Control of detonators and containers of detonators

These Guidelines are designed to assist safe control of the security and the movement of detonators to be used underground.

1. A person may only have charge of a container of detonators if that person is:
 - (a) a shotfirer;
 - (b) a trainee shotfirer; or
 - (c) a person who is competent to handle a container of detonators and is authorised in writing by the manager for that purpose.
2. No person except a person mentioned in paragraph 1 above should open any container of detonators or handle any detonator.
3. A person who is at a place other than an explosives store must not remove a detonator from a container unless the detonator is required immediately:
 - (a) for priming a cartridge; or
 - (b) for testing.
4. A shotfirer or trainee shotfirer who has been issued with a container of detonators must, throughout a single period of duty:
 - (a) keep personal possession of the key to that container; and

- (b) ensure that the container and all the detonators are kept in a securely locked box.

However, nothing in this paragraph prevents the shotfirer or trainee shotfirer concerned from using the detonators in shotfiring operations.

- 5. Subject to paragraph 6 (below), every shotfirer or trainee shotfirer who, at the end of a period of duty, has not used all the detonators issued to that person, must return unused detonators (and explosives) to an explosives store.
- 6. Nothing in paragraph 5 (above) prevents a shotfirer or trainee shotfirer from depositing unused detonators at a temporary and secure storage place designated by the manager, pending their return to an explosives store.
- 7. Where a securely locked box is used in accordance with paragraph 4b (above), it should be suitably marked, and located in a safe place near the shotfirer's working place. The box may be one provided for the shotfirer's equipment, but not one containing explosives. While on duty the shotfirer or trainee shotfirer should keep personal possession of the key to the box.
- 8. A shotfirer or trainee shotfirer should not accept a container of detonators unless the details on the check sheet agree with the contents of the container. (Check sheets are dealt with further in Section 4.3.6.)

4.3.6 Locked containers and check sheets for explosives and detonators

- 1. Only persons designated by the manager may issue explosives or detonators.
- 2.
 - (a) Any person who issues a container of explosives must ensure that it holds nothing more than explosives of the same composition and an explosives check sheet. The check sheet should contain the type and quantity of the explosives in the container. The person issuing the container must make provision for the recording of the usage and return(s) of explosives.
 - (b) Any person who issues a container of detonators must ensure that it holds nothing more than detonators of the same type and a detonator check sheet. The check sheet should contain the type, the delay and the quantity of detonators that are in the containers. The usage and return(s) of detonators should be recorded.
- 3. No person who has control of a container of explosives or detonators must place in it:
 - (a) in the case of a container of explosives, anything other than explosives of the same composition and a check sheet; and
 - (a) in the case of a container of detonators, anything other than detonators of the same type and delay and a check sheet.

4.3.7 Action on finding explosives

1. A person finding any explosives, detonators or primed cartridges should take whatever steps considered necessary to prevent danger. This may involve stopping a conveyor or other transport system or preventing access by other persons. Having ensured the find is adequately fenced or guarded, the finder should inform a person competent to deal with the matter.
2. Explosives that exude liquid or appear to be damaged, deteriorated, contaminated or abnormal in any way may be sensitive to movement. Refer to the section on safe disposal of explosives or detonators.
3. For the purposes of this Section (4.3.7) a competent person would include an explosives store attendant, a shotfirer, a person in charge of part of the mine, or a person senior to such a person.

4.3.8 Maintenance of materials and equipment

Materials and equipment provided in connection with shotfiring should only be used for their intended purpose. All materials and equipment associated with shotfiring should be maintained in optimum working order. Some of the more important aspects are listed here.

1. The manager of a mine should ensure that all explosives, detonators, exploders, **apparatus for testing exploders, circuit testers and shotfiring cable** are of a type approved for the purpose for which they are intended.
2. The manager should take necessary steps to ensure that any equipment provided for shotfiring operations is properly maintained and stored when it is not in use.
3. Exploders should be thoroughly cleaned after use.
4. The manager must make arrangements to control the issue and return of explosives, detonators and associated shotfiring equipment. This includes ensuring that an accurate record is kept of the receipt, issue and return of explosives, detonators and shotfiring equipment referred to above.
5. No person should tamper with any explosives, detonators, exploder or circuit tester.
6. If a shotfirer considers an exploder to be defective, that person must:
withdraw it from service immediately;
return it to the surface for examination; and
report the facts to a senior mining official or a person appointed for the purpose.
7. An item cannot be considered as satisfactory if the conditions of the approval are not complied with.

4.3.9 Maintenance and testing of exploders

Exploders must be overhauled and tested at such intervals as approval conditions and/or the manufacturer's specifications may require. Exploders must not be used unless current **testing certificates** are available and testing has proved (as indicated in the certificate) the exploder to be satisfactory for use.

All exploders should be thoroughly cleaned, overhauled and tested at an approved testing authority. The overhaul frequency is indicated below.

1. At intervals not exceeding twelve (12) months. Generator-type exploders may need to be overhauled more frequently than battery-type if they are not used frequently.
2. At such lesser intervals as may be specified in the relevant exploder type approval and, additionally, shot exploders should be tested, above ground, in a manner specified in the approval conditions:
 - (a) on every occasion prior to use of the exploder; and
 - (b) if in the event of firing a round of shots with such an exploder a misfire occurs.

No exploder should be taken below ground unless the appropriate tests prove it to be satisfactory.

4.3.10 Maintenance and testing records for exploders

The manager should arrange for records to be kept which show each time an exploder is overhauled and/or tested. These records should include the following details:

1. maker's name, type of exploder and serial number;
2. date of cleaning and overhaul, or of test;
3. a statement whether it was
 - (a) an annual or a more frequent test as required by conditions of approval,
 - (b) a test prior to use, ora test of exploder after misfire (and by whom);
4. result of test, if any, including remarks; and
5. signature or person making the report, which should be signed and dated by the manager or a person appointed by the manager for the purpose.

Each exploder should also have a label affixed to it showing dates when it was last tested and overhauled. Adhesives, solvents or coatings should not be used to affix labels to, or clean the plastic case(s) of, exploders without the agreement of the manufacturer.

It is recommended that the person appointed to arrange the testing of exploders should be the same person to whom any defects in exploders are reported.

4.4 Planning the shotfiring process

4.4.1 Handling and use of explosives and detonators

Each person who handles or uses explosives and detonators should treat them with care and ensure that they are kept apart until used to prime a cartridge.

Careful handling of explosives and detonators is required because all explosives and detonators are liable to initiation by impact, friction and/or heat.

Cartridges of explosives should not be cut, broken open, crushed or handled roughly. The sensitivity of an explosive is increased if contaminated by dirt or grit or rust.

Explosives and detonators should never be subjected to undue force or struck by mining tools, drills or other machines because there is a possibility of accidental explosion.

Detonators are liable to premature ignition if exposed to stray currents or voltage or if their wires are pulled with excessive force.

4.4.2 Safe job procedures and practices

Underground mining operations are complex and safety awareness and practice should be constant. Use of explosives can compound the complexity. Having regard to the complexity of underground shotfiring and the potential for accidents, the manager should ensure that safe working procedures are drawn up for each new place where roof and sides of the entry are to be interfered with by the firing of shots. Procedures for ventilation requirements must also be developed — and carried out.

Safe job procedures and practices need to take into account the characteristics of explosives and detonators and of equipment and containers (Appendixes 1 and 2). The safe working procedures may be formulated from a risk assessment and should include:

1. a method for firing the shots, including **shot pattern** and **tests** to be carried out prior to firing;
2. the correct detonators and their delays to be used for each job.
3. the type of explosive to be used, its approval conditions and its storage underground;
4. the potential for desensitisation of the explosives;
5. the nature of the rock strata and its physical conditions (ie, water, flammable gas, etc.); and
6. the type of equipment to be used in connection with the job.

4.4.3 Stray electrical currents and voltages

Clause 151 of the Coal Mines (Underground) Regulation 1999 notes that a shot or round of shots in a mine must be fired by means of electric shotfiring apparatus of a type approved for the purpose. Considerable risks can be associated with stray electrical currents and voltages.

There are dangers during shotfiring operations of **inadvertent initiation** by **electric current leakage** and interference from high voltage induction, other **electrical sources** and **high frequency radio transmission**.

The manager should take all reasonable steps — such as conducting design and operational risk assessments — to identify any such risks and implement barriers and practices to minimise the identified risks.

In particular, the manager should consider the following factors in order to specify a safe system of work: **electrical (power) systems faults**; formation of **electrical cells**; **lightning strikes**; **static electricity**; and **current leakage** (from the exploder circuit). The factors and aspects that need to be addressed, are discussed below.

Electrical (power) system faults

Stray electrical currents may arise from alternating current sources in which there are faults, or as a result of **induction**. These factors may cause **leakage current** to pass through detonators via the rock strata and the mine earthing system.

It is essential that the **electrical earthing system** at the **main substation** of the mine (located at the surface of the mine) be maintained at low values of resistance and that testing of the resistance of the main substation earthing system be conducted at least once every twelve (12) months.

It is recommended that care be taken in the siting of electricity supply cables, water pipes and any other electrical conductors. Where possible, disconnect any metallic conductors located within the shotfiring zone, such as the removal of trailing cable plugs.

Formation of electrical cells

Saline water and metals immersed in that water can form electrical cells which can have sufficient energy to initiate detonation.

Lightning strikes

Stray electrical currents may arise underground from the propagation (via the **mine earthing system**) of lightning strikes on overhead electricity transmission (power) lines or on structures at the surface of the mine or by ground strikes (via the rock strata) at the surface of the mine. Therefore, all shotfiring work at any mine should be suspended during the occurrence of an electrical storm overhead and all persons withdrawn to a position of safety away from loaded shotholes.

It is recommended that the main electricity (power) substation earth grids and electrical installations associated with lightning protection (in particular for overhead electricity transmission (power) lines) be designed and installed to reduce the risk of propagation of electrical currents from lightning strikes underground via the **mine earthing system**. In any case, for such electrical installations and structures at the surface of the mine, lightning protection should be installed to comply with the AS/NZS 1768—1991, Lightning Protection.

Static electricity

It is possible for a build up of **electrostatic charge** to initiate a detonator. It is recommended that all exposed metal pipes and ducting located within the shotfiring zone be bonded together to an **earthing system**. Any flexible pipes or hoses should be manufactured from anti-static material. **Discharge nozzles may require bonding to the common earthing system.**

Current leakage from the exploder circuit

Current leakage to earth may occur from the **exploder circuit** due to breaks in the insulation and unprotected joints which are in contact with conductive ground or wet rock strata. This may result in insufficient current passing through some of the detonators, thereby giving rise to misfires.

Insulated systems of connection for the detonator/exploder circuit should always be provided and used. The shotfirer should ensure that the shotfiring cable and detonator leads are not damaged (eg, by abrasive rocks) and that care is taken in keeping the joints dry and away from each other, as well as away from the rock strata or metallic objects.

4.4.4 Shotfiring fumes

The presence of **nitrous fumes** and other **toxic gases** after detonation of explosives can be a serious hazard. The manager has a responsibility to carry out, or cause to be carried out, a risk assessment. Having identified the risks, measures should be introduced to prevent or adequately control exposure to any identified hazard.

Some types of explosives produce only small amounts of after-detonation fumes and these should always be used when appropriate for the particular task.

Post-shotfiring examinations (ie, examinations after firing) by the person firing the shots should not be carried out until a period of at least ten (10) minutes after the shot has been fired. Before carrying out this examination, the person firing the shots may consider a longer period to be necessary having regard for: the weight of the charge; the type of explosives; and the ventilation for the clearance of fumes.

The delay in carrying out the post-shotfiring examination is to minimise danger: from fumes; and from any shot which may fire later than the others in the round. (Refer to Section 4.6.)

4.4.5 Misfires

Plans should be clearly defined to outline the procedures that must be taken following a misfire. This is dealt with in more detail in Section 4.7.

4.4.6 Special shotfiring applications in underground coal mines

Underground coal mines can include areas of high risk for use of explosives. For example, shotfiring should only be carried out in exceptional circumstances in the vicinity of such areas as **goaf** associated with **longwalls** or pillar extraction, or **methane drainage systems** and other areas of restricted or limited access. This is because of difficulties in determining **flammable gas** concentrations.

If shotfiring is carried out in these circumstances, safe work procedures (managers rules) should be written beforehand to ensure a satisfactory system is available and that shotfiring is not carried out indiscriminately.

Reference should be made to the safe practices relating to **stemming** (cf Section 4.5.3), correct use of delay detonators, testing for flammable gas, type of explosives to be used and charging of shotholes. The rules should also specify (among other matters):

1. any additional precautionary examinations;
2. **support** of the excavation and workings;
3. the direction, inclination and spacing of shotholes to **avoid damage to equipment and blowing through into old or adjacent workings**;
4. additional protection to be afforded to equipment and fittings, including cables and hoses; and
5. the consideration needed to only fire the shot(s) when the smallest number of people is underground.

4.5 Firing of shots

Duty of Safety

Every shotfirer should take all reasonable precautions to ensure that all stages of a shotfiring operation are carried out in such a way as to ensure safety of all persons.

4.5.1 Drilling, placement and charging of shotholes

1. Persons other than the shotfirer or trainee shotfirer may assist with the charging and **stemming** of **shotholes**. However, the shotfirer should be satisfied that the shotholes are properly placed and drilled and subsequently correctly charged and stemmed.

2. A shothole should not be drilled into any **charge** or **socket** (or **butt**) remaining from a previous **shot**.
3. No shothole should be drilled to a size which would be incompatible (ie., inappropriate) with the explosive to be used (cf paragraph 4). (Refer to approval conditions for the explosive to be used.)
4. The diameter of the shothole and explosive charge should be compatible (ie, appropriate) to allow free and unimpeded charging of the shothole but not having excessive space between the cartridge and the sides of the shothole. In New South Wales it has been standard practice and part of previous coal mining industry regulations that a shothole should not be charged unless the diameter of the shothole exceeds by at least 3 millimetres the diameter of the explosive cartridge to be inserted in that hole.
5. If, when drilling and charging operations are taking place, a significant **break** is evident, then that hole should be marked and a **break detector** used to determine the size of the break. The shotfirer should then carefully assess the risk or any effect the break may have on the safety of the shotfiring operation. If any significant risk is evident, the hole should be clearly marked by the driller or shotfirer and not subsequently charged. A break greater than 3 millimetres where the coal has been undercut could be considered significant.
6. A person responsible for charging a shothole should ensure that the following steps or factors have been complied with.
 - (a) A shothole should not be charged unless it is safe to do so.
 - (b) Where necessary, the back of the shothole is plugged with approved stemming.
 - (c) The shothole is stemmed with sufficient amount of stemming material.
 - (d) Any tool inserted into a charged shothole is made of wood or of an anti-static material.
 - (e) All tools and equipment other than those required for charging a shothole should be removed from the vicinity before the charging operation commences.
 - (f) When placing cartridges into a shothole care must be taken to ensure that no other material lodges between one cartridge and another.
 - (g) No shothole is to be overcharged (cf clause 160 of the Coal Mines (Underground) Regulation 1999).
 - (h) A shothole found in cut coal or a ripping to have a break wider than 3 millimetres in any direction, should be marked by the driller or the shotfirer in a distinctive manner and not subsequently charged.
 - (i) A shothole, or different shotholes in a round, should only be charged in a round with primed cartridges which contain explosives of the same type and detonators of the same type.

7. **A shothole should not be charged if one or more of the following conditions occurs or is present, or the statement describes a reason for not charging.**
- (a) Do not charge if there is any likelihood of the shot blowing out or causing other danger or interference with one or more shots in the same round by **desensitisation or cut-off**.
 - (b) Do not charge a shothole as part of a delay round unless the primed cartridge is inserted first with the detonator at the back of the hole.
 - (c) Do not charge with more than one detonator unless for the purposes of relieving a misfire.
 - (d) Do not charge with an incomplete cartridge of explosives or cartridges of different diameters.
 - (e) Do not charge above the maximum approved charge per hole unless special exemption is given.
 - (f) If there is a charged shothole within the vicinity such that, except as part of the same round or to relieve a misfire, do not charge because there may be a danger of damage to either charge if one of the charges is fired.
 - (g) Do not use undue force to press a cartridge into the shothole.
 - (h) Do not charge unless cartridges are clearly marked as approved, and the cartridge weight labelled.
8. If the manager provides blasting parameters the shotfirer should comply in normal conditions. If circumstances change the shotfirer should use judgment having regard to the task performed.
9. Where compressed air is used to clean out a shothole steps should be taken to minimise the raising of dust and creation of electrostatic charges — for example, by the use of water sprays and non-ferrous blow pipes.

4.5.2 Delay periods

Where permitted **delay detonators** are to be used, the **following delay** period calculated by reference to the **normal delay** timing of the detonator between the first and last shots in a round should be consistent with the following conditions. Appendix 1 summarises information on delay detonators.

1. Where non-permitted detonators and explosives are to be used in virgin stone drifts or shafts, then special approval must be obtained from the Chief Inspector of Coal Mines. Approval conditions and the manufacturer's specifications should be adhered to. Management plans will be required.
2. The full range of Carrick millisecond delay detonators (cf Appendix 1) may be used in certain circumstances and should be subject to a risk assessment being carried out. The assessment must address the **flammable gas make** of the seam, **dangerous dust, ventilation**, general geological conditions and anomalies, proximity and thickness of known coal seams, old workings, **goaf barometric changes** and other relevant issues. Application should then be made to the District Inspector of Coal Mines for approval. Note that exploratory holes may be

required to gather information to assist risk assessment. This should include management systems.

3. Only **Carrick delay detonators**, up to 150 milliseconds delay period, are to be used in the following circumstances:
- in all places within 5 metres of goaf or waste workings;
 - in all roadways in solid coal;
 - in stone driveages within 5 metres of any known coal seam more than 300 millimetres in thickness;
 - in roadways being driven in solid stone and coal; and
 - in all other coal workings in roof and floor (eg, overcasts, sumps, grading floor).

Where more than one of the above categories may apply to a place where shots are to be fired, the more restrictive delay period should be used.

4. In special shotfiring applications, which may include, for example, goaf associated with longwall faces and pillar extraction, delay periods may need to be reduced depending on the conditions prevailing at the time. This may be determined by a risk assessment being carried out in each instance. Shotfiring in special circumstances should be carried out only after alternatives have been carefully considered.

The shotfirer should ensure that in all cases adequate incombustible dust is spread at the face to the roof, sides and floor for each round of shots. High standards of **stonedusting** are essential and their effectiveness in reducing the likelihood of the propagation of coal dust explosions cannot be overemphasised.

The manager should ensure that any dust that can be raised into the air in the vicinity of the shotfiring operation contains not less than 75% incombustible matter.

Appendix 1 includes a table setting out the types of explosives which may be used in various circumstances.

4.5.3 Stemming

Regulations require shotholes to be stemmed to prevent a **blown out shot**.

Non-flammable materials such as sand, clay or water gels may be used as suitable **stemming**. A sand-clay mixture of three parts sand to one part clay forms an effective stemming material provided it is moistened so that it can be moulded by hand. The material must be soft enough to allow it to be tamped firmly in position but not so soft that it is difficult to push it into the shothole.

A person charging a shothole must ensure that the stemming is sufficient to prevent a shot from being blown out. Although there is no definition of “sufficient” stemming, a rule of thumb is approximately one third of the hole length should be stemming. An example of this appears in the approval conditions for Powergel 3000 permitted explosives. One of the

conditions states "... provided that the shot hole is more than 1.8 metres in length with a minimum burden on such hole of 0.5 metres with at least 0.6 metres of approved stemming in each hole."

Any **stemming stick** to be used for tamping stemming must be made from wood and any **flushing pipe** used for the removal of stemming should be non-ferrous. (Refer to Appendix 2 for additional information.)

4.5.4 Safety precautions prior to shotfiring

There are several test and warning steps that must be carried out by a shotfirer before any shot or round of shots is fired. These are most important for the safety of the shotfirers and other personnel, and for the prevention of damage to equipment.

1. **Test for general safety prior to charging**

Before charging the shotholes, the examination for general safety should include:

- the security of supports;
- a check on other operations being carried out in the vicinity to ensure that they will not affect the shotfiring operation or be put at risk by it; and
- the likely effect of blasted debris obstructing the ventilation.

The need for such an examination, and the level and detail of the examination will depend on factors such as:

- changes in circumstances;
- the passage of time between commencing charging and actual firing; and
- other mining operations being carried out simultaneously in the vicinity.

2. **Retest for general safety before firing**

Immediately before firing a shot or round of shots, an examination as described in 1 above will be conducted a second time.

3. A test for methane should be made

There is a range of steps and tests that must be carried out to check for the presence of methane.

- (a) A person must not charge or fire a shot unless the person has carried out an examination for general safety (as above in 1 and 2) and tests for the presence of **methane** in the general body of air.
- (b) A test for methane must be made with a locked oil flame safety lamp or a **methanometer**.
- (c) A person must not charge a shothole or fire a shot if, during any test, the person can see any indication of methane on the lowered flame of a locked oil flame safety lamp or finds with a methanometer any place with a methane content of 1.25% or more.
- (d) A person who intends to fire a single shot must:
 - (i) immediately before the hole is charged, carry out an examination for general safety and test for methane in the vicinity and at the mouth of the shothole and in all safely accessible places within a radius of

20 metres of the shothole, paying particular attention to goaf and cavities created by falls within this 20 metres; and

- (ii) immediately before firing, test for methane in the vicinity of the shothole and in all safely accessible places within a radius of 20 metres of the shothole.

- (e) A person who intends to fire a round of shots must:

- (i) immediately before the first shothole of the round is charged
 - carry out an examination for general safety, and
 - test for methane in every safely accessible place within 20 metres of each of the two shotholes in the round of shots which are furthest apart, and test for methane at the mouth of each shothole in the round of shots; and
- (ii) immediately before firing, test for methane in the vicinity of each shothole and in all safely accessible places within a distance of 20 metres of each of the two shotholes which are furthest apart.

- (f) **If a person, during any test, sees any indication of methane on the lowered flame of a locked oil flame safety lamp, or finds when testing with a methanometer (at any place) a methane content of 1.25% or more, that person must immediately report that indication or finding to the deputy assigned to the district in which the test was made. No attempt should be made to charge any holes, connect any cables or fire a shot until the methane content is diluted to less than 1.25%.**

4. **Warning for persons**

Immediately prior to firing, the shotfirer must warn any person working near the place where the shots are to be fired and who may be affected by the shotfiring.

If any person is working near a place where shotfiring is to take place and is likely to be affected by that shotfiring, then the shotfirer should warn that person immediately prior to firing the shot. Any person working on the immediate return side of where the shots are to be fired should be brought to a place of safety which will not be affected by the fumes from the shotfiring.

Any person working in a place where shots may blow through should be withdrawn from that place until shotfiring is completed in that place.

Attention should be given to the 5 metre limit. However, the explosives to be used should be subject to a risk assessment of the particular site with respect to geological conditions, gas make in the seam, general body flammable gas, dangerous dust and adequacy of ventilation and any other relevant matters.

4.5.5 Stray electrical currents and voltages

There are dangers during shotfiring operations of inadvertent initiation by electrical current leakage and interference from other electrical sources. This matter is described in Section 4.4.3 and should be referred to because of the risks that can be caused to shotfiring

operations. The manager should take all reasonable steps, such as conducting design and operational risk assessments, to identify any such risks and implement barriers to minimise the identified risks.

4.5.6 Priming of cartridges

Priming of cartridges should only be carried out in a place of safety. There should only be one person priming cartridges at a time, either a shotfirer or a trainee shotfirer under the supervision of the shotfirer.

A person priming a cartridge should only have one container of explosives open at one time and the detonator container should only be open while detonators are being removed.

In cases where the ends of **detonator lead wires** are bare, the exposed conductors should be short-circuited (ie, twisted together) before the cartridge is primed.

When priming a cartridge, a **non-ferrous pricker** should be used to pierce a hole along the cartridge to accommodate the detonator fully.

4.5.7 Security of primed cartridges

Priming of cartridges should not be carried out prematurely (ie, not too soon before charging) and should normally finish when charging of the whole round can commence without delay. The number of cartridges primed should not normally exceed the maximum number of shots shown in any shotfiring pattern which the manager has provided.

The manager must develop a management plan to specify procedures to be adopted in the event of an emergency which interrupts priming or charging. Such a plan is to ensure that primed cartridges are kept under secure control by the shotfirer or some other designated person.

4.5.8 Shotfiring cable

DRAFT

There are several important steps that must be followed by the shotfirer when preparing for charging and firing.

1. A person must not use **shotfiring cable** other than for firing shots.
2. A person using any shotfiring cable must take all reasonable steps to ensure that the cable is safe for use.
3. Suitable specifications for shotfiring cable are provided in Appendix 2.
4. The person using any shotfiring cable should examine that cable throughout the whole of its length before use and should not use any cable which is found to be damaged or defective.

5. Shotfiring cable for use in a shaft should be of sufficient length to enable shots to be fired from a safe place outside the shaft. In other cases the length of cable run out should be as specified in the manager's plans.
6. Although the cable lengths ensure a minimum distance between the shot and the firing station, factors relating to danger zones and withdrawal from danger zones should always be taken into account when determining the cable lengths.
7. The length of shotfiring cable run out for use should either be supported at suitable intervals throughout, preferably by insulated hangers, or be otherwise positioned such that it is protected from damage, however it is positioned. For example, the cables should be protected from damage by moving vehicles.
8. The ends of the shotfiring cable should remain short-circuited at the shotfiring station until they are required for testing or firing.
9. Before connecting the shotfiring cable to the detonator circuit, the shotfirer should minimise the risk of premature detonation by ensuring that it is not in contact with the exploder, with any other cable or other electrical apparatus, or with any other source of electrical charge.
10. No additional wire should be used to connect detonator leads to each other or to the shotfiring cable. A firing station should not have more than one shotfiring cable extending from it.

4.5.9 Danger zones and withdrawal of persons

It is most important that the safety of all persons, and the protection of all equipment, be a primary concern of the shotfirer.

Before firing, the shotfirer proposing to fire a shot should determine the **danger zone** likely to be created. The danger zone should include the area in which persons could be struck by projected or flung material, including ricochets, or otherwise endangered by shotfiring operations (eg, blast effects). The shotfirer's determination of the danger zone should take particular account of the amount of explosives being used, the nature of the coal, mineral or rock strata and the position of each shothole to be fired. Account should also be taken of the risks from shotfiring fumes.

No person should fire any shot unless the person has, at each entrance to the danger zone, either posted a sentry or placed an appropriate fence conspicuously marked with the words "DANGER" and "SHOTFIRING" together with the date and the shotfirer's initials. Any fencing erected should be removed at the completion of the post-shotfiring examination. Sentries are a more effective means (than fencing) of preventing unauthorised entry into a danger zone and should be used in preference to fencing where practical.

Before firing a shot, all persons and all explosives and detonators not forming part of the charge should be removed from the danger zone. Electrical apparatus and machinery within the zone should also be protected. Shots should be tested or fired from outside the danger zone.

Where a shot may blow through into another place, any persons likely to be affected should be given adequate warning. Any resultant ventilation disruptions should also be taken into account and remedial measures put into place.

4.5.10 Steps to be taken before a shot or round of shots is fired

The shotfirer in charge of firing a shot or round of shots should take the following steps before firing any shot or round of shots.

DRAFT

1. Check to ensure that detonators are coupled in the correct manner and sequence and ensure adequate connection to the shotfiring cable.
2. Many problems, such as currents induced during testing from outside sources (including electrical storms), may be experienced with **transformer-coupled (or mains) shotfiring**. For this reason mains shotfiring is not recommended. However, in special circumstances, where shots are required to be fired by means other than an approved exploder, then site-specific approval with appropriate conditions must be obtained from the District Inspector of Coal Mines following submission of a management plan by the mine manager.
3. Where the shots are to be fired by an approved exploder the shotfirer in charge of the shot or the trainee shotfirer acting under the close supervision of the shotfirer should ensure that the electrical resistance is checked with an approved ohmmeter calibrated by a NATA-accredited Authority. (NATA is an abbreviation for **National Association of Testing Authorities**.)
4. Ensure that all open and accessible places are fenced off and that sentries are posted at the entry to the danger zone and that the shotfirer and all other persons are withdrawn to a safe area outside that danger zone.
5. Prior to connecting the shotfiring cable to the shotfiring device the shotfirer should determine that the impedance/resistance of the circuit is such that a misfire is unlikely to occur. Calculations should be carried out on a site-specific basis.
6. All trailing cables of equipment within the danger zone should be disconnected before cartridge priming begins. *Safety tags should be attached (eg, "Out of Service" or Personal Danger Tag).*
7. In carrying out the above procedures the shotfirer in charge of the shot should be aware of the requirement that while carrying out tests in compliance with these Guidelines, those tests should be carried out from a pre-determined firing station or suitable area located outside the defined danger zone.
8. Any testing of a circuit should only be carried out using an approved ohmmeter.

4.5.11 Operation of exploder

The shotfirer in charge of the shot or a trainee shotfirer acting under the close supervision of the shotfirer should take specific care when operating the **exploder**.

1. While engaged in the charging of the shot, the shotfirer or trainee shotfirer acting under the close supervision of the shotfirer should ensure that the **removable handle** or **key** is removed from the exploder. The key must remain in the personal care of the shotfirer or trainee shotfirer at all times to stop unauthorised operation of the equipment.
2. The shotfirer or trainee shotfirer should ensure that the removable handle or key is not positioned in the exploder until immediately before the firing of the shot and must remove the handle or key immediately after the shot is fired or following an unsatisfactory circuit test.
3. The shotfirer or trainee shotfirer should take all such precautions (according to Regulations) as are necessary to maintain the safety of personnel who are required to work in the area.

4.5.12 Sentry's duties

In section 4.5.9 a warning was given about danger zones likely to be created by firing a shot or round of shots. At each entrance to a danger zone, a **sentry** should be posted, or an appropriate fence and warning signs erected.

1. A person who has been posted to act as a sentry in respect of a particular danger zone
 - (a) must forbid all persons except the shotfirer (whose duty it was to ensure the sentry was so posted) or any trainee shotfirer working under that shotfirer's close personal supervision to enter that danger zone; and
 - (b) must not leave the post until the particular person who requested the posting has personally directed that the sentry may leave the post.
2. Each sentry posted should remain in an adequately sheltered position and do no other work which could prevent the sentry from fully carrying out any instructions given to the sentry by the shotfirer (cf Section 4.5.13).

4.5.13 Duty to comply with sentry's orders and with notices

All personnel should comply with a sentry's orders and/or obey a warning notice.

1. A person should not pass a sentry who has forbidden entry to a danger zone.
2. A person should not pass a fence erected for the purpose of forbidding entry to a danger zone unless with the permission of the person firing the shot.

4.6 Precautions to be taken after firing

Before the shotfirer personally examines the area affected by the blast for the purpose of ensuring that it is safe for work to be resumed, a minimum of ten (10) minutes should be allowed to elapse. A longer period may be considered necessary depending on the weight of the charge, type of explosives and the ventilation for clearance of fumes.

During the post-firing examination the shotfirer should conduct three checks or precautionary steps as described below.

1. So far as the shotfirer is able, check that all shots have fired, and that no unexploded part of the charge remains either in sockets (or butts) or in the debris.
2. The shotfirer should make general safety checks covering supports, ventilation, flammable and noxious gases and equipment.
3. Depending on the results of the checks or investigations mentioned in steps 1 and 2 the shotfirer should subsequently arrange for any necessary corrective action to be taken.

Where the shotfirer can not make personal examination after firing, no person should enter the affected area until the post-shotfiring examination has been carried out by a competent person appointed by the manager. This examination should be carried out as soon as practicable. Whilst making this examination the shotfirer may be accompanied by one other person or, in the case of **shaft sinking**, two persons.

4.7 Steps to be taken by the shotfirer in the event of misfire

The management plan for steps to be taken in the event of a **misfire** are noted in Section 4.1. To complement that information, the responsibilities of a shotfirer to take steps in the event of a misfire are summarised below.

1. In the event of a misfire the shotfirer in charge of the shot must:
 - (a) take whatever steps are necessary to determine the cause of the misfire and to deal with the misfire in a way that is consistent with the management plan; and
 - (b) report the misfire to the manager or most senior official on the same shift.
2. The manager should consult with the shotfirer and:
 - (a) investigate the circumstances of any misfire report that needs to be investigated; and
 - (b) review the shotfiring procedures to reduce the likelihood of further misfires.
3. **Misfire revealed whilst loading out**

During the **loading out** process, a misfire may be identified that had previously been obscured. The management system, as required by the Regulations, will provide for the recovery, transportation and disposal of any detonator and explosives remaining, and those steps must be followed.

No person should leave unguarded, abandon, discard or otherwise neglect to safely dispose of, any explosive recovered in the treatment of misfires.

WARNING. If the place in which any shothole containing a misfired charge is to be left unattended for any period of time (eg, end of shift), it must be clearly marked and adequately fenced off until the misfire has been correctly dealt with. Similar precautions must be taken if the detonator or unexploded material has not been recovered.

4. Additional duties of shotfirer

- (a) The shotfirer should ensure that all shotholes charged or primed cartridges held by the shotfirer or by other persons acting under close supervision of the shotfirer are fired before the end of the shotfirer's period of duty.
- (b) Where a shotfirer is prevented by reasons beyond control from complying with sub-paragraph (a), that shotfirer must report the matter either to the person who is directly supervising the shotfirer or to a person senior to that person, who must either carry out the relevant duty personally or require it to be carried out by another shotfirer. In such a case that other shotfirer is obliged to comply with the duty concerned.
- (c) Where a trainee shotfirer is prevented by reasons beyond control from complying with any specific duty, that duty must be carried out by the shotfirer under whose close personal supervision the trainee is working.

It is important that potential sources of danger should be made safe as quickly as possible. In particular, charged shotholes should be fired as soon as it is safe to do so.

When a potential source of danger cannot be made safe immediately all persons should be withdrawn from the vicinity and suitable fencing and notices erected to prevent any persons inadvertently entering the place of danger.

4.8 Shotfirer's records

Every shotfirer must, in respect of each period of duty worked, make a comprehensive record. The matters that need to be recorded (and included in the written record) include those that are listed below.

1. The date and time of shots fired.
2. The number of detonators taken into the mine by the shotfirer.
3. The number of detonators taken out of the mine by the shotfirer.
4. The result of all examinations made by the shotfirer.
5. The number of shots fired by the shotfirer or under the shotfirer's supervision or, if the shotfirer fired rounds of shots, the number of rounds of shots fired by the shotfirer or under the shotfirer's supervision and the number of shots in each round.

6. The type(s) of explosives used *and the weight of explosives used.*
7. The number and type of shots fired in:
 - (a) coal;
 - (b) stone drifts;
 - (c) grading roof or floor; and/or
 - (d) elsewhere (with a full description).
8. The number and location of any misfired shots and the action taken, and the name of undermanager or senior mining official to whom the action was reported on that shift.
9. Any charged shotholes, primed cartridges, misfires or post-shotfiring examination which the shotfirer was unable to deal with. (A shotfirer, having charged a shot, must not leave that place unsupervised or unfenced.)
10. The location of any fences and danger boards in place.
11. If the shotfirer supervised a person in the firing of shots, the name of that person.

The record should be seen and signed by the manager or by a person appointed by the manager for the purpose.

APPENDIX 1

EXPLOSIVES, DETONATORS, EXPLODERS, CIRCUIT TESTERS AND EXPLODER TEST APPARATUS

The Coal Mines (Underground) Regulation 1999 summarises the use of explosives and detonators in mines. Discussions about the use of explosives and detonators have been made at Clauses 151 to 161 of that Regulation.

These Guidelines and this Appendix expand on the descriptions of explosives and detonators.

1. Explosives

Explosives may be approved under one or more groups eg, P1 to P5. The approval documents relate to the various uses. For example, P1 explosives are not normally approved for firing in waste nor for delay firing in coal. Table A1.1 summarises types of explosives applicable to various uses.

Despite explosives being divided into Groups, eg, P1, P3, P4, P4/5, only two of these are readily available in Australia. These two are P1 and P5.

P1 (ordinary permitted explosive) This is an explosive approved by the Chief Inspector of Coal Mines, New South Wales, as a Group P1 explosive. P1 explosives must comply with all requirements of Group P1 explosive documented in the Testing Memorandum Number 2 issued by the Health and Safety Executive of the United Kingdom.

P5 (designed primarily for delay firing in solid coal where a district inspector consents to this) This is an explosive approved by the Chief Inspector of Coal Mines, New South Wales, as a Group P5 explosive. P5 explosives must comply with all requirements of Group P5 explosive documented in the Testing Memorandum Number 2 issued by the Health and Safety Executive of the United Kingdom.

The criteria for the categorisation of explosives was developed in the United Kingdom and tests are known as the Buxton tests.

As test conditions are much more severe than practical shotfiring conditions, a proportion of ignition is allowed.

In test conditions a charge of explosive is placed in a steel cannon so that the end of the charge is 51 millimetres from the mouth of the bore. The charge is fired into a 9% methane/air mixture.

In the case of P1 explosives a percentage of ignitions is permitted. In the case of P5 category explosives, no ignitions are permitted, despite the fact that almost three (3) times the explosive quantity is used in the test. When tested with flammable dust, no ignitions are permitted by either P1 or P5 explosives.

2. **Detonators**

Only Carrick or Carrick II millisecond delay detonators are approved. Electric detonators must have copper tubes and copper leading wires. Instantaneous detonators may be used in any situation. The detonator tubes should be marked clearly to identify the period of delay.

The normal delay periods corresponding to the delay numbers for detonators presently available for use in coal mines in Australia are shown in Table A1.2.

NOTE. Approval conditions or manufacturer's recommendations for explosives may provide for the use of specific strength detonators. The use of detonators other than those specified may introduce problems such as misfires.

3. **Exploders**

Refer to Section 4.3.9 (Maintenance and testing of exploders), and Section 4.3.10 (Maintenance and testing records for exploders).

4. **Testers**

The requirement for circuit testers for checking the resistance of shotfiring circuits, and for devices for testing the performance of exploders are specified in Section 4.3.9 (Maintenance and testing of exploders).

TABLE A1.1 TYPES OF EXPLOSIVES FOR VARIOUS USES

Use	Explosives Type
Virgin stone drifts and shafts (no coal seams present).	Non-permitted explosives may be used subject to application being made to the Chief Inspector of Coal Mines and compliance with approval conditions. In other cases, P1 permitted explosives may be used.
In applications of shaft sinking, including longhole shotfiring and drift driveage, shooting roof for over casts, shooting floor for sumps, shooting coal roof and floor or mining through faults and dykes or similar activities.	P5 explosives to be used. However, subject to a full risk assessment being carried out and approval being obtained from the District Inspector of Coal Mines, P1 explosives could be used. DRAFT
Full face firing — solid coal.	P5 explosives are to be used. In certain circumstances other permitted explosives may be used subject to application to the District Inspector of Coal Mines.
Special Applications — refer to Section 4.4.6 of these Guidelines — including goaf of longwalls, pillar extraction and such like.	P5 explosives are to be used and only after all other alternatives have been considered. In many cases, it is difficult to test for flammable gas in these areas.

NOTE. Risk assessments should take into consideration such factors as geological conditions (eg, nature of the rock strata); geological disturbances (such as dykes, faults, etc.); flammable gas make of a seam; general body flammable gas levels; deposition of dangerous dust; moisture content of dust and surrounding rock strata; ventilation; number of shots to be fired; delay periods; and other relevant issues.

TABLE A1.2 CARRICK DELAY AND CARRICK II DELAY DETONATORS

A. Carrick Delay

Delay No.	Nominal Delay Time (millisec)	Nominal Interval (millisec)
0	5	25
1	30	25
2	55	25
3	80	25
4	105	25
5	135	30
6	165	30
7	195	30
8	230	35
9	265	35
10	300	35

If other types of detonators become available, delay periods may vary. Advice should be obtained from manufacturers or suppliers. Manufacturers and suppliers of any substance for use by persons at work have an obligation under the *Occupational Health and Safety Act 1983* to provide adequate information about their products to ensure that the product will be safe and without risks to health when properly used. As an example, Table A1.2B is for **Carrick II** detonators which supersede the more familiar **Carrick** detonators. It must be remembered that, although they are no longer manufactured, some mines may still have **Carrick** detonators in stock as well as **Carrick II** detonators. Note that the delays are different. Similar delay numbers have different delay times — eg, Delay no. 5 has a 150 millisec delay in **Carrick II** but 135 millisec in **Carrick**.

B. Carrick II delay

DRAFT

Delay No.	Nominal Delay Time (millisec)	Nominal Interval (millisec)
0	0	0
1	25	25
2	50	25
3	75	25
4	100	25
5	125	25
6	150	25
7	175	25
8	200	25
9	225	25
10	250	25

Tables A1.2A and A1.2B list the nominal firing times in milliseconds (ms) of low incensive, short-delay detonators (**Carrick** and **Carrick II**, respectively) presently in use in the Australian coal mining industry.

CAUTION. From time to time, manufacturers may change specifications of their products. Shotfirers and supervisors are strongly advised of the necessity to check the description of the products they are intending to use and also any information available from the manufacturer.

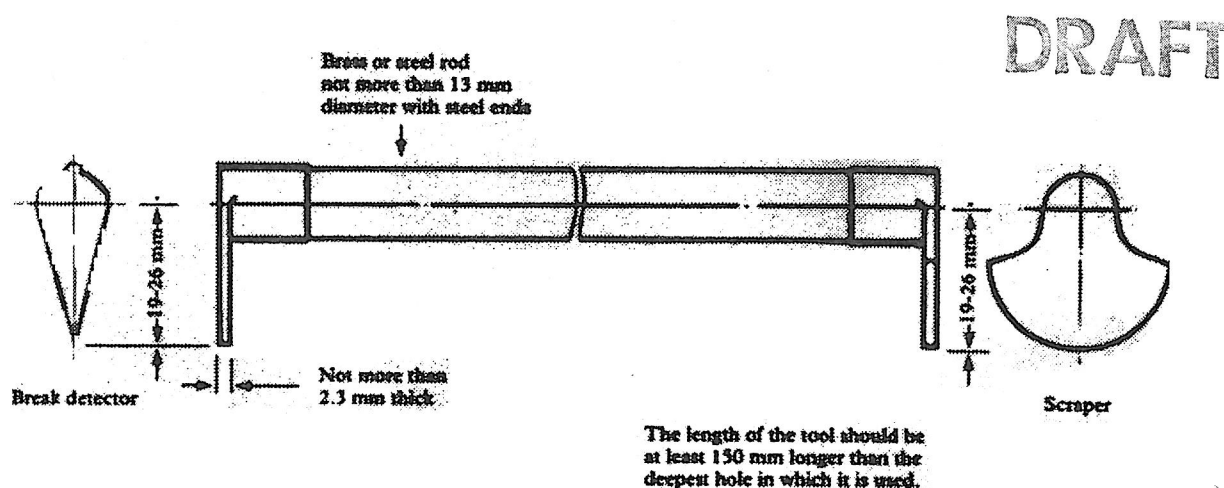
APPENDIX 2

DESIGN OF SHOTFIRING EQUIPMENT AND CONTAINERS

Scraper and break detector

The end of the **scraper** used for cleaning out shotholes should not comprise more than half a disc (see illustration).

The **break detector** used should be a straight rod made of a rigid, durable material such as hard brass or hardwood (see illustration). Light materials or alloys of light metals are not suitable. It should be fitted with a flat prong on one end, which forms an integral part of the detector or is securely attached to the detector, and which is made of or tipped with hard-wearing metal.



Scraper and break detector.

to be
(Redrawn from Health and Safety Commission 1993)

Stemming stick

The **stemming stick** used for charging and stemming shotholes should be made entirely of wood. The ends should be flat, with a diameter not less than three quarters of the diameter of the shothole. Any other device used for charging or stemming should be made of anti-static materials.

Shotfiring cable

Shotfiring cable should be twin core cable comprising two stranded copper conductors each with a cross-sectional area of not less than 0.8 mm^2 (0.8 square millimetre).

The cable cores should be insulated throughout their length with a grade of insulation capable of withstanding 1500 Volts for at least 30 seconds.

The cable should be capable of resisting wear and rough use, with any joints properly made and vulcanised or moulded or by using suitable insulated connectors of a type in which no uninsulated metal is visible after completion of the connection.

Primary looping wire

The primary looping wire for use with transformer-coupled electric detonators should be single core copper wire with a cross-sectional area of not less than 0.28 mm^2 (0.28 square millimetre). It should be effectively insulated throughout its length.

Construction of explosives containers

Any containers used for the transport of explosives at a mine should be purpose-built, robustly constructed in steel, waterproofed, and suitably lined with non-ferrous but not light metal alloy (ie, not metals or alloys of aluminum, magnesium or titanium). The box must be capable of being securely locked.

The containers should be coloured red and clearly marked with the words "DANGER" and "EXPLOSIVES".

Provision should be made for fire extinguishers (80:BE).

Design of containers for explosives and detonators

All containers for explosives, detonators or primed cartridges should be capable of being locked, with a removable key, and stout enough to retain the contents undamaged during transport and storage. Each container should have a lid or cap which closes easily and when locked prevents entry of extraneous or unwanted material. Construction should allow the contents to be packed without force and should be without any internal protrusions or surfaces which might damage the contents.

Containers which are to be carried by hand should be fitted with secure handles.

Detonator containers should be capable of being carried personally by the shotfirer.

Containers used for detonators should be constructed to electrically isolate the contents from electrical sources outside. Their design should make it impossible for any detonator lead to be exposed when the container is closed.

Bulk explosives

NOTE. Large underground mining operations (eg, metalliferous mines) are purchasing explosives in bulk from manufacturers. The term "bulk" generally refers to explosives in a large single package in contrast to the individually packed sticks of explosives commonly used in underground coal mining. The use of bulk explosives is becoming more popular and the explosive may be pumped into shotholes in a slurry form, especially when very large

quantities are required for a particular task. There are advantages in cost, time and security. To date, such bulk explosives have not been used in coal mining in Australia. If this does occur in the future, then appropriate management systems will be required.

Reference:

Health & Safety Commission, 1993. *Explosives at coal mines and other safety lamp mines. Coal and Other Safety-Lamp Mines (Explosives) Regulations 1993*. HMSO (Her Majesty's Stationery Office), United Kingdom, 48pp.

DRAFT

DRAW 1