

Australian Standard™

Explosives—Storage and use

Part 2: Use of explosives



This Australian Standard was prepared by Committee CE-005, Explosives. It was approved on behalf of the Council of Standards Australia on 3 August 2005. This Standard was published on 2 February 2006.

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Australian Standard™

Explosives—Storage and use

Part 2: Use of explosives

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PREFACE

This Standard was prepared by the Standards Australia Committee CE-005, Explosives, to supersede AS 2187.2—1993, *Explosives—Storage, transport and use, Part 2: Use of explosives*.

The objective of this Standard is to provide requirements, information, and guidance for the use of explosives, the management of a site where explosives are used and the destruction of excess or deteriorated explosives, which ensure risks are acceptable minimized. This Standard is for reference by manufacturers, suppliers, and users of explosives. In addition, it is for reference by regulators and beneficiaries of activities involving explosives.

The major changes in this revision include the following:

- (a) Inclusion of requirements for large operations.
- (b) Adoption of a risk management approach with a greater emphasis on planning.
- (c) Use of the term ‘close proximity’ in lieu of specific distances.
- (d) Where appropriate, removal of reference to approval by authorities.
- (e) Inclusion of requirements for electronic and remote blasting.
- (f) Significant changes to ground vibration and airblast overpressure assessment.
- (g) Inclusion of a new appendix covering exclusion zones.
- (h) Inclusion of requirements for the use of explosives in atmospheres greater than atmospheric pressure.

This Standard is one of a series which includes the following:

AS

- 2187.0 Explosives—Storage, transport and use—Terminology
- 2187.1 Explosives—Storage, transport and use—Storage
- 2187.2 Explosives—Storage, transport and use—Use of explosives (this part)
- 2187.3 Explosives—Storage, transport and use—Pyrotechnics—Shopgoods fireworks—Design, performance and testing
- 2187.4 Explosives—Storage, transport and use—Pyrotechnics—Outdoor displays

The terms ‘normative’ and ‘informative’ have been used in this Standard to define the application of the appendix to which they apply. A ‘normative’ appendix is an integral part of a Standard, whereas an ‘informative’ appendix is only for information and guidance.

CONTENTS

	<i>Page</i>
FOREWORD.....	6
 SECTION 1 SCOPE AND GENERAL	
1.1 SCOPE	7
1.2 APPLICATION	7
1.3 REFERENCED DOCUMENTS	7
1.4 DEFINITIONS	8
1.5 REGULATORY AUTHORITIES.....	11
 SECTION 2 GENERAL REQUIREMENTS	
2.1 RISK.....	12
2.2 PLANNING.....	12
2.3 EXECUTION	12
2.4 SOURCES OF IGNITION NEAR EXPLOSIVES.....	12
2.5 BLAST EQUIPMENT	12
2.6 REPORTING OF THEFT OR LOSS OF EXPLOSIVES.....	13
2.7 REPORTING OF DAMAGE OR INJURY	13
2.8 EMERGENCY PROCEDURES	13
 SECTION 3 ON-SITE MANUFACTURE OF EXPLOSIVES	
3.1 GENERAL	14
3.2 MATERIALS	14
3.3 FIRE PRECAUTIONS ON MIXING SITES	14
3.4 MIXING APPLIANCES AND BUILDINGS	15
3.5 MANUFACTURE OF ANFO.....	18
3.6 STORAGE OF ON-SITE MANUFACTURED EXPLOSIVES	19
 SECTION 4 PLANNING	
4.1 GENERAL PROVISIONS.....	20
4.2 BLAST MANAGEMENT PLAN	20
4.3 ADMINISTRATION AND LEGISLATION	20
4.4 SAFETY AND SECURITY.....	20
4.5 BLASTING HISTORY AND CONSULTATION	21
4.6 PHYSICAL CHARACTERISTICS AND GEOLOGY	21
4.7 RESPONSIBILITIES	21
4.8 ENVIRONMENTAL IMPACTS	22
4.9 GENERAL SAFETY PRECAUTIONS	22
4.10 SPECIAL PRECAUTIONS	23
4.11 BLAST DESIGN	23
 SECTION 5 BLAST PREPARATION	
5.1 BLAST MANAGEMENT PLAN	25
5.2 BLAST AREA PREPARATION AND ACCESS	25
 SECTION 6 OPERATIONS PRIOR TO CHARGING	
6.1 BLAST AREA MANAGEMENT	27
6.2 PNEUMATIC CHARGING	29
6.3 PREPARATION OF CHARGES	29
6.4 BOOSTERS/PACKAGED PRODUCTS	31

6.5	SURFACE CHARGING.....	32
SECTION 7 CHARGING		
7.1	SAFETY PRECAUTIONS	33
7.2	PRECAUTIONS AT SITE	33
7.3	BLASTHOLES (CLEANLINESS)	33
7.4	INSERTION OF CHARGE	34
7.5	STEMMING	35
7.6	BULLING	36
SECTION 8 METHOD OF INITIATION		
8.1	GENERAL PROVISIONS.....	37
8.2	METHOD OF INITIATION	38
8.3	FIRING.....	44
SECTION 9 POST BLAST PROCEDURES		
9.1	GENERAL SAFETY CONSIDERATIONS	45
9.2	SHIFTWORK	45
9.3	ELECTRIC FIRING	46
9.4	POST-BLAST INSPECTION	46
9.5	SITE HOUSEKEEPING	47
SECTION 10 MISFIRES		
10.1	DETERMINATION OF MISFIRES	48
10.2	MISFIRE MANAGEMENT SYSTEM	48
10.3	TREATMENT OF MISFIRES.....	49
SECTION 11 DESTRUCTION OF DEFECTIVE AND SURPLUS EXPLOSIVES		
11.1	GENERAL PROVISIONS.....	51
11.2	METHODS OF DESTRUCTION	51
SECTION 12 SPECIAL CONSIDERATIONS		
12.1	EXTRANEIOUS ELECTRICITY	53
12.2	GROUND VIBRATION AND AIRBLAST OVERPRESSURE.....	54
12.3	FLY	54
12.4	BLASTING UNDER WATER	54
12.5	USE OF EXPLOSIVES IN AN ATMOSPHERE GREATER THAN ATMOSPHERIC PRESSURE	55
12.6	BLASTING IN HOT MATERIAL	57
12.7	HIGH TEMPERATURE BLASTING	58
12.8	DEMOLITION	59
12.9	BLASTING IN OXIDIZING GROUND	59
12.10	LASER HAZARDS	59
APPENDICES		
A	BLAST MANAGEMENT PLAN AND RECORDS	60
B	EQUIPMENT FOR ELECTRICAL FIRING	63
C	FIRE PRECAUTIONS	67
D	PREPARATION OF PRIMERS	68
E	FLYROCK AND FLY	70
F	FIRING CIRCUIT CONNECTIONS.....	79
G	DETERIORATION OF EXPLOSIVES	88

Page

H	DESTRUCTION OF EXPLOSIVES (OTHER THAN DETONATORS) BY BURNING	90
I	EXTRANEIOUS ELECTRICITY	93
J	GROUND VIBRATION AND AIRBLAST OVERPRESSURE.....	98
K	DEMOLITION OF STRUCTURES	119
L	EXCLUSION ZONES	124

FOREWORD

Explosives are a concentrated source of energy, and because of their chemical properties are capable of inflicting death or injury to persons or damage to property or the environment. Similarly, they present a security problem if someone has unlawful possession of explosives or if explosives are in the hands of the inexperienced or those with ill intent.

Explosives thus present a high risk with potentially severe consequences unless stored, transported and used by competent persons in a safe and secure manner.

This Standard provides information on hazards presented by explosives and ways to manage and control the identified risks at a level that is acceptable to the community and in accordance with safe and secure industrial practice.

It is highly recommended that persons required to handle and use explosives are familiar with AS/NZS 4360, *Risk management*. Similarly, it is recommended that management plans, used to facilitate safe work procedures, plans and processes dealing with explosives, be based on AS/NZS 4804, *Occupational health and safety management systems—General guidelines on principles, systems and supporting techniques*.

For the purpose of this Standard it is a fundamental requirement that persons are competent and authorized by their employer to handle and use explosives. Competence, with respect to handling and use of explosives, is recognized through compliance with relevant legislation and by having documentation confirming one or both of the following:

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

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

Frequent reference is made in this Standard to the risk management process, risk analysis and risk controls; it is fundamental that persons using or referencing this Standard have a basic understanding of these terms.

Some hazards or risk controls associated with the handling and use of explosives may not be referenced in this Standard. This is not a deliberate omission but the application of proper risk management techniques should be sufficient for such hazards to be identified for specific or unusual situations relevant to individual work sites.

STANDARDS AUSTRALIA

Australian Standard

Explosives—Storage and use

Part 2: Use of explosives

SECTION 1 SCOPE AND GENERAL

1.1 SCOPE

This Standard sets out the requirements and precautions for the use of factory-made commercially available explosives and certain explosives mixed or assembled at sites.

This Standard does not apply to the following:

- (a) Safety ammunition.
- (b) Propellant powders.
- (c) Pyrotechnics, including fireworks, rockets, fog signals or the like.
- (d) Purpose-designed and manufactured military explosives.

NOTE: This Standard should not be regarded as overriding statutory requirements, including licensing, but may be construed as a set of working rules to be used in conjunction with such requirements.

1.2 APPLICATION

This Standard shall be read in conjunction with AS 2187.0 and the definitions therein apply to this document except where a definition is given herein.

1.3 REFERENCED DOCUMENTS

Where a provision of any of the referenced documents (other than legislation) in this Standard is inconsistent with any provision of this Standard, the provisions of this Standard takes precedence.

The following documents are referred to in this Standard:

AS	
1019	Internal combustion engines—Spark emission control devices
1678	Emergency procedure guide—Transport
1678.5.1.002	Part 5.1.002: Ammonium nitrate
1742	Manual of uniform traffic control devices
1742.3	Part 3: Traffic control devices for works on roads
1743	Road signs—Specifications
2187	Explosives—Storage, transport and use
2187.0	Part 0: Terminology
2187.1	Part 1: Storage
2397	Safe use of lasers in the building and construction industry
2601	Demolition of structures

AS	
2670	Evaluation of human exposure to whole-body vibration
2670.2	Part 2: Continuous and shock-induced vibration in buildings (1 to 80 Hz)
2809	Road tank vehicles for dangerous goods (all parts)
4326	The storage and handling of oxidising agents
60529	Degrees of protection provided by enclosures (IP Code)
AS/NZS	
1768(Int)	Lightning protection
2211	Safety of laser products (all parts as applicable)
3000	Electrical installations (known as the Australian/New Zealand Wiring Rules)
3191	Electric flexible cords
4240	Remote controls for mining equipment
4360	Risk management
4804	Occupational health and safety management systems—General guidelines on principles, systems and supporting techniques
HB 76	Dangerous Goods—Initial emergency response guide
BS	
2050	Specifications for electrical resistance of conductive and antistatic products made from flexible polymeric material
6472	Guide to the evaluation of human exposure to vibration in buildings (1 Hz to 80 Hz)
7385	Evaluation and measurement for vibration in buildings
7385-1	Part 1: Guide for measurement of vibrations and evaluation of their effects on buildings
7385-2	Part 2: Guide to damage levels from groundborne vibration
ISO	
2631	Mechanical vibration and shock—Evaluation of human exposure to whole-body vibration
2631.2	Part 2: Vibration in buildings (1 Hz to 80 Hz)
USBM	
RI 8507	United States Bureau of Mines
Department of Transport and Regional Services	
ADGC	The Australian Code for the Transport of Dangerous Goods by Road and Rail
AE Code	Australian Code for the Transport of Explosives by Road and Rail

1.4 DEFINITIONS

For the purpose of this Standard, the definitions given in AS 2187.0 and those below apply.

1.4.1 Airblast

The sudden increase in air pressure, generated by a shock wave, produced when an explosive is detonated.

1.4.2 Airblast overpressure

See airblast.

1.4.3 Amplitude

Distribution of frequencies derived using Fourier techniques, often using a Fast Fourier Transform (FFT).

1.4.4 A-weighting

A frequency-dependent scaling of a sound wave that mimics the response of human hearing.

1.4.5 Bar down

See scale.

1.4.6 Blasthole

A hole that has been drilled or prepared for the purpose of being charged with explosives, or has been charged with explosives.

1.4.7 Branch line

A length of detonating cord or signal tube connected to a trunkline on one end and to which downlines are connected on the other end.

1.4.8 Close proximity

An acceptable distance determined through risk assessment procedures for a specific application unless the distance is legislated.

1.4.9 Competent person

A person who has acquired through training, qualification or experience, or a combination of these, the knowledge and skills to carry out the required task.

1.4.10 Component velocity

One of the orthogonal particle velocities; typically one of radial, transverse, or vertical velocity.

1.4.11 C-weighting

A frequency-dependent scaling of a sound wave often used for impulsive noise such as airblast.

1.4.12 Damage

Physical expression of threshold failure of structures, architectural elements and/or surrounding ground.

1.4.13 Deflagrating

An explosive burning process that occurs at a rate less than the sonic velocity of the explosive material.

1.4.14 Downline

A length of detonating cord, signal tube, safety fuse or wire, one end of which is connected to the primer in a blasthole. The other end may be connected to a trunkline, a branch line or an electrical circuit.

1.4.15 Electric detonator

A detonator that is initiated by the direct application of an electric current to a fuse head within the detonator via the detonator's lead wires.

1.4.16 Electronic detonator

A detonator where the delay timing is provided by electronic circuitry within the detonator and initiated by way of digital signals provided by specialized firing equipment. Prior to activating the electronic circuitry within, the detonator may be programmed by specialized computer or programming devices.

1.4.17 Fly

The undesirable projection of any material as a result of a blast

1.4.18 Flyrock

The undesirable projection of rock as a result of a blast.

1.4.19 Fourier transform

A transformation of a time history into its frequency spectrum.

NOTE: The reverse process is usually called an inverse Fourier transform.

1.4.20 Ground vibration

Mechanical energy (vibration) produced by a blast and transmitted through the ground.

1.4.21 Human comfort

Levels of ground vibration and/or airblast that do not cause discomfort to humans.

1.4.22 Lead-in line

The main line of signal tube that leads to the shot that usually exceeds 100 m in length. It can be initiated either by a signal tube starter, detonating cord or a detonator and terminated with a detonator.

1.4.23 On-site

At or near the intended place of use of explosives.

1.4.24 Overpressure

See airblast.

1.4.25 Particle velocity

The time history of the velocity of particles within the ground.

NOTE: Analogous quantities exist for acceleration and displacement, which are each related via appropriate integration or differentiation.

1.4.26 Peak component particle velocity

The peak level of the particle velocity for an individual component.

1.4.27 Powder factor

The mass of explosive required to blast a unit of material to produce a given outcome.

1.4.28 Primer

A cartridge or booster that either carries a detonator or is coupled to detonating cord, by which the remainder of a charge is detonated.

1.4.29 Remote firing

The act of initiating explosives using an exploder activated by means of remote-controlled signalling equipment.

1.4.30 Scale

The process of removing loosened material that is likely to endanger persons.

1.4.31 Shock wave

A propagating discontinuity (abrupt change) in stress/pressure and particle velocity.

1.4.32 Shotfirer

Person licensed or authorized to use explosives in the applicable jurisdiction.

1.4.33 Signal tube

A small bore, flexible plastic tube coated internally with an explosive powder so that it is capable of transmitting a shock wave along the length of the tube.

NOTE: The external surface of the signal tube is not normally affected by the transmission of the internal explosion, although side blow-outs may occasionally occur.

1.4.34 Signal tube starter

A device for initiating the explosion in a signal tube.

1.4.35 Source of ignition

A source of energy sufficient to initiate an explosive or ignite a flammable atmosphere, and includes naked flames, lighters, lit smoking materials (such as lit cigarettes), exposed incandescent material, electrical welding arcs, mechanical or static sparks, and electrical or mechanical equipment.

1.4.36 Sound level meter

A measuring device that measures the level of sound, and may provide dBL, dBA and dBC values.

1.4.37 Sound pressure level (dB)

A logarithmic scale of pressure with a reference pressure of 20 μPa .

1.4.38 Trunkline

The main line of detonating cord or signal tube on the surface of a blast (including underground blasts) to which branches or downlines are connected.

1.4.39 USBM

United States Bureau of Mines (now disbanded although publications are readily available).

1.4.40 Vector peak particle velocity (VPPV)

The peak level of the particle velocity calculated from the vector formed by the magnitude of the three orthogonal components of the particle velocity over their measured time history.

1.4.41 Zero-crossing frequency

The frequency calculated from the half-period associated with the zero crossings about an individual peak in a ground vibration or airblast time history.

1.5 REGULATORY AUTHORITIES

Explosives in each State and Territory are governed by appropriate regulatory authorities. Persons planning blasting operations should ensure compliance with the legislative requirements applicable to the activity to be undertaken.

The words 'required' or 'approved', where used in this Standard, refer directly to the appropriate regulatory authority or a competent person, whichever is applicable.

A permit may be required for people intending to purchase or use explosives.

The manufacture, purchase, sale, transport, storage or disposal of explosives are regulated in most circumstances in Australia by regulatory authorities in most States and Territories.

SECTION 2 GENERAL REQUIREMENTS

2.1 RISK

Users of explosives shall be constantly aware of the dangers associated with the use of explosives.

Whenever explosives are to be used, a competent person(s) should carry out a detailed risk assessment to identify all foreseeable potential hazards, and take appropriate steps to eliminate or reduce the likelihood and mitigate the severity of any effects of such hazards, so that risks are at an acceptable level.

NOTE: Some explosives may need approval for use in specific applications.

2.2 PLANNING

Before the commencement of any blasting operation, an investigation of the site or item to be blasted shall be carried out. On the basis of the investigation, in conjunction with considerations detailed in but not limited to Section 12, a blast management plan incorporating a risk assessment shall be prepared by a competent person. No blasting shall commence until the blast management plan has been authorized by a competent person. The blast management plan shall be in accordance with Appendix A.

Where conditions revealed during execution of the blasting operation necessitate changes in the blast management plan, notification shall be given and authorization confirmed before the proposed changes are commenced except in emergency situations.

Planning shall include, but not be limited to, the following:

- (a) Risk assessment.
- (b) A site safety management plan.
- (c) Blast design.

The extent to which the above is undertaken shall be commensurate with the size, location, nature and complexity of the blasting operation to be undertaken.

2.3 EXECUTION

The blasting operation shall be executed by competent persons in accordance with safe working practices and the requirements of the blast management plan.

NOTE: Blasting and post-blast records should be maintained.

2.4 SOURCES OF IGNITION NEAR EXPLOSIVES

Operations that can lead to ignition or initiation of explosives shall not be carried out in close proximity to where explosives are being handled. In addition, sources of ignition, for example fire, spark and similar, shall not be brought within close proximity to where explosives are being handled, except such as may be necessary to handle, charge or initiate an explosive.

2.5 BLAST EQUIPMENT

For the purposes of this Clause, the term 'blast equipment' includes equipment used for the initiation of detonators by the use of signal tube, electrical, electronic or remote systems.

Blast equipment shall be in a sound condition and suitable for the blasting operation being undertaken. Faulty or poorly maintained blast equipment shall not be used. The shotfirer shall ensure that the blast equipment is fit for its intended purpose and safe to operate.

Equipment used for testing and firing electric detonators shall comply with, and, where appropriate, be tested in accordance with Appendix B.

Equipment used for testing and firing electronic detonators, remote initiation and non-electric initiation shall be tested, calibrated and maintained in accordance with manufacturer's recommendations.

2.6 REPORTING OF THEFT OR LOSS OF EXPLOSIVES

Identification of loss or theft of explosives can be either manifest discrepancy or physical evidence of theft. Where a discrepancy, theft, or attempted theft, of explosives has been verified, it shall be immediately reported to the appropriate authorities.

2.7 REPORTING OF DAMAGE OR INJURY

2.7.1 Damage to property

Where property is inadvertently damaged by blasting operations, there may be a requirement to report such damage to the appropriate authority.

2.7.2 Injury or death to person(s)

Where injury or death to a person(s) occurs as a result of blasting operations, the incident shall be reported to the appropriate authority or authorities. Care shall be taken to not unnecessarily disturb, move or remove any equipment or material other than to rescue or protect any injured person until permission has been granted by the appropriate authorities.

2.7.3 Damage to the environment

Where the environment is inadvertently damaged by blasting operations, there may be a requirement to report such damage to the appropriate authority.

2.8 EMERGENCY PROCEDURES

Emergency procedures should be developed for any site where explosives are used, stored or manufactured. These procedures may be developed as part of the site safety management plan dealing with risk.

Possible emergency situations include but are not limited to the following:

- (a) Fire.
- (b) Transport accident.
- (c) Natural phenomena.
- (d) Unplanned detonation.
- (e) Unauthorized site entry.
- (f) Deteriorated explosives.

SECTION 3 ON-SITE MANUFACTURE OF EXPLOSIVES

3.1 GENERAL

Explosives may be manufactured on-site in readiness for blasting. Where this is done a detailed risk assessment of the operation shall be carried out and appropriate operating procedures developed to ensure all identified hazards have been reduced to an acceptable level.

This Section provides requirements for the manufacture of ANFO and for mobile mixing units.

Most jurisdictions require that preparation areas, raw material storage areas and mixing equipment be duly licensed. States and Territories of the Commonwealth may have legislation that applies to site manufacture of explosives.

3.2 MATERIALS

The materials used in the mixing of explosives on site shall be either in accordance with Clause 3.5.2 for ANFO or as specified by the manufacturer for other explosives. Variations shall not be made to either the constituent materials or the method of mixing.

Ingredients used in the mixing of explosives shall be stored and transported such as to prevent accidental mixing.

Ingredients shall be clean and free of all foreign materials.

A comprehensive waste disposal plan for the collection and disposal of waste ingredients and waste packaging materials shall be in place. This shall take into account the possibility of all waste being contaminated with explosives.

3.3 FIRE PRECAUTIONS ON MIXING SITES

The following precautions shall be taken to minimize the possibility of fire at any place where explosives are mixed:

- (a) Surroundings within close proximity shall be kept clean and free from all combustible material.
- (b) Smoking shall not be permitted within close proximity.
- (c) Operations constituting a fire hazard, such as welding, grinding, cutting or the like, shall not be conducted on or within close proximity of a mixing plant unless all mixed explosive has been isolated from the source of possible ignition.
- (d) A detailed evacuation plan shall be developed to quickly and safely evacuate people from the site and immediate surrounds to a safe place in case a fire gets out of control. The safe place shall be as set out in the risk management plan.

NOTES:

- 1 In large mixing houses, not of a temporary nature, a water flooding system with external valves is recommended so that all equipment and adjacent areas may be flooded at the first sign of fire. An appropriate open drainage system directed to an area where the propagation of fire can be contained is also recommended.
- 2 Because of the possibility of explosion, if a fire that cannot be controlled occurs, the area should be evacuated in accordance with established procedures.
- 3 Appendix C gives guidance on fire precautions.

The treatment of fires should be a component of the blast management plan.

3.4 MIXING APPLIANCES AND BUILDINGS

3.4.1 Appliances

Appliances and associated equipment used for mixing explosives shall comply with the following:

- (a) Materials used in the construction of such equipment shall be compatible with all the ingredients, particularly ammonium nitrate. Where contact with ammonium nitrate cannot be avoided, galvanized steels, zinc, copper and alloys of these metals shall not be used (see Note 1).
- (b) Machines used for mixing shall—
 - (i) be designed to minimize the possibility of frictional heating, compaction, overloading, accumulation of compositions and confinement;
 - (ii) have bearings, motors or gears protected from spillages of material (see Note 2); and
 - (iii) be designed to facilitate cleaning operations.
- (c) All systems used for the measuring of ingredients shall be calibrated in accordance with manufacturers' recommendations.
- (d) The frames of all mixers and any associated equipment shall be effectively bonded and a continuous electrical path to earth provided.
- (e) Spark ignition (petrol-fuelled) engines shall not be used for power-operated mixers.
- (f) In the construction of mixing appliances, the potential for build-up of explosive mixtures shall be avoided (see Note 3).

NOTES:

- 1 Certain materials form sensitive compounds with ammonium nitrate, which may be hazardous. For this reason, their use is prohibited for mixing vessels, internal linings or where the material is likely to come into contact with ammonium nitrate, ANFO or similar mixtures. This also precludes their use as corrosion-resistant treatments for internal fastening devices for linings such as nails or screws. Steel, stainless steel, aluminium and some anti-static plastics materials are generally suitable.
- 2 Bearings that have cotton or similar materials used as packing should not be used.
- 3 Solid sections (e.g., rods, angles, channels and T-sections) are preferred. Hollow sections, especially those that are sealed, represent a particular hazard should explosive mixtures work their way behind faulty welds or into worn parts. If hollow sections are used, they should be left open and/or provision made for cleaning.
- 4 Plain steel nails and screws may be used but they suffer from the serious disadvantage of accelerated corrosion in the presence of ammonium nitrate.

3.4.2 Mobile mixing units

In addition to the general requirements set out in Clause 3.4.1, mobile mixing units shall comply with the following where applicable:

NOTE: Requirements for the transport of dangerous goods are set out in the Australian Code for the Transport of Dangerous Goods by Road and Rail (ADGC).

- (a) The vehicle shall be roadworthy and in sound mechanical condition and repair.
- (b) The body of the vehicle shall be constructed of materials that are not combustible.
- (c) The engine and exhaust system shall be located forward of the rear of the cabin or shielded in accordance with the AS 2809 series. A compression engine shall be fitted with an exhaust spark arrestor in accordance with AS 1019.

- (d) Any battery shall—
 - (i) be secured to prevent movement in the event of vehicle overturn;
 - (ii) be in an accessible position; and
 - (iii) have a substantial acid-resistant and ventilated cover that is electrically insulated on the side adjacent to the battery terminals.
- (e) A battery isolation switch shall be fitted and arranged to isolate the battery from all circuits and equipment, except where the maintenance of electrical supply to certain vehicle instrumentation within the cabin is acceptable to the regulatory authority.

The means of operating the isolation switch shall be—

- (i) located on the right-hand side of the vehicle immediately to the rear of the cabin, in such a position that it is clearly visible and easily accessible to a person outside the vehicle, yet protected against any detrimental effects of sunlight; and
- (ii) clearly labelled to indicate its function and method of use.
- (f) Where the engine is fitted with an alternator, the battery isolation switch shall be of a type that automatically opens the alternator field coil circuit immediately before the battery is isolated.
- (g) Electrical cables shall comply with AS 2809 series, be of stranded copper with a minimum of 7 strands and of adequate current-carrying capacity and, except on battery and starter cables, be provided with terminals of the insulation gripping type.
- (h) Wiring outside and to the rear of the cabin shall be carried in conduit in accordance with AS 2809 series, or as otherwise approved by the regulatory authority.
- (i) Each circuit, except the starting and ignition circuit, shall be protected by a fuse or manual-reset circuit-breaker in accordance with the following requirements:
 - (i) The current rating of the fuse or circuit-breaker shall not exceed the rated current-carrying capacity of the conductor.
 - (ii) Circuit-breakers shall be of the manual-reset type with instantaneous short-circuit protection capable of repeatedly opening the circuit in which it is used, without failure.
- (j) Where the mixing appliance is to be used to load free-flowing granular explosives pneumatically, consideration shall be given to the provision of an adequate earth (see Clause 6.2).
- (k) Where the vehicle fuel tank is located to the rear of the cabin, it shall be—
 - (i) protected so that the likelihood of accidental damage is minimal; and
 - (ii) designed to prevent accumulation of spilt fuel on any part of the vehicle.
- (l) A quick-acting fuel cut-off device shall be fitted to the engine fuel supply line. It shall be fitted in such a position that it is effective, clearly visible and easily accessible to a person outside the vehicle, and clearly labelled to indicate its function and method of use.
- (m) The design of the processing equipment shall also provide for the effective segregation of ingredients prior to mixing (including minimizing the possibility of mixing during incident/accident conditions).
- (n) All ingredients and explosives shall be adequately protected against direct sunlight and adverse weather conditions. Such protection shall be secure and not liable to be dislodged during normal transport.

- (o) When electric power is supplied to any processing equipment by a self-contained motor-generator located on the vehicle, the motor-generator shall be separated from the explosive discharge area of the vehicle.
- (p) Pressure relief shall be provided on containers of ingredients or explosives that might produce pressures under confinement or in the event of fire. The pressure relief shall be installed in such a manner that protection is provided against permanent closure in an accident. If a pressure-relief valve is fitted as the pressure relief mechanism, then it shall be directed so as to prevent harm to personnel in the vicinity of the vehicle.
NOTE: Pressure relief may be provided by means other than pressure-relief valves.
- (q) Tanks for liquid ingredients or explosives shall be constructed to dampen movements of the contents during transport if such movements are liable to cause a loss of vehicle control or any other hazardous situation.
- (r) All tanks and storage equipment shall comply with AS 4326.
- (s) All processing equipment shall be firmly and effectively secured to the body of the vehicle. All mobile equipment, including hoses, shall be effectively restrained while travelling.
- (t) All transfer equipment, including delivery hoses, shall be adequately restrained to ensure control is maintained during transfer operations.
- (u) A positive action parking brake, which will set the wheel brakes on at least one axle, shall be provided on vehicles equipped with air brakes and shall be used during delivery operations. Wheel chocks shall be provided on the vehicle to supplement parking brakes whenever required.
- (v) The mixing and delivery system shall be arranged so that the operator in normal position during operations has full view of explosives delivery points, or has adequate communication with another operator who does have such a view.
- (w) The mixing and delivery systems shall be equipped with an emergency stop, appropriately labelled and in easy reach of the operator monitoring these operations.
- (x) All processing equipment including tanks, hoses, taps and valves shall be clearly labelled to properly identify contents and use.
- (y) The vehicle shall be marked as follows:
 - (i) When carrying explosives, the vehicle shall be marked in accordance with the AE Code
 - (ii) When carrying only ingredients of explosives, markings for any dangerous goods carried in sufficient quantities shall be as required by the Australian Code for the Transport of Dangerous Goods by Road and Rail.
 - (iii) Where 'EXPLOSIVES' signs are not required for mixing vehicles, such signs shall be available for display at the site during mixing operations.
 - (iv) The following signs warning about moving augers and the need for eye protection shall be displayed:
 - (A) 'EYE PROTECTION MUST BE WORN WHEN IN OPERATION.'
 - (B) 'CAUTION—AUGERS MAY MOVE WITHOUT WARNING.'
- (z) The vehicle shall be equipped with emergency procedure guides appropriate to the materials being transported.

NOTE: For further guidance see AS 1678.5.1.002 or HB 76 as applicable.

3.4.3 On-site mixing-house buildings

On-site mixing-house buildings shall comply with the following:

- (a) They shall be constructed so as to minimize the risk of fire.
- (b) They shall have non-oil-absorbent floors with an adequate open drainage system to the outside.
- (c) Materials in excess of current mixing requirements shall not be stored in the buildings. Raw material used in the process should be stored in accordance with AS 2187.1 or the relevant Australian Standard appropriate to the raw material.
- (d) All electrical installations including circuits and switching shall comply with the relevant requirements of AS/NZS 3000. All electrical equipment enclosures shall comply with a rating of IP55 in accordance with AS 60529.

NOTE: Particular attention should be paid to the possible existence of combustible dusts, such as powdered aluminium in mixing operations, which may necessitate a higher degree of protection for electrical equipment. In such cases the regulatory authority should be consulted.
- (e) When explosives are prepared at a central mixing plant or in several mixing-house buildings, such buildings shall be located in accordance with the safety distances specified in AS 2187.1.
- (f) Lightning protection shall be installed in accordance with AS/NZS 1768(Int).
- (g) Attention shall be given to the possible accumulation of gases or fumes or oxygen deficiency.

3.5 MANUFACTURE OF ANFO

3.5.1 General

ANFO (Ammonium Nitrate Fuel Oil) is an explosive that is often mixed on-site or close to the point of use. It is relatively simple to manufacture. Mixing and handling of ANFO shall be with done with extreme care. ANFO is ideal for use in dry blastholes but its performance can be readily affected by moisture or wet conditions. Ammonium nitrate is very soluble in water.

3.5.2 Materials

3.5.2.1 Ammonium nitrate

Only porous prilled ammonium nitrate shall be used in the manufacture of ANFO. Other forms of ammonium nitrate should not be used as misfires can result.

3.5.2.2 Fuel oil

Fuel oil, or other oil used for mixing with ammonium nitrate, shall be clean, with a closed-cup flashpoint of 60.5°C or higher. The oil shall be of such a viscosity that it is readily absorbed by the ammonium nitrate.

NOTE: Automotive diesel fuel (distillate) is recommended for standard ANFO.

3.5.2.3 Additional materials

The addition of other materials, such as polystyrene or aluminium powder, when used, shall be in accordance with the manufacturer's specifications. Such additions may require regulatory approval.

3.5.2.4 Colouring agent

A colouring agent, which is soluble in the fuel oil, should be used as a guide to ensure that the fuel oil is uniformly and thoroughly blended with the ammonium nitrate. The use of a colouring agent will also enable mixed explosive product to be readily differentiated from the unmixed ingredients.

3.5.3 Mixing of ANFO

The ammonium nitrate and fuel oil shall be thoroughly blended to create a uniform mix.

Fuel oil used to manufacture ANFO shall be nominally 6% by mass of ammonium nitrate. The quantity of fuel oil is critical. Excess oil leads to a slight reduction in blasting effect and a moderate increase in the volume of toxic fumes released; and insufficient oil leads to a considerable reduction in blasting effect and a moderate increase in the volume of toxic fumes released.

Table 3.5.3 gives the correct proportions to be used for quantities of ammonium nitrate up to 50 kg, within the 6% limit.

TABLE 3.5.3
QUANTITIES OF MATERIALS FOR
SMALL BATCHES OF ANFO

Ammonium nitrate (Kg)	Fuel oil (5.8%) (L)
10	0.75
20	1.5
25	1.90
30	2.25
40	3.00
50	3.75

3.6 STORAGE OF ON-SITE MANUFACTURED EXPLOSIVES

Where large-scale mixing operations necessitate an extended delivery time, storage between mixing plant and the point of usage is acceptable, provided that such stored explosives are in a receptacle suitable and safe for its intended purpose and placed in a magazine.

NOTES:

- 1 Explosives should be mixed as required and in quantities sufficient only for current use.
- 2 Prolonged storage of ANFO can result in oil migration or absorption of water, with a resultant loss of sensitivity in the explosive, which can result in misfires.
- 3 Oil migration or absorption of ammonium nitrate can create a fire hazard in timber-lined magazines.

SECTION 4 PLANNING

4.1 GENERAL PROVISIONS

All blasts, whether surface, underground or submarine, shall be planned and designed to achieve the required outcome with first considerations being the protection of persons, property and the environment.

Before the commencement of any blasting operation an investigation of the site and its environs, or the item to be blasted, shall be carried out identifying any potential hazards/risks. On the basis of the investigation, a blast management plan incorporating a risk assessment and control measures shall be prepared.

4.2 BLAST MANAGEMENT PLAN

There shall be an overall blast management plan in accordance with Appendix A. Records should be maintained. No blasting shall commence until a competent person has authorized the blast management plan.

4.3 ADMINISTRATION AND LEGISLATION

People planning blasting activities have an obligation to identify and assess the relevant licences, permits or legislative requirements needed for blasting activities. These may include the following:

- (a) Appropriate shotfirer's licence and qualifications for blasting activity.
- (b) Permits to purchase explosives.
- (c) Permits to receive explosives.
- (d) Licences to manufacture explosives.
- (e) Explosives storage licences and requirements.
- (f) Explosive transport licences and requirements.
- (g) Type of explosives, authorizations and availability.
- (h) Dangerous goods storage and transport requirements.
- (i) Requirements set out by other government departments/authorities.

Planners shall identify and assess reporting requirements and controls that are necessary to minimize the undesirable effects of blasting (e.g., loading procedures, monitoring procedures, drilling procedures, load charts, timing plants, maintenance records, etc).

Planners shall ensure that a blast management plan is completed prior to any blasting activity, and maintained in accordance with any legislative requirement.

4.4 SAFETY AND SECURITY

Safety and security are priority goals of the risk management process for the blast management plan. Areas for consideration in the risk management process include but are not limited to the following;

- (a) Influence of the surrounding environment.
- (b) Blast methodology, for example, selection of explosives, means of initiation and related equipment required, onsite manufacture.
- (c) Transport to and from site (see the AE Code).

- (d) On-site transportation.
- (e) Storage of explosives (on-site or off-site).
NOTE: The type of blasting operation may influence the selection of a preferred location and means of storage.
- (f) Stock reconciliation.
- (g) Operational security, e.g., sentry locations and traffic flow.
- (h) Prevention of unauthorized access.
- (i) Traffic flow at the blast location.

Other aspects may be highlighted during the risk assessment process.

4.5 BLASTING HISTORY AND CONSULTATION

Consultation with any parties that have been involved in similar operations may provide valuable information to assist in identifying hazards/risks that may have been present. Where accessible, any previous records of blasting in similar conditions or applications shall be reviewed. Any safety information or site procedures in accordance with the blast management plan, which may already be in place, shall be identified and assessed.

4.6 PHYSICAL CHARACTERISTICS AND GEOLOGY

The physical characteristics and potential hazards, which may be associated with the characteristics of the material to be blasted, shall be identified and assessed. The purpose of the assessment is to determine any inconsistencies in relation to the material being blasted, which may prevent an effective blast from being carried out. This information can come from exploration samples, drill operators, geological surveys and reports, and blasting history related to the site. Factors for consideration include but are not limited to the following:

- (a) Geological structure, e.g., faults, fissures, intrusions.
- (b) Varying rock type.
- (c) Oxidizing/reactive ground.
- (d) Hot/high temperature material.
- (e) Consistency of material, e.g., voids, layering, floaters.
- (f) Flammability or combustibility of material.
- (g) Presence of hazardous atmospheres.
- (h) Presence of water, e.g., tidal, flow, depth.
- (i) Blasting in atmospheres greater than atmospheric pressure.
- (j) Brittleness of material.
- (k) Previous mine workings.
- (l) Characteristics of the face.

4.7 RESPONSIBILITIES

The blast management plan shall comprehensively document the allocation of responsibilities.

The person with overall responsibility encompassing each and every stage of the blasting operation shall ensure that the people assigned specific duties are competent for the tasks assigned. The person assigned responsibility for the blasting operation shall confirm that persons assigned specific duties understand the requirements or activities to be performed. This includes public and site notification, special vehicle requirements, signage, provision of competent persons, and any other equipment/procedures identified in the blast management plan.

The plan shall have provisions for the handing over of responsibilities where shiftwork is in progress and explosives-related activities are incomplete.

Specific responsibilities may also be assigned in regulations.

4.8 ENVIRONMENTAL IMPACTS

The area surrounding the blast site should be inspected and assessed to determine appropriate means of minimizing environmental impacts. Regulatory limits may apply.

In conducting the risk management, foreseeable factors should be considered, including, but not limited to the following:

- (a) Distances to buildings, structures, and other environmental effects.
NOTE: See Appendix J for guidance.
- (b) Identification of monitoring requirements and the requirement for monitoring locations, systems and instruments.
- (c) Ground vibration and airblast overpressure.
NOTE: See Appendix J for information and guidance on the environmental effects of ground vibration and airblast overpressure.
- (d) Effects of various weather patterns and wind directions.
- (e) Effects of dust, fume, sediment run-off, noise.

Any of the above factors can be expected to have an impact on the blast design. It should also be noted that significant lead times may apply to any required interruption to utilities, e.g., gas, water, electricity.

4.9 GENERAL SAFETY PRECAUTIONS

4.9.1 Working at or below heights

The blasting process often involves working at or below heights where fall hazards exist. Standards and site rules should be complied with.

4.9.2 Services

Due to the equipment used and activities undertaken during blasting, services can pose a significant hazard. Services that may be affected by the blast or that might themselves affect the blast shall be identified. Such services may include, but are not limited to the following:

- (a) Energy systems, e.g., electricity.
- (b) Water.
- (c) Gas.
- (d) Communication cables.
- (e) Effluent systems.
- (f) Steam.

These services could be located above, at or below the surface.

4.9.3 Environmental hazards

All persons performing outdoors activities, including manufacturers of explosives in on-site mixing-house buildings, have potential exposure to environmental hazards. These hazards can include the following:

- (a) Lightning.
- (b) Wind.
- (c) Rain.
- (d) Hail.
- (e) Snow.
- (f) Flooding.
- (g) Cyclones.
- (h) Fire.
- (i) Dust storms.

If the manufacturing, mixing or blasting operation is likely to be exposed to any of the above, then an appropriate risk control or procedure shall be actioned. The risk assessment should form part of the emergency response planning process.

4.10 SPECIAL PRECAUTIONS

Due to the many environments in which blasting takes place, not all hazards can be identified and raised in this document.

The onus is on the entities undertaking blasting activities to use this document, and specialist experience within the blasting operation they are undertaking, to manage risks associated with the blasting activity. It is foreseeable that every blasting operation will have specific and special precautions that need to be implemented for the safety and health of persons, property and environment.

4.11 BLAST DESIGN

After performing the risk assessment process, the blast design should be formalized. A document control process should be established to ensure that all persons involved in the blasting operation have access to all necessary documentation, including the correct blast design for the task. In some jurisdictions, the blast design may be required to be submitted to a regulatory authority for approval, e.g., demolition.

The blast management plan shall outline the objective of the blast. The objectives may include the following:

- (a) Fragmentation.
- (b) Movement.
- (c) Environmental considerations.
- (d) Preservation of the stability of adjacent rock.
- (e) Minimization of back-break/over-break.

These objectives may be applied to the following operations:

- (i) Open cut blasting.
- (ii) Underground blasting.

- (iii) Submarine blasting.
- (iv) Construction/demolition/agricultural blasting.
- (v) Secondary blasting.
- (vi) Blasting in confined spaces.

Parameters required for the blast shall be identified and assessed by applying basic shotfiring calculations. The explosive requirements shall be identified by determining or calculating the following:

- (A) Powder factor.
- (B) Burden.
- (C) Spacing.
- (D) Hole diameter.
- (E) Subdrill.
- (F) Stemming.
- (G) Initiation system and delay sequence.
- (H) Type of explosive required (e.g., ANFO, wet hole products, presplit products, and similar).
- (I) Explosive loading/detonation sequence/effective charge mass per delay (MIC).
- (J) Calculation of predicted ground vibrations.

Where conditions revealed during execution of the blasting operation necessitate changes in the blast plan, notification shall be given to the competent person who approved the initial plan and authorization re-confirmed before the proposed changes are commenced, except in emergency situations.

SECTION 5 BLAST PREPARATION

5.1 BLAST MANAGEMENT PLAN

The person with responsibility for the blast management plan should ensure that blast preparation can commence in accordance with the blast management plan.

Prior to the blast preparation process proceeding, the site shall be inspected and the blast plan shall be reviewed to ensure that it is still valid and any significant variations are identified and assessed.

5.2 BLAST AREA PREPARATION AND ACCESS

5.2.1 General

The blast area and access shall be prepared so that it is safe and suitable for its intended purpose. For example, the area shall be large enough for plant to manoeuvre safely and effectively in a way to avoid damaging blastholes already drilled.

5.2.2 Access

Provision should be made for the intended access to and from the blast area to be in suitable condition under the predominate weather conditions that would be expected during blasting operations.

The area around the blast site should be properly delineated in accordance with Appendix L.

5.2.3 Pattern markout

Good blasting results require the following:

- (a) Accurate and clear drilling plans.
- (b) Accurate marking of the positions of intended blastholes.

Intended blastholes should be located safely e.g., located parallel or away from a butt, located for the safety of drilling operations. The use of toe holes may need to be considered.

5.2.4 Hole diameter

Blastholes shall be of sufficient diameter as to permit free insertion of the charge without ramming, forcing or removal of cartridge wrapping.

5.2.5 Pre-drilling examination

Before drilling commences, the area in close proximity to the intended blasthole shall be examined for the presence of explosives. If examination reveals explosives are present, they shall be treated as misfires in accordance with Section 10.

5.2.6 Drilling

The drilling process is extremely important to the outcome of most blasting activities, it is the foundation for a successful blast. In order to achieve successful blasting outcomes it is important that blastholes are drilled according to an accurate plan. To ensure this occurs, the following applies:

- (a) A clear communication system between shotfirers and drillers shall be implemented and used.
- (b) The driller shall record and report any unusual events during the drilling, e.g., cavities, soft rock, an inability to drill holes in accordance with the blast plan.

- (c) Verification of the blasthole length and orientation should be carried out and compared with the blast plan. Where deviations are found, they shall be identified, recorded, assessed and remedial action shall be taken where required.

5.2.7 Drilling in cut-offs or butts

Drilling shall not be carried out in cut-offs or butts, except where it is carried out using remote-controlled drilling equipment, or other procedures that offer equal or greater safety to operators.

5.2.8 Prevention of blasthole blockage

Measures should be implemented to prevent the unintentional entry of drill cuttings, surface debris and spoil/stemming material into blastholes via the collar.

SECTION 6 OPERATIONS PRIOR TO CHARGING

6.1 BLAST AREA MANAGEMENT

6.1.1 Blast management plan

The person with responsibility for the blast management plan should ensure that charging can commence in accordance with the blast management plan.

6.1.2 Charging material availability

All materials required for the completion of the shot loading and firing should be available to ensure the safe completion of the charging operation. These materials may include, but are not limited to, the following:

- (a) Bunting and signage.
- (b) Stemming.
- (c) Explosive products.
- (d) Gas bags.
- (e) Tamping sticks.
- (f) Testers.
- (g) Tape measure.

The person with overall responsibility for the blasting operation should ensure that all items required for the blast are identified and available in a timely manner. This is especially important for the delivery of explosive products due to the need for specialized transport.

6.1.3 Blast area inspection

A blast area inspection shall be conducted before loading commences. Any hazards identified as posing an unacceptable risk shall be mitigated.

6.1.4 Environmental conditions

An assessment of environmental, including weather, conditions should be made prior to any loading activities. If conditions that would cause the stoppage of loading are expected or predicted during the charging period, a review of the required charging should be undertaken in accordance with the blast management plan. This is especially important for operations where circumstances require charging and firing to be completed in a limited time period.

6.1.5 Precautions at site

The operation shall establish, within the blasting plan, a non-work-zone around the blast area. The non-work-zone should be established taking into consideration vehicle movements adjacent to the blast area, plant maintenance and other non-blasting-related activities.

Where charging operations are occurring at more than one location at a particular site, adequate communication shall be maintained between each operation if there is a likelihood of one or more of the locations affecting another.

There shall be no sources of ignition introduced into the blast area other than that which is required to initiate the shot. This shall not preclude the plant required for charging operations. Plant to be used in the blast area shall be assessed for its suitability and unacceptable risks shall be mitigated before it is used.

6.1.6 Traffic management

The movement of vehicles in and around a blast area can pose a significant risk. It is critical that all potential vehicle interactions with initiation systems are identified and managed. For example, where signal tube initiation systems are used, entanglement may occur with a moving vehicle and this is the main mechanism by which 'snap, slap and shoot' incidents occur, which can cause unintended initiation.

The impact of vehicular traffic on the area should be subject to risk assessment and control measures should be developed. Issues that should be included in the risk assessment are the following:

- (a) Access to and around the blast area.
- (b) The interaction of vehicles with other vehicles and personnel.
- (c) The blasthole layout and the ability to reach each blasthole without driving over blastholes or explosive products.
- (d) Control of activities on or immediately adjacent to a blast site.

As a result of this process, the following outcomes should be attained:

- (i) Traffic management is incorporated in the blast management plan.
- (ii) Difficult to reach blastholes are identified and subsequent loading plans are prepared, e.g., load difficult to reach blastholes first.
- (iii) The maximum number of vehicles allowed in the blast area at any one time is declared in the blast plan and controlled on site.
- (iv) Procedures for the management of vehicles caught in difficult situations should be prepared.

6.1.7 Blasthole measuring

The blastholes shall be checked prior to loading for location, depth, diameter, angle and presence of water.

A system of blasthole identification should be developed. Such a system should aid in the clear communication of loading requirements, especially for blastholes requiring special treatment. Examples of issues that require identification include the following:

- (a) Blastholes that contain water.
- (b) Blastholes that are to be decked.
- (c) The initiation blasthole.
- (d) Blastholes that have partially or fully collapsed.
- (e) Blastholes that vary from the blast plan.

When variances from the blast management plan are discovered, their effects should be assessed and any unacceptable risks should be mitigated.

6.1.8 Loading sequence

The sequence of loading should ensure safe and efficient blast charging and take into account vehicle movements. Loading should be undertaken in a sequence that enables a portion of the blast to be sectioned off, tied and initiated, if an unexpected event occurs before all loading is completed, e.g., thunderstorm approaches.

6.1.9 Sleeping

Where charged blastholes are left unfired, adequate safety and security measures shall be developed and implemented to protect people and property.

The blast management plan should include procedures for sleeping charged blastholes, and considerations include, but are not limited to, the following:

- (a) The explosive manufacturer's recommendations.
- (b) Temperature of the ground.
- (c) Groundwater.
- (d) Steps to be taken to secure the area from unauthorized entry.

6.1.10 Night loading or poor visibility

Where blastholes are being loaded when natural sunlight is not adequate to light the blast area, additional hazards arise, which shall be identified and addressed. Such hazards include but are not limited to the following:

- (a) Artificial light glare.
- (b) Shadow formation.
- (c) Visibility of blasthole locations and personnel working on the blast (i.e., the ability to see and be seen).
- (d) Fatigue.
- (e) Identification of correct charging materials.
- (f) Taking and recording correct charging measurements.

6.2 PNEUMATIC CHARGING

Where pneumatic charging devices are used, they shall be effectively electrically earthed, and semi-conductive (antistatic) loading tubes shall be used. Such tubing shall have a resistance of not less than $15 \times 10^3 \Omega/\text{m}$ and shall be of such length that its resistance is not more than 2 M Ω . The resistance shall be measured as described in BS 2050.

The charging devices and associated equipment shall be earthed to give a total resistance to earth of not more than 1 M Ω . Water lines, compressed air lines, wire-covered hoses, rail or permanent electrical earthing systems shall not be used as a means of earthing.

NOTE: The possibility that pneumatic charging devices may generate static electricity, which may accumulate in sufficient amounts to cause premature detonation of the priming charge, have to be recognized. Before pneumatic charging is employed in any operation, thorough tests, using appropriate equipment, should be made to evaluate this hazard. Pneumatic devices should not be used in full-scale operation until such tests are completed and evaluated (including the introduction of additional safety factors to account for all variations in rock conductivity, sensitivity, temperature, humidity and air pressure that might occur).

6.3 PREPARATION OF CHARGES

6.3.1 Capping safety fuse

6.3.1.1 Capping site

The fitting of fuses to detonators shall not be carried out within close proximity of a magazine or other place where explosives are stored, and then only in an area protected from weather and dust.

Capped fuses not required for immediate use shall be placed in a suitable receptacle or stored in a detonator magazine.

6.3.1.2 *Safety fuse*

Safety fuse used shall comply with the following requirements:

- (a) It shall be inspected for damage and tested for burning rate, both on receipt and prior to use, to ensure that its condition has not been adversely affected by storage.
- (b) If damaged in any way, it shall not be used.
- (c) If being used in damp conditions, the first and last 300 mm of exposed fuse shall be discarded if left for periods in excess of 1 h.
- (d) The burning rate of safety fuse, when determined on 1 m long samples, shall be such that a sample shall burn in not less than 90 s and not more than 120 s when tested at sea level.
- (e) The minimum length of fuse for all charges shall be 1 m. In any event the length shall be such that the person firing the charge has sufficient time to withdraw from the blasting area to a safe location without undue haste.
- (f) The end of the fuse for insertion in the detonator shall be cut square, and only an end that is dry, clean and freshly cut shall be inserted into any detonator.

NOTE: The end of the fuse intended for lighting should also be freshly cut.

6.3.1.3 *Inspection of plain detonators*

Before insertion of the fuse, detonators shall be examined to ensure they are not physically damaged, deteriorated or otherwise corroded and are free from condensation or foreign matter.

WARNING: DO NOT CLEAN DETONATORS BY BLOWING OR PRICKING WITH ANY TOOL OR IMPLEMENT.

6.3.1.4 *Insertion of fuse in detonators*

A fuse shall be inserted into a detonator by being pushed gently, without twisting, into contact with the detonator composition. The detonator shall be crimped to the fuse, 3 to 5 mm from the open rim of the detonator, by means of a purpose-made crimper.

NOTE: The detonator should be held in such a manner as to reduce the possibility of personal injury in the event of accidental detonation, i.e., pointing away from the body.

WARNING: A CAPPED FUSE CAN BE INITIATED BY STATIC ELECTRICITY.

6.3.1.5 *Waterproofing of detonator and fuse junction*

Where a fuse is used in a blasthole or any situation containing free water, the crimp at the junction of the fuse and detonator shall be made waterproof.

NOTE: If necessary, waterproofing compounds that are not reactive with explosives or the safety fuse may be used.

6.3.2 Testing electric detonators

Where electric detonators are tested for electrical resistance before use, such tests shall be performed using a circuit tester as specified in Appendix B and the detonator under test shall be so shielded that no injury can result to persons in the vicinity. Such tests shall be conducted in a manner that precludes the possibility of detonation of other explosives should the detonator itself explode. The detonator shall not be used if the electric resistance is not within the range given in the manufacturer's specification.

NOTES:

- 1 The electrical resistance of each electric detonator should be tested individually before use.
- 2 The time that a detonator is kept in a shield should be at least twice the delay time of the detonator.
- 3 Steel pipe used as a shield should not be less than 50 mm diameter as it may fragment when in contact with an exploding detonator. A 50 mm diameter steel tube (minimum wall thickness 3 mm) or a bucket of dry sand into which the detonator is fully inserted would normally be suitable.

6.3.3 Preparation of primers

Primers should be made up immediately prior to charging.

The initiating medium used to form a primer shall have sufficient strength and sufficient contact with the primer cartridge (or in the case of cast primers their design for use will be such) to ensure initiation and shall be attached in such a way that it will not become detached from the primer cartridge during loading.

Where a primer is to be lowered into a blasthole by means of the lead wires, safety fuse, detonating cord or signal tube, the mass of the primer shall not exceed one-third of the breaking strain of the weaker component. If the breaking strain is not known, the mass of the primer shall not exceed the following:

- | | |
|---------------------------|---|
| (a) Detonating cord | 12.5 kg. |
| (b) Lead wire | 2 kg. |
| (c) Signal tube | 2 kg. |
| (d) Safety fuse | manufacturer's or supplier's recommendations. |

When detonators are used as the initiating medium, they shall be attached to the primer cartridge in such a way that during loading no tension is applied to the safety fuse, lead wires or signal tube where they enter the detonator.

NOTES:

- 1 It is essential that manufacturer's or supplier's recommendations be strictly adhered to, to ensure that the initiating medium is of sufficient strength to initiate the primer cartridge.
- 2 Side initiation of the principal charge or stemming disruption may occur with detonating cord downlines.
- 3 Additional information on the preparation of primers is provided in Appendix D.
- 4 It is essential that manufacturer's recommendations be strictly adhered to, to ensure that the initiating medium is of sufficient strength to initiate the primer cartridge.

6.4 BOOSTERS/PACKAGED PRODUCTS

6.4.1 Cutting of cartridges

The cutting of cartridges to reduce the mass charge, or for any other reason, is not recommended unless manufacturer's instructions regarding the cutting of cartridges or other specialist packaged products are followed.

6.4.2 Location of primer

The primer shall be located in the blasthole in such a position as to minimize the risk of non-initiation through being cut off during the blasting sequence.

In the case of surface blasting, the primer should be placed in the bottom part of the explosive column in the blasthole with the detonator facing the charge. In deep blastholes, mid and top priming may be included as well as bottom priming.

NOTE: This sequence is intended to ensure initiation of the charge and that no unexploded explosive remains after firing.

6.5 SURFACE CHARGING

6.5.1 General requirements

Blastholes shall be loaded in accordance with the blast design and loading sequence. Each initiation system shall be adequately secured to prevent it from falling into, and subsequently being lost in, a blasthole.

If during the charging it is noticed that a blasthole deformity or loss of initiation system has occurred, the shotfirer shall be notified. The shotfirer shall then determine an appropriate course of action.

It is the responsibility of the shotfirer to ensure that the intended explosive products are loaded. The shotfirer should therefore monitor the deliveries to, and/or manufacture of explosives at, the blasting operation. Where the shotfirer is not satisfied that the intended products are being used, the shotfirer shall instigate appropriate corrective action, which may include the stoppage of loading.

6.5.2 Charging wet blastholes

6.5.2.1 General

Blastholes containing water should not be charged with explosives (for example ANFO), including initiation systems, whose performance is affected by the presence of water unless appropriate measures are taken to ensure that the explosive in use is not affected. Examples of such measures include sleeving, decking, de-watering, waterproofing or the use of waterproof explosives.

WARNING: THE USE OF PLASTIC-LINED OR PLASTIC-SLEEVED BLASTHOLES GREATLY INCREASES THE RISK OF ACCIDENTAL INITIATION BY STATIC ELECTRICITY.

NOTE: When selecting explosives for use in wet blastholes, the effect of water on the explosives should be considered where extended sleep time is planned or likely.

Where there are wet and dry blastholes, those that contain water shall be identified and clearly marked.

6.5.2.2 Dewatering

Where dewatering of blastholes is carried out, this activity shall be undertaken by a competent person.

SECTION 7 CHARGING

7.1 SAFETY PRECAUTIONS

Before charging commences, unauthorized personnel and machinery not involved with the blasting operations shall be removed from the area.

Warning signs shall be displayed advising that blasting operations are in progress.

NOTE: Information for signs used on public roads is provided in AS 1742.3 and AS 1743.

The following precautions should be observed during charging operations:

- (a) In order to avoid delays and the consequent increased risk, all equipment required for the charging operation should be ready on site before charging commences. This includes adequate stemming and explosive materials.
- (b) Appropriate records should be kept (see Appendix A).

7.2 PRECAUTIONS AT SITE

No work or vehicular activity, other than that associated with the charging operation, shall be performed within close proximity of a blasthole or initiation system. Where vehicular access is essential, special procedures shall be developed and implemented to prevent the vehicle damaging or initiating the blast.

If charging operations are occurring at more than one location at a particular site, adequate communication shall be maintained between each operation.

There shall be no smoking, naked lights, or machinery likely to generate heat or sparks within close proximity of any blasthole being charged. A risk assessment shall be conducted and controls implemented before machinery that is likely to generate heat or sparks is used within this safety distance.

In normal operations, charging shall not begin unless it is practicable to complete the charging and firing operation on the same day, and in no circumstances shall charged blastholes be left unattended or unsecured. Where charging operations may continue over a period of more than one day, a risk assessment shall be conducted and any necessary control measures shall be implemented.

7.3 BLASTHOLES (CLEANLINESS)

Blastholes shall be thoroughly cleaned of all loose material before charging. If not charged immediately, blastholes shall be plugged or otherwise protected to prevent debris entering the blasthole.

NOTE: Each blasthole should be examined before insertion of the charge.

7.4 INSERTION OF CHARGE

7.4.1 Procedure

Undue force shall not be used to insert the charge in the blasthole. Except in the case of deck charging, care shall be taken to avoid the presence of extraneous matter between cartridges.

NOTES:

- 1 If an obstruction is encountered in a blasthole after charging of that blasthole has begun, the obstruction may be removed using either a flow of water or water and compressed air. If the obstruction cannot be removed, charging, which should include an additional primer, may continue provided the charge is not too near the collar and therefore result in unwanted noise or fly.
- 2 Blastholes that are charged with a primer above an obstruction can give rise to additional noise, toe, and vibration problems if multi-row firing is used.
- 3 Safety fuses, lead wires, detonating cords or signal tubes should be secured firmly at the collars of blastholes to prevent their ends from being drawn down and lost in the blasthole during the remainder of the charging operation.

7.4.2 Free-flowing granular explosives

7.4.2.1 General

When using free-flowing granular explosives, care shall be taken to ensure continuity of the charge.

NOTE: For gravity-fed situations, this will normally be ensured if the angle of the blasthole is limited to a maximum of 30° from the vertical. Free-flowing granular explosives may be pneumatically charged into blastholes at any angle.

7.4.2.2 Protected-type detonators

Protected-type detonators shall be used when pneumatic charging and electric firing of free-flowing granular explosives are employed.

NOTE: Because of the possibility of static discharge causing premature detonation—

- (a) electric detonators should not be placed in plastic tubes; and
- (b) free-flowing granular explosives should not be poured or pneumatically loaded into paper or plastic liners containing detonators.

7.4.3 Cutting of cartridges

Where practicable, only whole cartridges shall be charged into blastholes.

Where it is essential and safe to cut nitroglycerine-based cartridges to provide a correct mass charge, such cartridges shall not be cut against a hard, metallic, or rock-like surface.

7.4.4 Location of primer

The primer shall be located in the blasthole in such a position as to minimize the risk of non-initiation through being cut off during the blasting sequence.

NOTE: In general, the primer should be placed in the bottom part of the explosive column in the blasthole with the detonator facing the charge. In deep blastholes, mid and top priming may be included as well as bottom priming. This sequence is intended to ensure initiation of the charge and that no unexploded explosive remains after firing.

7.4.5 Pumpable explosives

When delivering pumpable explosives into a blasthole, controls shall be implemented to ensure the following:

- (a) The explosive is mixed according to the manufacturer's specifications.
- (b) The operator remains at the control panel or control device.

- (c) Spillage does not occur.
- (d) Overfilling of the blasthole does not occur.

7.5 STEMMING

7.5.1 Stemming material

A wide variety of material may be used as stemming material, and the requirements vary with the size of the blasthole and the site conditions.

NOTE: Appendix E, which covers flyrock and fly, gives guidance for choosing appropriate stemming material.

The following should be considered:

- (a) In small diameter (less than 45 mm) blastholes, the stemming material may be soil, sand, drill cuttings or aggregate of a size no greater than one-tenth of the blasthole diameter.
- (b) In large diameter (greater than 45 mm) blastholes, drill cuttings are often used; however, aggregate as in Item (a), is recommended.
- (c) In wet blastholes, aggregate as in Item (a) is recommended as it sinks through the water, is self-tamping and interlocks well.
- (d) Where blastholes are horizontal or are inclined upward from the collar, the stemming material may be preformed and, where necessary, wrapped in paper and held in position by a plug of wet clay. Alternatively, wet newspaper well tamped into the blasthole may be used.
- (e) Where the potential exists for sulphide ore dust explosions, special requirements may apply.
- (f) In reactive ground situations, it is not advisable to use drill cuttings as stemming material.

7.5.2 Tamping rods

Tamping rods of suitable length of wood or other non-metallic material shall be used. Metal ferrules, tips or connectors that may damage downlines or cartridges shall not be used. Where a tamping rod is used for inserting a charge, the ends shall be kept clean and square and the rod shall be thoroughly cleaned of any adhering grit.

7.5.3 Tamping of stemming material

Where required, stemming material shall be tamped as follows:

- (a) Tamping with an appropriately made tamping tool shall be light at first, but as the blasthole becomes filled, the tamping pressure may be increased.
- (b) For top-primed blastholes, tamping shall not begin until at least 150 mm of stemming material has been placed.

7.5.4 Precautions

Care shall be taken to ensure that the lead wires, detonating cord, signal tube or safety fuse connected to the primer are not damaged during the placing of stemming material and subsequent tamping.

NOTE: Safety fuses, lead wires, detonating cords or signal tube should be held firmly while the stemming is being placed in the blasthole, to prevent them from kinking.

7.6 BULLING

Where blastholes are to be bulled, suitable protective guarding shall be placed in front of the collar of the blastholes to reduce the danger of fly.

NOTES:

- 1 Where alternative methods are available, this method of blasting is not recommended as there is always the danger of heating in the blasthole and excess charging and prolonged excess noise.
- 2 Where a bulling charge is being fired, stemming is not generally used, but if it is, it should be water.

SECTION 8 METHOD OF INITIATION

8.1 GENERAL PROVISIONS

8.1.1 Risk management

Controls and procedures to assist in achieving an acceptable level of risk should be considered for the management of the following:

- (a) Adverse weather conditions.
- (b) Sleeping of shots.
- (c) Fume minimization.

8.1.2 Allocation of responsibilities

Roles and responsibilities associated with the firing activity, including the shotfirer, shall be clearly established. Responsibilities to be assigned may include but are not limited to the following:

- (a) Shot tie-in.
- (b) Shot initiation.
- (c) Sentry positioning.
- (d) 'All-clear' determination.
- (e) Misfire management.
- (f) External/public communications.
- (g) Environmental or condition monitoring.
- (h) Emergency procedures.

8.1.3 Connections

Where required by the blast management plan, a documented firing sequence plan should be in use. This plan should include the following information:

- (a) Identification of the initiation point.
- (b) Identification of the control row.
- (c) The delay times to be used within the blast, and their location.
- (d) Method of initiation.
- (e) Final inspection.

Where applicable, a method shall be developed to ensure that the firing sequence plan and procedures are explained to all persons involved in the connecting process, prior to commencement of connection. Controls shall be developed that minimize the occurrence of incorrect connections shall be developed. Incorrect connections can result in the following:

- (i) Misfire.
- (ii) Fly generation.
- (iii) Excessive ground vibration or airblast.
- (iv) Poor blasting performance.

8.2 METHOD OF INITIATION

8.2.1 Selection of initiation method

Careful selection of an initiation method shall be made following a risk analysis. Before selecting an initiation method, a risk assessment should include, but not be limited to, the following issues:

- (a) Safety issues.
- (b) Compatibility of initiation system with the charge.
- (c) Environmental issues.
- (d) Performance and reliability of initiation system.
- (e) Economic considerations.

8.2.2 Electronic detonator systems

NOTE: Personnel using electronic detonator systems should undertake specific training in the use and handling of the particular manufacturer's product.

Manufacturer's warnings and instructions shall always be followed.

Safety precautions include, but are not limited to, the following:

- (a) Components from different electronic systems or suppliers shall not be combined as misfires can result. This is due to the nature of the unique communication protocols and customized connectors of the various electronic blasting and initiation systems.
- (b) Only wires, connectors, and coupling devices specified by the manufacturer shall be used.
- (c) Wire ends, connectors and fittings, shall be short-circuited where required by the manufacturer and, as far as possible, kept clean and clear from dirt or contamination.
- (d) Electronic detonators shall not be held while being tested or programmed.
- (e) Manufacturer recommendations to protect electronic detonators from electromagnetic, radio frequency or other electrical interference sources shall be followed.
- (f) Manufacturer's instructions when aborting a blast shall be followed. A minimum of 30 min shall be allowed before returning to the blast area after aborting the blast unless a manufacturer provides other specific instructions.
- (g) Care should be taken when allocating delay times to ensure the intended blast sequence is implemented, otherwise this can result in misfires, fly, excessive airblast overpressure and ground vibration.
- (h) Electronic detonator systems shall not be used during the approach and progress of an electrical storm. Personnel shall be withdrawn to a safe location.

Maintenance, as prescribed by the manufacturer/supplier, shall only be carried out by authorized personnel. Records of maintenance done on all equipment, including date and person carrying out the work shall be kept.

WARNING: ELECTRONIC DETONATORS ARE EXPLOSIVES AND THEY SHOULD BE HANDLED ACCORDINGLY.

8.2.3 Non-electric firing

8.2.3.1 *Signal tube*

Signal tube may be initiated by one of the following methods:

- (a) A purpose-designed signal tube starter.
- (b) A detonator of required strength.