



Australian Explosives Industry And Safety Group Inc.

# **Code of Practice**

## **STORAGE AND HANDLING OF UN3375**

**Edition 4  
May 2017**



## About the AEISG

The Australian Explosives Industry and Safety Group (AEISG) is an incorporated association of Australasian explosives manufacturers and suppliers originally formed in 1994. Since then, AEISG membership has grown and currently includes:

- Applied Explosives Technology Pty Ltd
- Davey Bickford Australia Pty Ltd
- Downer EDI Mining – Blasting Services Pty Ltd
- Dyno Nobel Asia Pacific Pty Limited
- Johnex Explosives
- Maxam Explosives (Australia) Pty Ltd
- Nitro Sibir Australia Pty Ltd
- Orica Australia Limited
- Platinum Blasting Services
- Redbull Powder Company Ltd
- Thales Australia

The goal of AEISG is to continuously improve the level of safety and security throughout our industry in the manufacture, transport, storage, handling and use of explosives and related materials throughout Australasia.

One of the strategies adopted by AEISG in this regard is to identify areas where improved standards of operation need to be consistently applied and then develop and issue appropriate codes of practice which capture industry best practice in these areas.

AEISG codes of practice are adopted by members for the benefit of their employees, their customers and the general community. They are also made available free of charge on the AEISG website, [www.aeisc.org.au](http://www.aeisc.org.au), for use by any interested parties.

To keep abreast of technological advancements, industry progress and regulatory changes, AEISG Codes of Practice are subject to regular review and updated through the issue of amendments or revised editions as necessary. It is important that users ensure they are in possession of the latest edition and any amendments. References to superseded versions should be updated accordingly.

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## PREAMBLE

This Code sets out requirements and recommendations to control the risks (to people and to the environment) arising from the storage, handling (including transfer operations), transport and security of Ammonium Nitrate Emulsions, Suspensions and Gels conforming to UN3375. These materials are collectively referred to in this Code as ANEs (see definitions).

As described in the UN publication 'Recommendations on the Transport of Dangerous Goods, Model Regulations' and carried through to the ADG Code, ANEs are non-sensitised emulsions, suspensions and gels consisting primarily of a mixture of ammonium nitrate and fuel in a desensitised matrix, intended to produce a Type E blasting explosive only after further processing prior to use. Although the UN system classifies materials for the purpose of transport, it is a convenient classification system which is used in this Code to define which materials fall within its scope.

The underlying philosophy of this Code is that ANEs do not explode without warning. Unlike Class 1 explosives, there have been no documented cases of an ANE exploding without warning in over 4 decades of widespread usage. In the only known case where a product similar to ANE did explode, the explosion was the result of over an hour of intense fire engulfment where the product had been stored with large quantities of fuel (refer Appendix A).

Some jurisdictions define ANE as an "explosive". This can make it difficult to distinguish (in this Code) between an ANE material which conforms with UN3375 and one which, through further processing or otherwise, has become an explosive which no longer conforms with UN3375. To avoid any ambiguity in this Code the term 'ANE' is always used to mean material which conforms to UN3375, and the term "explosive" always excludes such ANE.

Any ANE conforming to UN3375 has been tested to ensure its thermal stability and its insensitiveness to shock and heating under confinement.

After manufacture, ANEs are often stored, handled and transported extensively before final processing to become explosive. In the course of this storage, handling and transport the ANE may inadvertently be altered in such a way that it no longer conforms to UN3375 - it either becomes explosive, or returns to a "raw material" stage. This Code includes requirements intended to ensure that the risk of an ANE inadvertently becoming explosive is anticipated and managed.

Requirements detailed in this Code are always supplementary to, and never take precedence over, explicit regulatory requirements. It is intended to supplement such regulatory requirements in a nationally uniform way and to, as far as possible, clarify any ambiguity or uncertainty in the regulatory requirements. The Code also sets out requirements and recommendations on aspects that are not explicitly covered by local regulations. These requirements and recommendations are based on industry best practice developed over many years, and are consistent with Australian Standards and regulations, international guides and codes, and advice from regulatory authorities. Although this is an industry code it is intended to be fully consistent with requirements in most jurisdictions and may be thought of as one way to meet the regulatory requirements. Some jurisdictions have endorsed or otherwise drawn upon previous edition(s) of this Code within their regulatory frameworks, and the same may apply to this edition.

In this Code it is important to distinguish between the different stages in the lifecycle of an ANE. The approach taken is that the ANE stage is one of three stages in the manufacture of some explosive products. The three stages are:

- a raw materials stage
- an ANE stage
- an explosive stage

This Code is intended to cover only the ANE stage - that is, from the point after raw materials are initially processed to become an ANE, through the various stages of handling, storage and transport to the point where the ANE is processed into an explosive, or is otherwise converted such that it no longer conforms with UN3375 (e.g. by being processed back into its constituent ingredients).

This Code acknowledges the major change in the security requirements for ANEs arising from the COAG Principles for Regulating Security Sensitive Ammonium Nitrate (SSAN) developed in 2004 but is not





prescriptive on security matters. It does however refer to security requirements where these arise in the ANE management process.

Abbreviations used in this document are listed in the Glossary in Appendix F

**Publication History**

Date	Version	Details
1999	Edition 1	Initial publication by the then AEMSC [Australian Explosives Manufacturers’ Safety Committee] under the title ‘Precursors for Explosives’.
April 2012	Edition 2	Revised to remove ambiguities in Edition 1 and to provide additional clarity, but without making any substantial change to the fundamental requirements, which had been previously agreed by various regulatory bodies. Included appropriate references to SSAN security requirements in addition to a general update. This revision was undertaken by the AEISG Inc. (successor body to the AEMSC) and the title was changed to ‘Ammonium Nitrate Emulsions, Suspensions or Gels – ANEs (UN3375)’ to align with UN definitions and requirements.
January 2015	Edition 3	Revision initiated by the discovery of an error in worked example 3, Appendix C (Activity Level was wrong). In addition to correcting that error the requirements for siting of ANE premises have been clarified via the use of a flowchart, and revised text, and the text has been generally updated for clarity.  The input from Henry Zuidersma (Principal Dangerous Goods Officer, Dangerous Goods Safety, Resources Safety, Department of Mines and Petroleum, WA) in identifying the error and developing the initial version of the flowchart and other improvements is gratefully acknowledged.
May 2017	Edition 4	Major Hazards Facilities explicitly not in scope (Section 1). Division 5.1 definition aligned with ADG7 (Section 2). Several additional definitions added. (Section 2). Comments on dried/crystallised ANE and requirement for inspection and cleaning added (Sections 3.4 and Appendix A). Noted various AN Codes which may be mandatory (Section 4 plus Appendix D). Treatment of loaded AN and ANE vehicles expanded (Sections 5.3 and 6.1). Requirements for emergency venting or fusible elements added (section 5.4). Good Practice general principles added (Section 5.7). Requirements for ANE hose assemblies added (Section 8). Requirements for ANE underground added (mainly in new section 9). Diagrams plus one additional example added to worked examples (Appendix C). Risk Assessment Considerations added (new Appendix G). Compliance checklist added (new Appendix H). Assessment template (new Appendix I). General updating and clarifications throughout.



## 1 SCOPE

This Code sets out the requirements and recommendations to control the risks arising from the storage, handling (including transfer operations), transport and security of Ammonium Nitrate Emulsions, Suspensions and Gels, which conform to UN3375. These materials are collectively referred to in this Code as ANEs (see definitions).

This Code does not apply to a Major Hazards Facility, where the requirements and recommendations to control the process safety risks arising from the storage, handling (including transfer operations), transport and security of ANE, are covered in the facility's Safety Case.

ANEs are used in underground mines. This Code does not apply to underground coal mines. For other underground mines the specific requirements and recommendations for ANE underground are detailed in Section 9. These are intended to be additional to the general requirements and recommendations, which (except where otherwise stated) apply to ANE in all situations. In the event of a conflict, Section 9 takes precedence.

The requirements in this Code apply as relevant to:

- Any person handling or transporting ANE;
- Any holder of a licence for transport or storage of ANE; and
- The occupier of any premises where any ANE is stored or handled.

This Code is intended to cover only the stage during which the material is an ANE. It does not apply to the raw materials used to manufacture ANEs (including ammonium nitrate solutions), or to any explosive manufactured from the ANE.

Where raw materials used to manufacture ANEs are Dangerous Goods they are subject to various regulatory requirements, standards and codes, and this Code is not intended to reduce or remove the need for compliance with these. Any intentional conflict with other relevant codes is noted. Any other conflict is unintentional and should be advised to the AEISG.

This Code does not apply to Mobile Processing Units (MPU), which are covered by the AEISG MPU Code. This Code provides guidance on the separation requirements for ANEs from Division 1.1 and Division 1.5 explosives. If these requirements are not met the ANE becomes part of the Division 1.1 and/or Division 1.5 explosives inventory (See Section 6 and 9). The requirements for Class 1 explosives are outside the scope of this Code. They are covered by specific state regulations and Australian Standards, and are only detailed in this Code where necessary to cover situations where explosives may be present close to ANEs.



The relationship between this Code and other regulatory requirements, standards and codes is illustrated in Table 1.

**Table 1**

ACTIVITY	REQUIREMENTS, STANDARDS AND CODES WHICH APPLY DURING THIS ACTIVITY
Transport of raw material to manufacturing premises	ADG7
Storage and handling of raw materials	Applicable Australian Standards and this Code
Manufacture of ANE	Applicable Australian Standards
Storage and handling of ANE	This Code
Transport of ANE “off-site” (i.e. on public road and/or rail)	ADG7 and this Code, or MPU Code
Transport of ANE “on site” (i.e. not on public road and/or rail)	This Code, or MPU Code
Management of waste and off-spec ANE	This Code
Destruction of ANE	This Code
Processing of ANE to become explosive (including calibration)	MPU Code
Relevant State regulations may apply to all stages of the lifecycle	

This Code is not intended to limit continuous improvement and innovation, and does not preclude the use of novel materials, designs, methods of assembly, procedures and the like which do not comply with a specific requirement of the Code, or are not mentioned in it, but which can be shown to give equivalent or superior results to those specified. Where one or more specific requirements of this Code are not met, either due to innovation or for another reason, a detailed risk assessment may be used to demonstrate that the risk is acceptable. The level of detail required by the risk assessment and what is deemed to be an acceptable risk will need to be discussed and agreed with those authorities who will have ultimate responsibility for approving and/or licensing the activity.

This Code is not intended to be applied retrospectively. Any ANE manufacturing, distribution or storage premises operating with a current valid licence and complying with applicable regulations and the previous version of this Code may continue to operate unchanged. However any such premises shall be brought into compliance with this version of the Code if any significant change is made to the premises. This Code applies to new ANE premises from its date of publication.

## 2 DEFINITIONS

Term	Meaning
Adjusted Net Explosive Quantity (Adjusted NEQ)	The mass of TNT that would produce an equivalent explosive effect to the inventory under consideration.
Ammonium Nitrate (AN)	Ammonium Nitrate, meeting the requirements of UN1942 including AN labelled as UN2067.
Ammonium Nitrate Emulsion (ANE)	Ammonium nitrate based emulsion, suspension or gel which meets the requirements of UN3375 under the UN (United Nations) classification system. Note: see Appendix E for more details.
ANE associated works	Offices, workshops, stores, ablutions and the like directly associated with the operation of the ANE premises.
ANE Premises	Any designated land, building, or area that is used for the storage, manufacture or handling of ANE. A fence may or may not form, or be part of, the boundary of the premises.
ANE process building	A building, in which an ANE is normally stored and/or handled and where no additional processing of the material into an explosive occurs.
Associated works	<b>Other</b> magazines, process buildings and storages of energetic materials, e.g. ammonium nitrate or other dangerous goods.
Competent Authority	The authority having jurisdiction for administering legislation covering the manufacture, transport, storage and handling of dangerous goods and/or explosives within a particular State or Territory. There may be more than one authority in an ANE supply chain.
Constant surveillance	The presence of an alert and authorised person or the continuous monitoring by video or electronic surveillance.
Credible Evacuation	A credible evacuation scenario is one with a high likelihood that within 45 minutes of the evacuation being initiated there is no person in a building within Protected Works Class B distance and no person in the open within Protected Works Class A distance. (Note that 45 minutes is the worst case – the target evacuation timeframe is 30 minutes.) Whether evacuation is credible can only be assessed on a site-specific basis. Refer Appendix A.
Critical equipment system	An equipment system which has been assessed to present unacceptable consequences if the equipment or its protective system should fail. This includes all failures or malfunctions which could lead to danger to life or significant harm to any person or to the environment.
Deadheading	The operation of a pump when there is no flow due to the outlet or discharge line being closed or blocked.
Division 1.1 explosives	Substances and articles which have a mass explosion hazard (a mass explosion is one which affects almost the entire load virtually instantaneously).
Division 1.5 explosives	Very insensitive substances which have a mass explosion hazard. This division comprises substances which have a mass explosion hazard but are so insensitive that there is very little probability of initiation or transition from burning to detonation under normal conditions of transport.

Term	Meaning
Division 5.1 oxidising substances	Substances which, while in themselves not necessarily combustible, may, generally by yielding oxygen, cause, or contribute to, the combustion of other material, and have been classified as Division 5.1 by testing and classification as per UN criteria. These substances would be expected to fail the UN test for determining whether a material is a Class 1 explosive.
Dry operation	The operation of a pump when there is no flow due to its inlet being closed, blocked or empty, or any other physical condition where the material being pumped is prevented from flowing into the pump.
Exposed Site (ES)	A Vulnerable Facility, Protected Work or ANE Associated Work that may be affected by an explosion of the PES under consideration. (As defined in AS2187.0)
Foreign Bodies (Also known as Tramp Material)	Foreign material not intended to be present in a process (such as bolts, nuts, gravel, etc.), that can have an adverse effect on the process and may cause an undesired event or deviation from the design intent.
Gasser Solution	Solution used to chemically change the density of the emulsions in order to sensitise them.
Incompatible	Relates to goods which when mixed or otherwise brought into contact with each other, are likely to react and increase risk because of the interaction.
Mass Strength (or Weight Strength)	The explosive strength of a unit mass of an explosive material expressed against a standard reference. Note: in this Code any reference to Mass Strength is with reference to TNT as the standard.
Material Safety Data Sheet (MSDS) (Also known as a Safety Data Sheet (SDS))	A safety data sheet which is in accordance with the Safe Work Australia Code of Practice for the preparation of Safety Data Sheets. The SDS is supplied for hazardous materials offered for sale or transport by the manufacturer or supplier of the material.
Mound	A barricade intended to intercept horizontal and low angle debris from an explosion, as detailed in Appendix B of AS 2187.1.
Net Equivalent Quantity	The comparative explosive strength of a product to a reference explosive such as ANFO or TNT.
Net explosive quantity (NEQ)	The mass of explosive material contained in an explosive.
No Warning Explosion	An explosion which occurs which is not as a consequence of some other cause which would be obvious to an observer in the vicinity.
Personal Protective Equipment (PPE)	Items of clothing or devices worn to protect an individual from the actual or potential risks to health or safety arising from an activity or process.
Politically Motivated Violence (PMV) Check	A security assessment in respect of a person, issued by ASIO.
Potential Explosion Site (PES)	A location that could be the source of an explosion.



Term	Meaning
Protected works	<p>The two classes of protected works are as follows: -</p> <p>Class A: Public street, road or thoroughfare, railway, navigable waterway, dock, wharf, pier or jetty, marketplace, public recreation and sports ground or other open place where the public is accustomed to assemble, open place of work in another occupancy, river-wall, seawall, reservoir, water main (above ground), radio or television transmitter, main electrical substation, private road which is a principal means of access to a church, chapel, college, school, hospital or factory.</p> <p>Class B: Dwelling house, public building, church, chapel, college, school, hospital, theatre, cinema or other building or structure where the public is accustomed to assemble, shop, factory, warehouse, store, building in which any person is employed in any trade or business, depot for the keeping of flammable or dangerous goods; major dam.</p>
Pump significant incident	<p>An ANE pump incident which involves sufficient overheating of the pump contents to be observed by pump operators (e.g. visible smoke, violent reaction of pump contents, rupture of the pump).</p> <p>Refer to section 8.7 for further clarification</p>
React dangerously	<p>In relation to the reaction of substances, to react in a manner that directly creates a hazard due to the reaction:</p> <ul style="list-style-type: none"> <li>• being violent; or</li> <li>• producing an explosion; or</li> <li>• producing a potentially explosive combination of products; or</li> <li>• producing potentially dangerous quantities of toxic vapour or gas.</li> </ul>
Risk Management	<p>The identification, analysis, assessment, control, and avoidance, minimization, or elimination of unacceptable risks.</p>
Safety Data Sheet (SDS)	<p>Refer Material Safety Data Sheet.</p>
Secure store	<p>A physically secure place where ANE is kept under lock and key or constant surveillance, and where there are procedures for:</p> <ul style="list-style-type: none"> <li>• controlling access;</li> <li>• secure control of keys; and</li> <li>• documenting the receiving and dispatching of measured quantities of ANE</li> </ul>
Security risk	<p>Risk of: -</p> <ul style="list-style-type: none"> <li>• theft of ANE; or</li> <li>• unexplained loss of ANE; or</li> <li>• possible sabotage of ANE; or</li> <li>• unauthorised access to ANE.</li> </ul>
Security Sensitive Ammonium Nitrate (SSAN)	<p>Ammonium nitrate, ammonium nitrate emulsions and ammonium nitrate mixtures containing greater than 45% ammonium nitrate, excluding solutions.</p> <p>Note: In this definition 'greater than 45%' shall be taken as 'greater than 45% by mass'.</p>
Shall/should	<p>For the purpose of this Code 'shall' is understood as mandatory and the word 'should' is advisory.</p>



Term	Meaning
Standard Operating Procedures (SOP)	<p>Written procedures containing an explicit description of how a job is to be performed. The SOP identifies the precautions required to safely and securely complete the task, and should include:</p> <ul style="list-style-type: none"> <li>• Personal protective equipment (PPE);</li> <li>• Hazards specific to the job and/or site;</li> <li>• The level of authority, responsibility and training required to complete the job safely;</li> <li>• Reporting relationships identified by management and any other relationships that may interact with other jobs, SOP's or work instructions;</li> <li>• Security Plans should be integrated into the SOPs.</li> </ul>
Tramp Material (Also known as Foreign Bodies)	Refer 'Foreign Bodies'.
United Nations (UN) classification	The classification of dangerous goods as outlined in the current edition of the document titled Recommendations on the Transport of Dangerous Goods, published by the United Nations (UN). The detailed tests supporting the Recommendations are described in a companion UN publication namely the Manual of Tests and Criteria.
Vulnerable facility	<p>A category of facility that includes, but is not restricted to, the following:-</p> <ul style="list-style-type: none"> <li>(a) Multistorey buildings, e.g. above 4 storeys.</li> <li>(b) Large glass fronted buildings of high population.</li> <li>(c) Health care facilities, child care facilities, schools.</li> <li>(d) Public buildings or structures of major historical value.</li> <li>(e) Major traffic terminals, e.g. railway stations, airports.</li> <li>(f) Major public utilities, e.g. gas, water, electricity works.</li> </ul>
With Warning Explosion	An explosion which occurs as a consequence of some other cause which would be obvious to an observer in the vicinity. (Two examples of obvious causes are large fires, or large amounts of fumes coming out of an ANE tank.)

### 3 SAFETY AND SECURITY MANAGEMENT SYSTEM

Every holder of a licence to store ANE shall have in place a safety and security management system (SSMS) covering the entire lifecycle of all ANEs from manufacture through to final use, or destruction, as appropriate to licence holder's activities.

The SSMS shall be documented and meet local regulatory requirements. AS/NZS 4804-2001 and Standards Australia Handbook HB167-2006 should be used as guidance. The SSMS shall include at least the following elements:

- A Safety Policy;
- A Safety and Security Management Plan;
- Training;
- Operating Procedures covering each ANE premises;
- Procedures to control all transfers of custody of ANE (including waste).

The SSMS shall be implemented in such a way that the relevant requirements of this Code are met at all stages of the lifecycle of the ANE relevant to every ANE premises and throughout every transport operation.

The SSMS shall apply to all employees and contractors involved in any aspect of ANE storage, handling or transport, and to all visitors to ANE premises.

#### 3.1 Safety Policy

This is generally a short public formal statement of policy by the Chief Executive Officer of the organisation which sets out the safety expectations of the organisation and outlines how these will be achieved.

#### 3.2 Safety and Security Management Plan (SSMP)

The SSMP shall include the following features:

- a) regular safety meetings for all employees with minutes and actions recorded;
- b) a schedule of audits covering safety and security at all ANE premises and a system to initiate corrective action whenever deficiencies are identified;
- c) a system for reporting, investigating and learning from accidents and incidents, including management reporting, analysis and review and continuous improvement and a process for reporting significant incidents to regulatory authorities (See also section 8.7);
- d) Emergency Response Plans (ERP) for each ANE premises and each transport operation, which shall be reviewed (and updated as appropriate) at least annually;
- e) Risk Assessment(s) for all new ANE premises (See Section 7);
- f) a system for change management.

#### 3.3 Training

As part of the SSMS, training systems are required in the following areas:

- a) induction for new employees, contractors and visitors, including use of PPE, any specific hazards on site, the evacuation plan, the location of first aid stations, communications, hot work permits, confined space entry, and any other additional safety or environmental considerations applicable to the site;
- b) an employee training system, covering SOP's, site specific procedures and job responsibilities. The system shall include documentation of training, re-training and verification of competency;
- c) a system to train employees in the correct procedures for the selection, maintenance and use of PPE;
- d) emergency response plans.



### 3.4 Procedures

Procedures shall be in place to cover the following:

- a) obtaining SDS's for all chemicals on the site;
- b) preparing SOP's for all routine tasks;
- c) control of lock out/tag out, confined space entry and hot work permits. This shall include, as a minimum, training, documentation, responsibilities and identified authorisation levels;
- d) approval and authorisation of all processes being conducted on site, including commissioning and waste disposal;
- e) inspection and cleaning of ANE tanks, hoses, pipework and equipment. (Note that the sensitivity of ANE to heat and impact may be increased if the ANE has dried out or crystallised, so regular inspection / cleaning of crystallised or dried out material is necessary. Note also that unnecessary cleaning should be avoided to limit generation of waste.);
- f) control of the modification of processes and equipment; (change management);
- g) control of all non-routine work or tasks (i.e. without an SOP) involving processes or formulations (e.g. development work);
- h) sampling, sample retention, product testing and recording of pertinent information;
- i) safe disposal of waste materials (recognising the possibility that ANEs may be inadvertently sensitised and that waste may still be SSAN);
- j) response to the approach of lightning (see also section 5.6);
- k) no parking of Class 1 explosives vehicles close enough to potentially cause sympathetic initiation of ANE, unless this is specifically allowed for in the assessment of minimum distances (as detailed in Section 6). Generally this will mean that vehicles transporting Class 1 explosives are not permitted to park within the ANE premises;
- l) managing all aspects of custody transfer (in or out) of ANE, including ensuring that ANE is only released into the custody of persons or organisations which are:
  - appropriately licensed;
  - aware of the requirements of this Code; and
  - likely to comply with regulatory requirements and this Code (to the best knowledge of the person or entity handing over custody of the ANE).

### 3.5 Emergency Response Plan (ERP)

An Emergency Response Plan (ERP) shall be in place and shall include as a minimum:

- a) signage (containing emergency contact numbers);
- b) a premises and area evacuation plan;
- c) appropriate fire risk management plans;
- d) procedures to address any reasonably foreseeable emergency;
- e) procedures that address the loss of normal communication systems.

Persons expected to assist in an emergency shall be trained to an appropriate level. The ERP shall be reviewed (and updated as appropriate) as required, eg after an incident or when improvements are identified, or at least annually. The review shall demonstrate the effectiveness of actions taken at the premises and all associated communications, but physical evacuation, and actual operation of equipment (such as fire extinguishers) are not required. The results of the review must be documented.

**NOTE: Evacuation guidelines. In the event of an uncontrolled fire (with a substantial source of fuel) capable of engulfing any ANE, it shall be assumed that the ANE may explode and evacuation shall take place. Evacuation distances shall be based on worst case explosion (refer Section 6). It is recommended that muster points should be at least 20% farther away than the minimum required distance.**



### 3.6 Other

Other items which should be covered by the SSMS include:

- a) chemicals register containing SDS for all chemicals;
- b) placarding and signage of all dangerous goods;
- c) first aid system including the provision of first aid boxes and a list of personnel trained to provide first aid. Ideally, at least one person working at the site should be trained in first aid;
- d) supervision of visitors and contractors in all areas where ANE is stored;
- e) vehicle operation, control and maintenance system;
- f) non-smoking policy;
- g) non-drug and alcohol policy;
- h) management of critical equipment systems;
- i) hot work (work involving open flames or risk of creating sparks); and
- j) system to check trips and alarms, including the documentation of test results.

## 4 LICENSING AND REGULATORY REQUIREMENTS

Currently, ANEs are regulated by several government agencies. It is the responsibility of the occupier of any premises to determine all applicable regulatory requirements and hold all applicable authorisations and licences. The requirement to hold specific licenses in relation to ANE varies between states and territories and may be dependent on the quantities involved and the planned duration of activity.

Depending on the nature of the business, licences will typically cover the authorisation to store, purchase, possess, sell and dispose of ANEs. Separate licences/authorisations may be necessary to cover:

- other onsite materials (e.g. AN); and
- security issues.

There are several Codes detailing requirements and recommendations for storage of AN - these are listed in Appendix D. Some of these may be mandatory and apply to any AN stored at the ANE premises, depending on the jurisdiction.

Any modifications made to processes, equipment or procedures at ANE premises may require approval in advance from relevant competent authorities, and/or re- issue or updating of relevant licences.

The following requirements shall be noted:-

- a) The occupier or licence holder of the premises shall keep a copy of relevant licences. Licences, or copies thereof, which are specific to the premises shall be held on the site. Licences covering more than one premises (e.g. authorisations of formulations, or unsupervised handling licences) must be able to be produced within a reasonable time if not held at site;
- b) The manufacturer of an ANE is responsible for ensuring the ANE has been properly classified as UN3375;
- c) When designing new premises, the requirements of the relevant Australian Standards and regulatory requirements shall be incorporated in the design of the premises.

On request, a copy of this Code shall be provided to an organisation or individual person being provided with ANE by the supplier.

## 5 ANE PREMISES DESIGN, LAYOUT AND MATERIALS OF CONSTRUCTION

### 5.1 General

This Section applies to all surface premises, and also, where relevant, to underground ANE stores. Construction requirements may be detailed in the regulations pertaining to particular jurisdictions. Otherwise, this Section highlights the more significant requirements for ANE premises.

While AS4326 does not specifically apply to ANEs it has been used as guidance in development of this Code, and is a useful further reference when designing ANE premises.

Section 8 details special requirements for the pumping of ANEs, and for ANE hoses.

Section 9 details special requirements for the transport, storage and handling of ANEs underground.

Section 11 details the security requirements applicable to ANE premises.

### 5.2 Fire

As a minimum:

- All foreseeable fire scenarios shall be covered by the ERP, which shall give guidance on which fires should be fought, and when evacuation should be initiated;
- All ANE premises shall have sufficient firefighting capability to carry out “first aid” firefighting to extinguish and prevent the escalation of fires in their early stages. Typically this will consist of appropriate numbers and types of fire extinguishers to cater for foreseeable fires.

Fixed fire systems may be required by regulatory authorities. Such systems are not otherwise required, but may be used if the owner or operator of the premises so wishes, however care shall be taken to ensure that the provision of any such system does not have the effect of encouraging people to stay and fight fires where there is a significant risk of explosion. Although not directly applicable to ANEs, AS4326 gives good guidance on fixed firefighting systems for oxidising agents.

### 5.3 Layout

Flammable and combustible liquids stored or used in ANE premises shall be located and stored in accordance with AS1940 and/or applicable local legislation for the separation of dangerous goods.

Incompatible materials must not be stored together and shall be located at least 5m apart (unless an effective means of separation can be provided to reduce the 5m and is authorised for use by the Competent Authority). Practical care must be taken in the collection, storage and disposal of waste which may contain incompatible materials (see Section 12).

ANEs typically contain high concentrations of ammonium nitrate. If solid sodium nitrite is improperly mixed with ammonium nitrate and/or other ammonium salts, a (possibly violent) reaction will occur and under certain conditions this mixture may explode. Weak aqueous solutions of sodium nitrite used for density reduction at point of explosives manufacture do not create an explosion risk but are classed as “incompatible” because they can, when intimately mixed with an ANE, react with the ANE to change its Dangerous Goods classification from Division 5.1 to Class 1.

Many ANE premises would be impractical to operate without facilities such as site offices, ablutions, service bays, spares storage and the like. However any personnel using such facilities must meet:

- all security requirements applicable to ANE; and
- separation and/or evacuation requirements as detailed in Section 6.

The design and layout of the premises shall minimise the occurrence of the following conditions:

- accidental mixing of incompatible chemicals;
- access to ignition sources;
- explosive atmospheres;
- common site drainage for incompatible chemicals and/or materials;

- confinement in drains;
- drains or sumps located under structures or process equipment;
- potential for pooling of flammable or combustible chemicals under oxidizer or ANE tanks, pipelines or services. Secondary containment (bunding) is generally not preferred around ANE tanks (also see below). Raised pads are recommended to reduce or eliminate the risk of fuels pooling under ANE tanks;
- routing of fuellines under, over, or through areas containing oxidisers or ANEs.

The plant layout should provide easy access for materials handling and minimise exposure to, and flow of, uncontrolled materials (especially fuels) into an area containing ANEs.

The impact (e.g. fire, cross contamination, knock-on effects) of a major event shall be minimised as far as practicable. Fuels shall not be stored where spillage or leakage could accumulate under or close to ANEs.

Entry to and exit from ANE premises shall be controlled. Provision shall be made for site security and evacuation. Emergency response access shall be provided (See Section 11 – Security Requirements).

Every ANE storage shall have a clear area at least 5 m wide around it, cleared of combustible material and any equipment that is not necessary for the operation of the premises. Any standing trees should be cleared for at least 15 m, or a distance equivalent to 1.5 times the height of the trees, whichever is the greater.

Unattended vehicles carrying ANE or AN should have defined parking locations far enough away from stored ANE or AN to ensure that vehicle fires do not affect stored materials, and any explosion of material on the vehicle does not cause any sympathetic initiation. Security needs to be addressed.

Spillage containment is generally not applied to ANE storages due to the high viscosity of the material (does not flow readily) and to reduce the risk that containment may concentrate fuels under the storage during fire conditions. Where spillage containment is not provided the design shall consider the management and recovery of spilled ANEs, which shall remain on the premises, and shall not enter water courses.

#### 5.4 Design of ANE tanks

In designing tanks for the storage of ANEs the following requirements shall apply:

- Each ANE tank shall be provided with either:
  - emergency venting according to AS 1940 with venting sized as if the ANE were an equivalent volume of hexane (note that it may be possible to provide this venting by having a loose fitting manhole cover) or
  - a means of automatically releasing the tank contents in a fire engulfment, by manufacturing the tank from low melting point material (e.g. aluminium, plastic) or by providing fusible element(s) at the bottom of the tank;
- The materials of construction of the tank and its supporting structure shall:
  - have adequate strength for the duty, taking into account the (normally high) density of ANEs, and
  - be resistant to corrosion from the ANE, or protected from attack by appropriate surface coatings (e.g. epoxy tars, chlorinated rubbers);
- For external tanks the design shall be sufficiently robust for the empty container to withstand wind forces which may be encountered at the particular location;
- Due to the corrosive and reactive properties of ANEs and in order to prevent the formation of sensitive materials which may be hazardous (explosive mixtures), exposed copper and its alloys, lead and zinc shall not be used in an area where ANE can come into contact with the metal;
- Where the duty is not obvious, the contents of all hazardous chemicals and process piping shall be clearly labelled.

In addition to the above mandatory requirements the following factors shall be considered and incorporated into the design as appropriate:

- adequate venting to prevent pressure or vacuum build up during loading or unloading;
- the use of combustible materials in construction should be avoided as far as practicable;

- hollow tubing should be avoided in the construction, as it may allow hidden accumulation of ANE or ammonium nitrate. Where hollow sections are used, they should be constructed with flushing points;
- the design of the tank and any pump transfer system should ensure that under the most adverse pumping conditions the pump inlet is supplied with ANE at a Net Positive Suction Head (NPSH) not less than the pump supplier's recommendations.

As noted above, AS4326 is a useful further reference when designing ANE tanks.

### 5.5 Electrical/Power

All equipment (electrical, hydraulic, pneumatic etc.) shall be designed to allow safe and easy isolation.

All electrical equipment which may come into contact with ANE shall have a rating of not less than IP55 in accordance with AS1939, to protect from corrosion.

Some sites may have materials which can give rise to hazardous areas as defined in the AS/NZS60079 and AS/NZS61241 series. Where electrical wiring, equipment, motors and other appliances are in such hazardous areas they shall comply with the requirements of those standards.

Mobile equipment carrying ANEs and other materials used to produce an explosive shall not be calibrated in an area where ANEs are stored, unless the individual components are calibrated separately and do not form an explosive. Where calibration equipment can create an explosive, the calibration equipment shall be separated from any area containing ANEs in accordance with the requirements detailed in Section 6.

### 5.6 Lightning

AS1768 sets out guidance for deciding whether lightning protection is required for specific sites, and an assessment to AS1768 should be carried out for any new installation. For the purpose of assessing the level of lightning protection required, the ANE shall be deemed to be non-flammable and non-explosive provided it is inside any building or in a metal container (including a metal tank on an MPU or tanker) irrespective of whether the container is earthed. As such the presence of ANE at a site does not create any requirement to evacuate at the approach of lightning.

Note that while ANE tanks and buildings do not require earthing due to the presence of ANE, they may require earthing for other reasons (e.g. as part of electrical system bonding, static bonding, part of personnel protection from lightning, etc.).

### 5.7 Good/Best Practices

Within the constraints of site supply and demand logistics, the design and operation of ANE premises should, as far as reasonably practicable:

- Minimise quantities of stored Dangerous Goods;
- Minimise number of people on site;
- Separate different activities;
- Maximise distances to exposed sites;
- Minimise the generation of waste;
- Manage waste;
- Maintain good housekeeping and cleanliness.

The extent to which various aspects or operations of a site are combined within a single premises versus split across multiple premises should be carefully considered.

Potential advantages of splitting:

- in general, any emergency or event will likely be smaller and affect less people and property; and
- can limit the business risk from loss of use of a site after an incident or during investigation.

Potential disadvantages of splitting:

- increased risk from additional travel, additional handling, and increased physical footprint with more widespread external interactions; and



- dilute site security and site supervision.

## 6 REQUIREMENTS FOR THE LOCATION OF ANE PREMISES

The dominant issue for the siting and layout of ANE premises is the risk of an explosion of a significant quantity of ANE. History indicates that the likelihood of such an explosion is extremely low however because of the quantities which are commonly stored the consequences could be severe. This Section details the requirements to ensure that ANE premises are located in appropriate places. This Section does not apply to underground ANE stores, except for the methodology of calculating PES size.

In many (most) situations the explosion risk arising from ANE cannot be considered in isolation. ANE premises are often co-located with explosives and/or AN. Rules and guidelines for explosives are detailed in the AS2187 series, which also defines the treatment of AN when it is present within defined distances of explosives. There are also various AN codes covering AN in isolation (refer Appendix D). But the AS 2187 series and the various AN codes do not cover ANE in combination with explosives and/or AN. For that reason this code, in addition to providing guidance on ANE by itself, also covers situations where ANE inventories are close to inventories of explosives and/or AN. Nothing in this code, however, is intended to supersede or conflict with the provisions of AS 2187, and in the case of any such conflict the AS 2187 provisions take precedence. Similarly, nothing in this code is intended to conflict with any known AN code, and where such a code is mandatory it will take precedence over this Code.

Other siting and layout issues which need to be considered are:

- the risk of fire generating toxic decomposition products; and
- the potential impact on the environment from spills or firefighting.

Compliance with this Code should ensure that these issues present an acceptably low level of risk, however they shall be considered and deemed acceptable as part of the risk assessment process for setting up new ANE premises (see Section 7).

Although deliberate third party intervention and sabotage are potential event scenarios, they are better evaluated in terms of security related activities and should be incorporated into the security plan (Section 11) and are not specifically addressed in this Section.

ANE classification and risk are reviewed in Appendix A.

### 6.1 Determining Acceptable Site Locations

When considering the suitability of a proposed location for ANE premises it is important to consider all of the explosion scenarios that could occur. Obviously the ANE itself is capable (under extreme circumstances) of exploding. But ANE premises often contain, or are closely associated with, other energetic materials, in the form of Class 1 explosives, and/or solid Ammonium Nitrate, so it is important to identify all the places where an explosion might start (PES), and also how far any explosion might propagate through sympathetic initiation (also known as knock-on). It is also important to distinguish between “with-warning” explosions, where evacuation would be an option to mitigate or manage the risk, and “no- warning” explosions, for which evacuation is essentially irrelevant. (Refer Appendix A for guidance on evacuation.)

Under this Code the following 4 steps are applied in determining whether a proposed location for ANE premises is acceptable:

1. Identify Potential Explosion Sites (PES), categorised as No-Warning or With-Warning;
2. Determine the size (adjusted NEQ) of the potential explosion from each PES, including knock-on effects;
3. Identify the relevant Exposed Sites (ES) that could be affected by an explosion at each PES;
4. Check whether separation distances and/or evacuation arrangements comply for each combination of PES and ES.

These steps are illustrated in the flowchart (Figure 6.1) and explained in detail below. Worked examples are included in Appendix C.



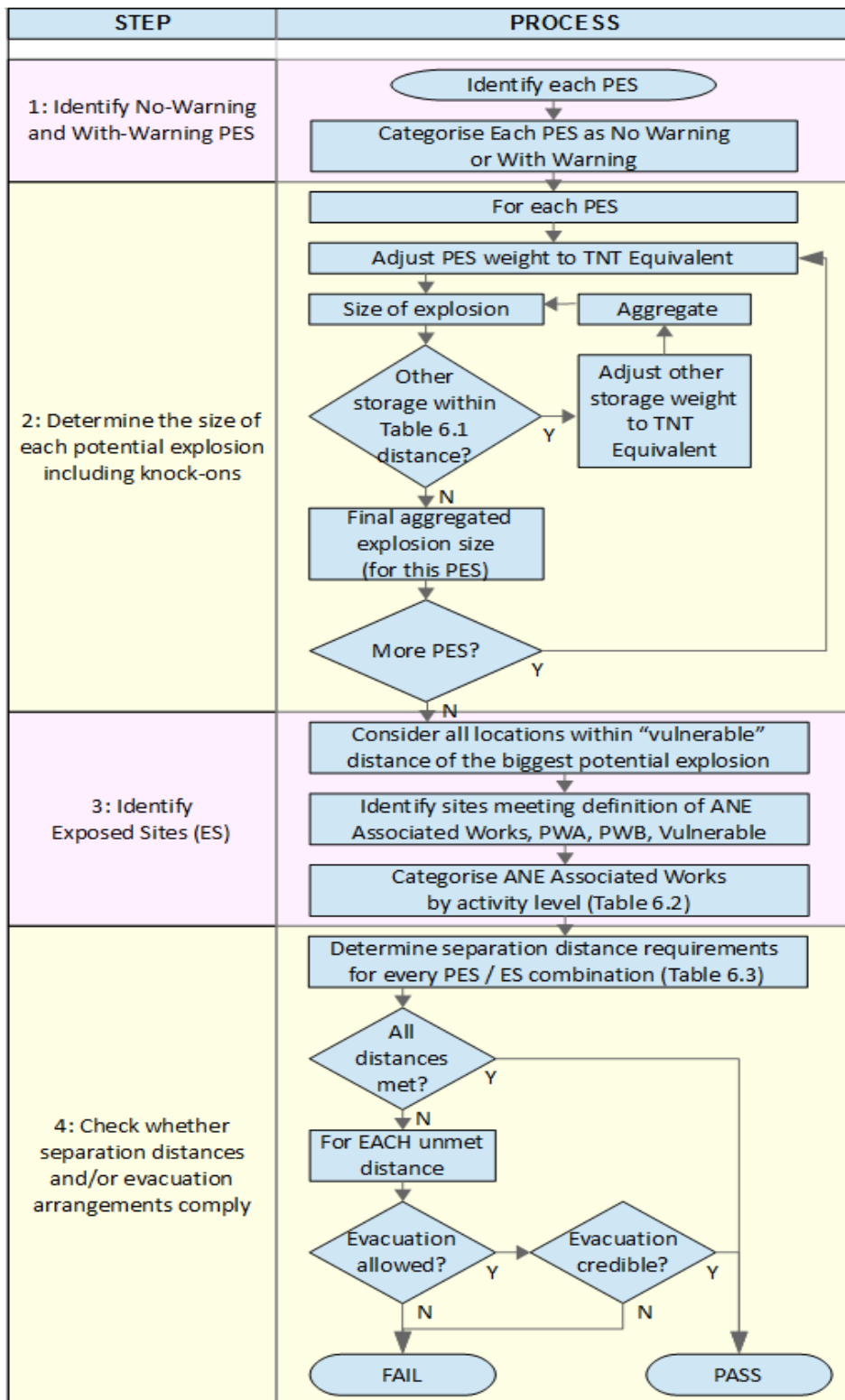


Figure 6.1 Flowchart for determining acceptability of ANE location

### Step 1: Identify Potential Explosion Sites (PES), categorised as No-Warning or With-Warning

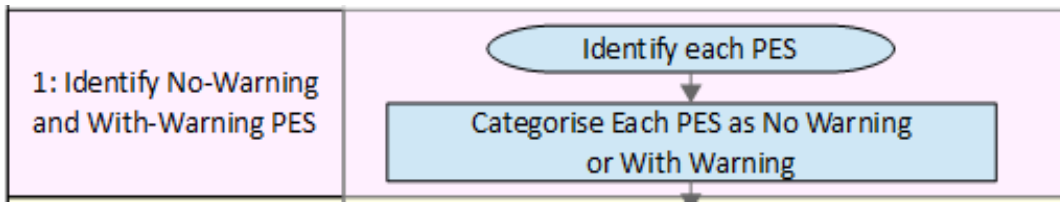


Figure 6.1.1

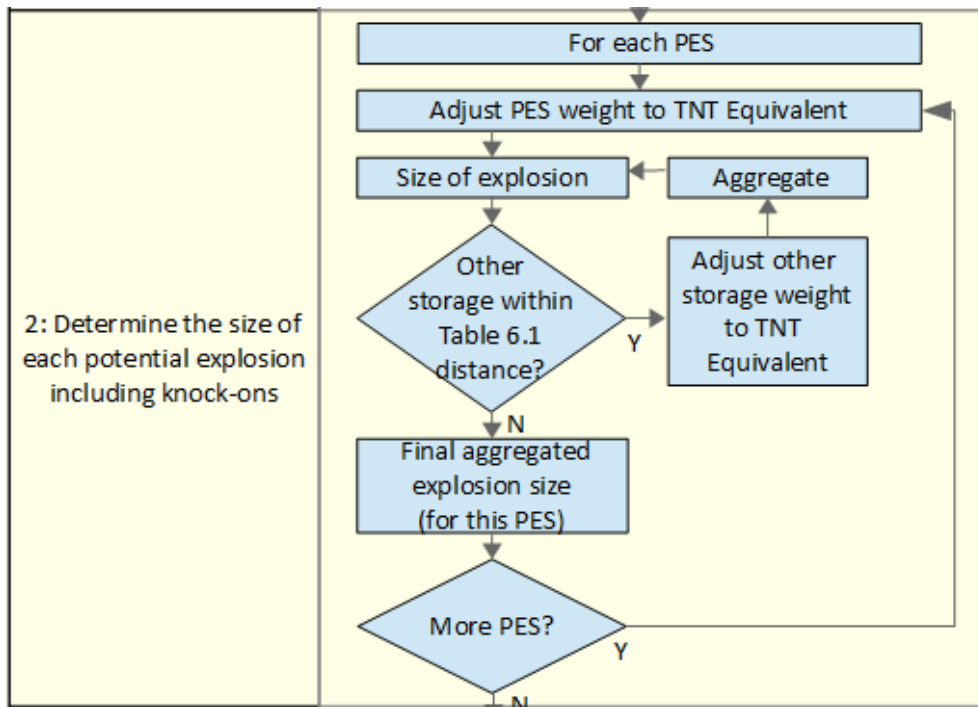
The aim of this step is to identify where an explosion might originate, and whether it would be “with-warning” or “no-warning”. (Later, in step 2, the possibility of “knock-ons” will be examined, but in this step the aim is to identify anything that could be the source, or initiator, of an explosion.)

For the purpose of this Code:-

- a) each inventory of explosive shall be considered as the potential source of a no-warning explosion. This includes any parked vehicle loaded with Class 1 explosives;
- b) each inventory of ANE shall be considered as the potential source of a with-warning explosion. This includes any parked vehicle loaded with more than a residual quantity of ANE. (Residual quantity is the amount left after a tank is emptied by the normal means (typically gravity or pumping));
- c) inventories of AN shall not be considered as the potential source of an explosion, but may contribute to an explosion by being sympathetically initiated (refer Step 2 below). This includes any parked vehicle loaded with more than a residual quantity of AN;
- d) there may be (particularly on large or complex sites) other PES’s arising from, for example, LPG storages, manufacturing plant process equipment or the like;
- e) the mass strength values used in calculations shall be as specified in local regulations, or
  - for explosives - as determined by the supplier or taken as 100% if no supplier figure is available;
  - for ANE - as determined by the supplier or taken as 100% of the non-aqueous component if no supplier figure is available;
  - for sympathetically initiated ammonium nitrate – the value published in SAFEX Good Practice Guide GPG 02: Storage of Solid Technical Grade Ammonium Nitrate (32% at date of publication of this Code);
- f) all site inventories other than vehicles shall be assumed to be at their maximum licensed capacities.

The output of this step is a list of all the identified PES, showing which are ‘No-Warning’ and which are ‘With-Warning’.

**Step 2: Determine the size of each potential explosion, including knock-on effects**



**Figure 6.1.2**

The aim of this step is to identify, for each PES identified in Step 1, the size of the explosion that could occur including knock-ons.

The process is:

- a) Adjust the actual weight of material at the PES to the TNT equivalent weight. This gives the size (adjusted NEQ) of the potential explosion of the PES alone.
- b) Then assess whether there would be any knock-on to other explosives, ANE or AN. (Residual quantities of ANE or AN on vehicles may be ignored for this step.) Table 6.1 below is used to determine if there is sufficient separation distance between the PES and neighbouring inventories to prevent knock-on.
- c) If any other explosives, ANE or AN is closer than the required distance then the TNT-equivalent weights (i.e. the adjusted NEQ's) shall be added together to give the size of the aggregated explosion.
- d) Repeat this process (steps b and c) until no further knock-ons are identified. Note that at each step the distances to other inventories must be measured from the closest of the inventories that have already been aggregated.
- e) Repeat the process for each PES.

The output of this step is the size of the aggregated explosion attributed to each PES.



**Table 6.1: Distances required to prevent knock-on**

Neighbouring Inventory (i.e. Material which may be initiated)	Distance to prevent initiation
Class 1 Explosives	Appendix B, "Other explosives storages" column "Mounded" or "Unmounded" as appropriate
ANE	Appendix B, column 'AN storage'
AN	Appendix B, column 'AN storage'

**Notes to Table 6.1:**

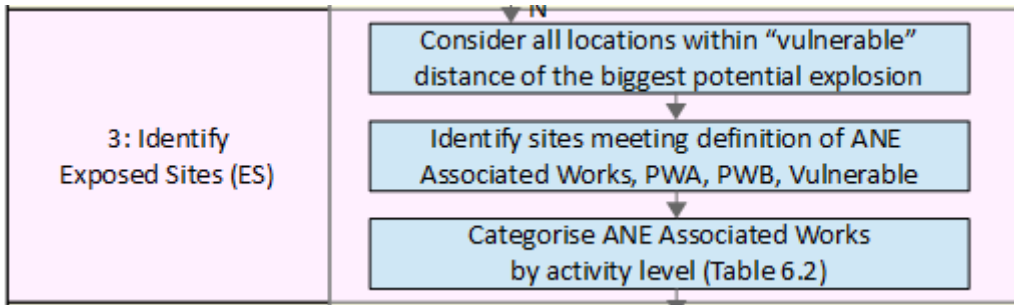
1. For the purpose of this Code the distances required to prevent initiation to ANE are identical to the distances required for AN, including the effect of mounding, as detailed in the Notes to the table in Appendix B.
2. Distances shall be the shortest distance between the boundaries of the inventories. Boundaries shall be:
  - For material in a storage room (e.g. a magazine), the walls of the room;
  - For material in a tank the walls of the tank; and
  - For material in stacks, the edges of the stack.

**NOTE: Subdivision of AN Inventories**

Under this Code AN is not a PES, but is susceptible to initiation. Where an inventory of AN is subdivided (e.g. into physically separate stacks of bags) then each stack may be considered as a discrete inventory for the purpose of this step. In most cases where there is an initiation of one stack it is likely there will be initiation of all stacks, but there may be exceptions if AN stacks are sufficiently separated.

Any AN solution tanks may be disregarded as they are not considered susceptible to initiation.

**Step 3: Identify the relevant Exposed Sites (ES) that could be affected by an explosion**



**Figure 6.1.3**

To assess the acceptability of a location it is necessary to consider the effects of every potential explosion on every other relevant site that may be affected. The aim of this step is to identify and categorise all the exposed sites that could be affected by an explosion at any PES.

The process is:

- a) Consider the entire area within at least the "vulnerable facilities" distance (Appendix B) for the biggest potential explosion. Identify all sites meeting the definition of:
  - ANE Associated Works
  - Protected Works Class A
  - Protected Works Class B
  - Vulnerable facilities

(In practice it is generally sensible to identify all ES within this distance, plus the closest of any type of ES which does not occur inside this distance. For example if there is no PWB within the area under consideration, then identify the closest PWB outside this area.)

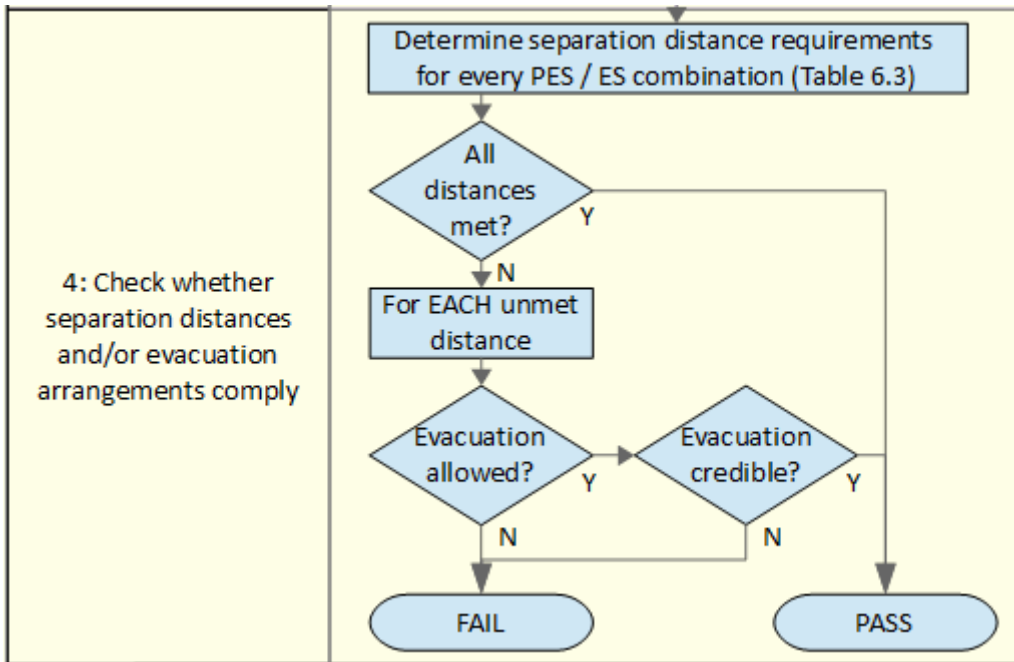
- b) Further categorise ANE Associated Works according to their activity level, as detailed in Table 6.2 below.

The output of this step is a grouped list of all the Exposed Sites which could be affected by any of the identified PES.

**Table 6.2: ANE Associated Works Activity levels**

Activity Level	Characteristics
Low	Not permanently attended, and Peak occupancy normally no more than 3 people
Medium	More than low but less than high
High	Usually attended for at least 1 shift (typically occupied >30 hours/week), or Peak occupancy more than 10 people

**Step 4: Check whether separation distances and/or evacuation arrangements comply**



**Figure 6.1.4**

The aim of this step is to determine whether the separation distances are adequate, noting that in some situations credible evacuation may substitute for (some of) the normally required distance. As per definitions, evacuation is credible if there is a high likelihood that when an evacuation is initiated it will have the effect that within 45 minutes there is no one in a building within PWB distance and no one in the open within PWA distance. It is important to note that evacuation does not protect fixed assets and property. (Guidance on Credible Evacuation is included in Appendix A.)

The process is:

- a) Determine the required separation distances for each combination of PES and ES (detailed in Table 6.3 below.);
- b) For each PES, check the actual distances to each ES. Note that for aggregated explosions the distance to the ES is measured from the closest material which explodes - which may not be the PES itself;
- c) If ALL distance requirements are met the proposal is a PASS.

If ANY distances are not met the proposal is a FAIL, unless evacuation is allowed, and credible, for EVERY unmet distance. In such cases the proposal may be accepted as a PASS.

**Table 6.3: Required Separation Distances**

PES Type	ES Type	Requirement (referenced to Appendix B)
No Warning	ANE Associated Works: Low Activity	AN Storage distance
	ANE Associated Works: Medium Activity	if there is a mound, Process Buildings distance. if there is no mound, 50% PWB. (This philosophy is adopted from the UK MSER regulations)
	ANE Associated Works: High Activity	50% PWB distance
	Protected Works Class A	PWA distance
	Protected Works Class B	PWB distance
	Vulnerable Facility	Vulnerable Facilities distance
With Warning	ANE Associated Works (any activity level)	No minimum distance provided evacuation is credible (but see note 1).
	Protected Works Class A	PWA distance, but may be reduced if evacuation is credible to: if there is a mound, Process Buildings distance if there is no mound, 50% PWB.  The required separation may be further reduced (or eliminated, subject to note 1 below) if evacuation is credible AND the owner of the protected works and any occupiers, are involved in the relevant emergency response procedures/plans.
	Protected Works Class B	PWB distance, but may be reduced if evacuation is credible to: if there is a mound, Process Buildings distance if there is no mound, 50% PWB.  The required separation may be further reduced (or eliminated, subject to note 1 below) if evacuation is credible AND the owner of the protected works and any occupiers, are involved in the relevant emergency response procedures/plans.
	Vulnerable Facility	PWB distance

**Notes to Table 6.3**

- 1) Note that even if there is no minimum separation distance required under this section, the requirements of Section 5 still apply.
- 2) For with-warning explosions evacuation is permitted as an alternative to distance for some types of exposed site. It should be noted that such evacuation does not protect fixed assets, and in the event of an explosion these would suffer greater damage than if the distances were greater. It should also be noted that these minimum distances may not meet the requirements of some regulatory bodies. (For example security considerations may influence the required separation distances.) These will be site specific and may require consultation with the regulatory authorities.
- 3) As detailed in Section 1, a risk assessment may be used to assess the acceptability of a site which does not meet the distances that would otherwise be required.
- 4) While involvement of the owner / occupiers of the protected work in emergency preparedness may allow for reduced distances to apply, this is not recommended for residential premises.

See Appendix C for worked examples

## 7 RISK ASSESSMENT

To assess the risk associated with proposed new ANE premises and confirm that it is acceptable, a Risk Assessment (or series of Risk Assessments) shall be conducted and documented, covering all activities related to the storage, handling and transport of ANE. Risk identification should be based on the planned facilities and operations and include, as a minimum, those risks identified in Appendix G.

Identified mitigation and contingency plans are to be implemented in the formal management system and be the subject of ongoing compliance audits.

Risk studies shall be conducted by appropriately qualified, multi-disciplinary teams and should include both engineering and operational personnel. Identified risks and controls should be documented in a site risk register with key controls also documented in procedure(s).

Site operating procedures are to be cross referenced to the relevant risk assessments to ensure key risk controls are documented in procedures. In such studies consideration should be given to the issues outlined below.

### 7.1 Site

- Exposed Sites within an appropriate radius (typically 2 kilometres). These should be identified on the plot plans.
- General site layout for the flow of materials.
- Consequence of fire.
- Consequence of explosion.
- Critical infrastructure that could be affected by fire and blast effects.
- Separation and segregation distances between incompatible dangerous goods.
- Site requirements for storage (i.e. minimum quantity to support operations, maximum quantity to manage risk).
- Mitigation of the effects of incidents and accidents, e.g. by reduction of quantities, separation distances.
- Provision for firefighting controls, emergency response and control of spills.
- Federal, state/ territory and local regulations.

### 7.2 Plant

- Materials of construction for tanks, process equipment and other materials in contact with, or exposed to, ANEs.
- Building or equipment design codes.
- Pipe work and instrumentation drawings, including a systematic examination of the deviations from standard conditions to identify required controls to handle the deviations.
- Process limits (e.g. maximum/minimum flow rates, levels, etc.)
- Process equipment, control logic, interlocks and equipment limitations.
- A review of pump protection systems (see also Section 8).
- Material handling procedures, ergonomics, equipment types and classification.
- Foreign bodies (tramp material).
- The prevention of uncontrolled heat, friction, pressure, confinement and cross contamination.





- The containment on-site of all wastes or residues from chemicals or materials.
- The prevention or minimization of waste generation.
- Earthing of equipment and buildings.
- Lightning protection (see also Section 5.6).
- Health, safety and environmental issues and quality control.

### 7.3 Operational requirements

- Standard operating procedures (SOPs), training and qualifications.
- Hazardous chemicals, their physical properties and compatibilities, and the provision of SDS.
- Personal exposure and requirements for the use and care of PPE.
- The management reporting structure and lines of communication.
- Site specific conditions including the staff 's language and customs.

### 7.4 Additional Issues for Underground Storage, Transport or Use of ANEs

- Storage rules – sites are to develop and implement a set of ANE storage rules to ensure the underground storages are properly managed and maintained.
- Storage locations in relation to refuge chambers and critical mine infrastructure.
- Transport incidents in relation to refuge chambers and critical mine infrastructure.

## 8 ANE PUMPS AND HOSES

### 8.1 Pump Hazards

The hazard potentially associated with ANE pumps is that they introduce heat into the ANE, generally under confinement. In normal operation the heating effect due to pumping is minor and is easily carried away by the flow of ANE. However when a pump is operated under no-flow conditions all of the heat is retained in the pump and the ANE that is in and immediately adjacent to it. Such no flow operation is the greatest risk and can arise if pumps are:

- a) run dry or the inlet is starved;
- b) run to a deadhead or the outlet is blocked.

Either of these situations will lead to a temperature build up which may cause a thermal decomposition of the ANE within the pump and possibly lead to an explosion of the pump contents.

### 8.2 Pump selection

In selecting a pump suitable for transferring ANE consideration shall be given to the pumping requirements. Factors which influence pump selection include:

- avoidance of mechanical hazards;
- avoidance of chemical hazards;
- operating temperatures;
- operating pressures;
- product viscosity;
- pump capacity/flow rate;
- acceptability of pulsation;
- pump wear considerations;
- space and weight limitations;
- power requirements.

In choosing a pump consideration shall be given to the possibility of 'dead spots' within the pump. These may have the potential to be a source of overheated ANE. For example ANE can get into a packed gland around a driving shaft. The ANE can then be overheated by friction. This is more likely to occur if the gland is under pressure.

**For this reason packed glands should be avoided in ANE pumps.**

The following table sets out guidelines for selecting a suitable type of pump for particular applications including the advantages and disadvantages of various pump types.



Type of	Advantages	Disadvantages	Comments
Air driven diaphragm pump	Inherently safe – stalls on deadhead and no dangerous heat if dry run	Very poor suction. Low pressure. Non metered flow. Relatively low flow rate. Pulsating flow. Often have poor solids handling. Compressed air has some safety issues that need to be managed (pressure vessels, risk of violent flailing of accidentally disconnected hose/ fitting).	No pump protective system required, but special care is needed to avoid exposed incompatible metals (e.g. brass) internally.
Gear pump or lobe pump	Relatively low hazard due to low confinement, low friction between rotating parts. Any heat generated is near the large area of exposed metal (which can radiate heat). Simple maintenance. High flow rates for size.	Low pressure. Relatively poor suction. Not suitable for solids. Some flow pulsation.	Pump protection system recommended.
Progressive cavity pump	Smooth flow. Good suction. High pressure capability. Handles solids without significant damage. Positive displacement with low leakage so metering is good. May stall, or break driveshaft etc. on a dead head.	Rubber stator traps heat on the inside, can't radiate through stator wall. Rubber heats due to "working" & rapid heating in no flow running. Relatively difficult to maintain. Pumps are heavy.	Requires pump protective system. Very widely used in explosives industry for high pressure, metered flow applications.
Piston pump	Very high pressure capability. Good suction. Compact. Accurate for metering. Suitable for air or hydraulic operation. Can be arranged to stall on dead head.	Pulsating & relatively low flow rates. Poor solids handling. May be susceptible to compression ignition risk. Moving parts & pinch points generally need guarding so often difficult to access for maintenance. Susceptible to malfunction from foreign objects.	Requires pump protective system.
Peristaltic pump	High pressure, Good solids handling, Good metering.	Pulsating flow, Heavy, big, can be difficult to maintain Messy when hose bursts. May be susceptible to compression ignition risk.	Requires pump protective system.

### 8.3 General ANE Pumping Requirements

- a) All pump applications, limitations, classifications and safety protection systems shall be defined in an engineering safety review and shall be authorised by the organisation for use with the technology involved and with the chemicals or materials used in the process.
- b) Pumps shall be operated within the limits established by the safety review, including speeds, pressures and direction(s) of operation.
- c) Each pump shall be uniquely identified, e.g. by a serial number stamped on the pump or on a tag securely attached to the pump.
- d) Periodic inspection and preventative maintenance requirements, and periodic testing of protective elements, shall be defined and implemented.
- e) Pumps shall be maintained by personnel who are accredited and/or authorised by the organisation.
- f) Spare parts shall be supplied by the original manufacturer or its authorised distributors unless alternatives are formally approved under the change management system.
- g) Operators shall be trained in the hazards associated with pumping ANEs, appropriate procedures, fault recognition and response. Records of such training shall be kept.
- h) The pumping system should as far as practicable be designed to prevent incorrect pumping. Suitable techniques include:
  - fixed connection of hoses to inlets and outlets;
  - providing different hose connectors for hoses with different purposes;
  - colour coding of hoses and connections;
  - provision of clear operating instructions and pump setup diagrams;
  - restricting pumping operations to suitably trained and authorised personnel;
  - Regular auditing of pumping operations.
- i) Pumping systems shall be designed so as to minimise the introduction of foreign bodies into the pumps. This may include the physical layout of the system and/or the appropriate use of filters or screens in the process.

### 8.4 Pump Protective Systems

#### 8.4.1 General

The details of the protective system are determined by the pumping application and the particular pump chosen.

Pump protective elements shall be considered in a hazard study which will address the requirements for each type of product, process or application. The hazard study shall explicitly consider the possibility that protective elements may not operate correctly due to the pump inadvertently running in reverse direction. For some applications the study may decide that there is no requirement for a protective system beyond 100% attendance at the pump (e.g. some bore hole loading applications). Applications where there is potential for the pump to be incorrectly left running unattended (e.g. transfer operations which take some time to complete) should not rely solely on operator supervision to guard against no-flow operation - other protective systems, such as time out or automatic shut down should be employed.

#### 8.4.2 Pump Protective Elements

The basis of safe operation, including reliance on supervision, inherent safety and automatic protective elements shall be documented. If automatic protection systems are used they shall be capable of detecting abnormal conditions and ensuring that no flow operation does not lead to an explosion.

Installed protective elements shall be regularly inspected and tested to ensure unrevealed faults are detected and rectified. Unless the safety review determines otherwise, testing shall be at least annual, and at least thorough enough to detect unrevealed failures.

Protection systems for new precursor pumping systems shall be assessed in accordance with IEC61508/IEC61511.

Examples of pump protective elements are:

- a) no flow detection / trip;
- b) temperature (or differential temperature) measurement / trip;
- c) thermal fuse (i.e. a melting element which can provide a flow or vent path);
- d) pump components which melt at a safe temperature;
- e) high pressure and low pressure trips;
- f) bursting discs;
- g) differential pressure trip;
- h) drive torque / power limiting;
- i) drive speed limiting;
- j) feed hopper level measurement / trip;
- k) time out or countdown automatic shut down system;
- l) voltage or current trip.

Care shall be taken to ensure the protective elements are installed in such a way that they are effective. For example:

- temperature sensors shall be positioned close to the point where heat is generated as the temperature gradients within static ANE will be very high;
- pressure sensors shall not be able to be isolated due to being downstream of a valve;
- bursting discs and pressure sensors shall be installed in such a way as to minimise the potential for formation of a crust or plug over the unit thus 'hiding' the true pressure. Plugs can form if the disc or pressure sensing element is installed in a T-piece.

## 8.5 Pump Operation

Pump operations are to be controlled by site procedure that specifies:

- Transfer pump design and construction specifications;
- Pump and hose maintenance requirements including scheduled inspections, audits and relevant checklists;
- Pumping system security to prevent unauthorised operation leading to unauthorised access to ANE;
- Pump system operation including start-up, normal operations, abnormal operations (fault conditions) and shutdown;
- Requirement to record and report any incident relating to the pumping operation; and
- Transfer of ANE by pump must be directly supervised by an authorised person at all times. Under no circumstance can a pump be left unattended.

## 8.6 Pump Management System

A pump management system is to be implemented covering:

- Maintenance, inspection and test schedule;
- Pump register, including:

- Equipment in service identified by type and serial number
- Confirmation of completion of planned testing, inspections and maintenance
- Results of testing and compliance checking, including signoff by authorised person(s)
- Log of breakdowns, failures and unplanned maintenance;
- Pump commissioning and decommissioning;
- Incident identification, response and reporting requirements;
- Qualifications, training and authorisation for pump operating and maintenance personnel;
- Pump protection system maintenance:
  - i. Scheduled testing against documented test procedures and test limits
  - ii. Test reporting;
- Authorised personnel for pump maintenance.

### 8.7 Pump Significant Incidents

A pump significant incident is one which involves sufficient overheating of the pump contents to be observed by pump operators (e.g. visible smoke, violent reaction of pump contents, rupture of the pump). Procedures shall be in place to ensure that all pump incidents are investigated and that pumping is not resumed before the conditions causing the incident have been identified and rectified. A pump significant incident may be subject to formal reporting requirements of the applicable regulatory authorities.

It is likely that various protective elements will operate from time to time due to a range of circumstances, such as:

- equipment fault;
- brief periods of high pressure (spikes) due to e.g. partial hose blockage;
- transient condition during start-up;
- tank run empty but detected immediately.

These kinds of occurrences are not pump significant incidents unless they are accompanied by significant overheating as outlined above.

### 8.8 Hose Assemblies

#### 8.8.1 Risks

Hose assemblies are used extensively in the handling of ANEs. The consequences of burst or leaking ANE hoses are much less than they would be for most dangerous goods, because:

- ANEs are generally viscous, meaning that spillages do not travel far and can usually be easily recovered;
- ANEs do not cause severe harm from corrosive or chemical attack on contact with skin; and
- ANEs do not release flammable or toxic vapours.

A burst in a pressurised hose has the potential to cause injuries due to the sudden release of pressure.

Hoses create less confinement than fixed pipework and may act as fusible elements to release ANE in a fire engulfment.

#### 8.8.2 Recommendations

Hose assemblies used with ANE must be suitable for the intended application. This includes product compatibility, pumping pressures, and other operational considerations such as weight and flexibility (for manual handling), UV resistance if exposed to sunlight and appropriate abrasion resistance. Hoses must be securely attached to end fittings to cope with system design pressures. Hose assemblies should be handled so as to avoid excessive curvature, stress, abrasion or kinking that may damage the hose or its connections. Spill collection trays should be provided wherever hoses are routinely disconnected.



ANE hose assemblies should be:

1. tagged with unique identification
2. regularly inspected for damage over their entire length and replaced where necessary
3. registered in a record keeping system, including details of:
  - a. date of supply;
  - b. date of installation;
  - c. dates and findings of inspections;
  - d. any repairs or maintenance.



## 9 ANE UNDERGROUND

ANE is often used, and stored in underground mines. This Section sets out the requirements to manage the risks associated with the storage, handling (including transfer operations), transport and security of Ammonium Nitrate Emulsions, Suspensions and Gels, conforming to UN3375, in underground mines (excluding coal mines).

This Section is intended to cover only the transport, transfer and storage of ANE within the underground operation. It does not apply to related surface operations or to the underground manufacture of explosives from ANE which is covered by the AEISG MPU Code.

This Section provides information and guidance related to the following areas:

1. Factors to be considered during the risk management process to assist in determining acceptable underground storage, handling and transport of ANE in the underground environment;
2. Summary of the hazards and risks associated with the underground storage and transport of ANE;
3. Separation requirements for ANEs from Division 1.1 and Division 1.5 explosives. If these requirements are not met the ANE becomes part of the Division 1.1 and/or Division 1.5 explosives inventory. The requirements for Class 1 explosives are outside the scope of this Code;
4. Assessment of storage locations and determination of maximum quantities to be stored;
5. Requirements for infrastructure for the storage of ANE;
6. Management of emergencies involving ANE in the underground environment.

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

### 9.1 Additional Definitions

Term	Meaning
ANE Bulk Transfer Unit	Single containers used to transfer ANE from surface stores to underground stores. These are typically in the 1000 to 2500kg range. Other terms commonly applied to Bulk Transfer Units are tanks, pods, IBC's, bins.
Division 1.1 explosives Division 1.5 explosives	Substances and articles containing a secondary explosive which have a mass explosion hazard (a mass explosion is one which affects almost the entire load virtually instantaneously).
Fixed ANE Storage	An ANE storage location for the long term storage of ANE. Fixed storages are limited in quantity and are often licensed.
Temporary ANE Storage	A storage location for temporary storage of ANE to be used in a single firing such as a mass blast. Temporary storages are limited in quantity and duration. (Refer Section 9.3.7)

### 9.2 Safety & Security Management System

The risks associated with the storage of ANE in an underground operation are to be minimised and mitigated through the development, implementation and maintenance of a formal Safety and Security Management System (SSMS), as detailed in Section 3. Note that whilst ANE is considered stable and relatively insensitive the consequence of an uncontrolled fire involving ANE in an underground operation could be catastrophic. The possibility for such an event requires that the quantity of ANE in an underground operation be minimised.

### 9.3 Requirements for Underground ANE Storage Facilities

The underground storage of ANE should be in properly constructed and maintained storages.

Temporary storages may be considered where large tonnages are to be used in a specific location in a short period, i.e. for mass blasts.



The recommended requirements for both fixed and temporary storages are detailed in this section.

### 9.3.1 ANE Storage in the Class 1 Magazine

Storage of ANE in licensed Class 1 magazines is acceptable provided the licensed NEQ of the explosives magazine is not exceeded when the quantity of ANE is aggregated with the explosives. When determining the equivalency factor for ANE the mass strength value shall be as specified in local regulations, or as determined by the supplier, or taken as 100% of the non-aqueous component if no supplier figure is available.

Where ANE is stored in a Class 1 magazine:

- the type and quantity shall be recorded and reconciled, similar to Class 1 products;
- where possible, ANE should be separated from Class 1 products e.g. separate compartment;
- sufficient room should be provided for vehicle movements and ease of loading/unloading;
- Class 1 products should be protected against potential impact e.g. raised storage bays, bollards, etc.

### 9.3.2 Requirements for ANE Storages not in an explosive magazine

The following headings detail the requirements for both permanent (fixed) and temporary ANE storages. These requirements are to be reviewed and documented in the risk assessment to be conducted prior to the operation of any ANE store.

Whilst the likelihood of fire / explosion involving ANE is low the consequences are potentially catastrophic and are to be managed by high level controls such as elimination and separation.

### 9.3.3 Determination of appropriate storage amounts.

The appropriate amount to be stored is the minimum to ensure continuity of supply to charging operations. The lack of surface facilities for the storage of ANE should not be the reason for the storing of large volumes in the underground operation.

The proposed storage volumes should be confirmed as meeting the requirement for minimum volume through reference to specific supply agreement / schedule and production forecasts.

### 9.3.4 Determination of ANE storage location.

When siting an underground ANE store the risk management process must be carried out at the planning and design stage to identify a suitable location.

Risk assessments must ensure the potential effects of a fire and unconfined explosion are adequately addressed. Crib rooms, refuge chambers, critical infrastructure and other non-production facilities must be adequately separated from the storage by an appropriate distance in order to minimise personnel exposure. Where multiple storages are located underground they should be sufficiently separated to minimise any interaction. Emergency response plans should include evacuation to designated safe locations and should aim to have all personnel at a safe distance within 45 minutes of a fire starting and engulfing ANE. In addition, the storage location should not impede an evacuation.

It is impossible to directly translate surface safety distances (e.g. AS 2187 table 3.2.3.2) into underground equivalents. In most underground situations, in the event of an accidental explosion there is little risk from the fireball or from the debris/shrapnel at any significant distance from the blast site. Blast overpressures, however, can propagate over significant distances, and the behaviour of blast pressure waves underground is highly site-specific.

The following must be risk assessed when determining the location of any underground ANE store:

- The distance from major service installations to manage the effects of a fire and explosion upon winders, electrical substations, pump stations, ventilation equipment or other critical infrastructure;
- Proximity to other Dangerous Goods stores (fuel, explosives etc.) and associated cross propagation risks;

- Proximity to likely ignition sources. These could include fuel sources such as refuelling depots, lubricant bays, workshops, electrical substations etc.;
- Proximity to high sulphide areas to be considered due to the hazard of reactive ground;
- An underground ANE store should be segregated from main travel ways (refer to the Access requirements below);
- Co-storage of gasser solutions should be segregated to minimise the potential for spillage and cross contamination leading to the unplanned sensitisation of the ANE. Segregation options include:
  - separated storage locations;
  - maintaining adequate distance between products;
  - separate bunds (fire resistant);
  - gasser storage down gradient of the ANE;
  - separate transfer systems, e.g. gravity decanting into the MPU instead of pumping;
- Proximity to active underground workings to minimise charge vehicle movements in order to facilitate charging operations;
- Access for resupply vehicles and charge vehicles to the storage location;
- Minimisation of interactions with production mining equipment (stope and associated vehicle movements); and
- The store should be sited in a region of competent ground to reduce possible damage caused by rock bolt failure, rock bursts and seismic activity.

The Site Emergency Response Plan (ERP) is to be reviewed against the planned location. This review is to consider:

- Fires involving ANE;
- Vehicle fire in proximity to the ANE store;
- Uncontrolled fire on MPU;
- Large spill.

### 9.3.5 Requirements for infrastructure for ANE storages.

These requirements apply to both permanent (fixed) locations and temporary stores except where noted.

- a) Access
 

The hazards of an out-of-control vehicle or locomotive entering the store should be addressed. Control options may include vehicles having to make at least one 90 degree turn to access the store. For rail access, a suitable de-railer or equivalent should be adjacent to the store. For temporary stores alternative methods may be required to address the hazard.
- b) Traffic Management
 

There must be adequate floor area for vehicle movements. A traffic management plan is to be developed that considers planned vehicle movements in the normal operation of the store.
- c) Unplanned movement
 

Unplanned vehicle interactions with transfer equipment and storage containers should be addressed. Control options may include physical barriers or elevated storage.
- d) Security
 

Access to ANE is to be controlled as it is a security sensitive product. Control measures should align with regulatory requirements and should include physical barriers:

  - to all access points on bulk containers (lockable lids, transfer valves, drain bungs, etc.); and/or

- security gates with appropriate locking devices at the storage access. (Note, where security gates are used, consideration should be given to appropriate direction of swing to ensure safe exit in an emergency, safety of products, trafficable routes, etc.)

Alternative methods (e.g. security guards) can be used, provided that security can be maintained.

e) Drainage

The store should be constructed such that large spills are drained away from the storage. Bunding is not recommended (refer to Spill Recovery section).

The access should be inclined or similar to provide adequate drainage to prevent deterioration of the access roadway and prevent water entering and pooling in the store.

f) Spill Recovery

Spillage containment is generally not applied to ANE storages due to the high viscosity of the material (does not flow readily) and to reduce the risk that containment may concentrate fuels under the storage during fire conditions.

The design shall consider the management and recovery of spilled ANE. The store should be constructed so that large spills do not accumulate near the storage.

g) Ground Conditions

The backs and walls of the store should be in a condition as to prevent a rock fall from impacting persons or products. The backs and walls should be free from loose or protruding rocks or meshed and bolted to secure from possible rock falls.

All intersecting boreholes are to be grouted and butts identified to ensure they are free of residual explosives.

The floor of the storage should be:

- Smooth for extensive foot traffic;
- Stable to prevent rutting from vehicle access;
- Suitable for storage container stability and vehicle operations; and
- Suitable to recover spills.

For fixed ANE storage, concrete or stabilised floors are recommended to address the above hazards and minimise the potential for tramp material being introduced.

For temporary ANE storage alternative methods may be employed provided these are assessed for risk.

h) Fire Fighting Equipment (FFE)

The specific requirement for FFE must be addressed in the risk assessment.

All storages require portable fire extinguishers to be located near vehicles or equipment where spot fires are more likely to occur. An adequate capacity is to be provided: e.g. 2A 60B(E) dry chemical, 2A 20B foam or water (refer AS 1851.1)

For fixed ANE storages of more than 10 tonnes capacity a deluge fire protection system is recommended. Such a deluge system should:

- be capable of manual or automatic operation;
- have pipelines and control valves that are fire-resistant, clearly marked and accessible from ground level, e.g. not plastic pipes or fittings; and
- be maintained in accordance with manufacturer's recommendations and inspected regularly.

i) Additional Safety Equipment

All stores where product transfers take place are to be provided with

- Spill kits with appropriate clean up equipment and labelled waste containers,
- Eyewash stations, and
- Additional PPE such as face shields, gloves and aprons as required, e.g. for acid and gasser solution transfer.

j) Signage and Notification

All personnel entering the underground operation are to be made aware of the location and access requirements for all ANE storages.

In addition the location of fixed ANE stores is to be recorded on the current mine plan.

All ANE stores shall display the following signs:

- Placarding (as appropriate to the storage, and in line with local legislative requirements);
- “No Smoking” and “No Hot Work”;
- Fire fighting equipment;
- Eyewash (if required);
- Store product names and quantity limits;
- “Authorised Access Only” or similar wording;
- Emergency contact numbers;
- Required PPE.

k) Documentation

ANE stores are to be provided with the following documentation in an accessible and protected location.

- Store operation rules, including requirement for preventing unauthorised access;
- MSDS and TDS for all products stored;
- Emergency response plan with actions for the different emergencies (Fire, unauthorised access, loss / theft of explosives, large spill);
- Location and type of FFE and or other equipment such as eye-wash bays;
- Stock records – Current stock and transfers.

l) Lighting

Lighting should be sufficient to enable a person to easily read markings, instructions, signs, etc. To improve illumination, walls and the roof may be painted white.

There is no specific requirement for fixed lighting unless identified as a control in the risk assessment. Where fixed lighting is installed it shall have a rating of at least IP55 to protect from corrosion or the rating applicable to the underground operation.

Electrical installations inside a storage area should be minimised.

m) Ventilation

Positive ventilation should be provided for fixed stores in order to:

- Disperse engine emissions;
- Disperse exhaust fumes due to any explosion or fire, from escape routes and workplaces; and
- Protect the products from adverse effects of high temperature or humidity or both.

For fixed ANE storages of more than 10 tonnes capacity the ventilation shall be linked with the return air ventilation. For fixed ANE storages less than 10 tonnes linking the ventilation to the return air ventilation is recommended.

### 9.3.6 Parking of MPU

MPUs containing ANE must be kept secure at all times. Control options include:

- Parking the MPU in a secured location;
- All access points being locked when unattended;
- Providing constant supervision by an authorised person.

A secure parking bay separate to any ANE storage area is recommended, to minimise any interaction with the storage.

Where the MPU is to be secured in the ANE store the risk assessment must consider the total quantity stored (if MPU loaded) and the increased risk of fire from ignition sources associated with the MPU. Control measures to be considered include isolating the power of the MPU and operator presence for 15 minutes after parking.

Explosives are not to be left on an unattended MPU.

### 9.3.7 Temporary ANE Stores

Temporary ANE storage near the charge site may be required in certain circumstances, e.g. single firing of a mass blast, to minimise charge vehicle movements and the associated vehicle interaction risks.

Temporary ANE storages should be limited in:

- Quantity. The minimum amount to facilitate charging should be stored but not more than 10 tonnes; and
  - Duration. Storages are to be removed once charging in the area is complete but usually no longer than 2 weeks.
- a) A procedure for the assessment, commissioning and decommissioning of any temporary ANE store is to be implemented. The following shall be covered in such a procedure:
1. Requirement for Risk Assessment;
  2. Determination of appropriate storage amounts;
  3. Determination of location;
  4. Requirements for infrastructure;
  5. Management of Temporary Storage including transfer pumping, spill response and emergency response;
  6. Security of product;
  7. Requirement to notify all persons in the area of the location of the temporary store.
- b) The temporary storage should not be located within eight (8) meters of the charge site / working area, but should be located nearby, in a location that minimises interaction risks. Aspects that require managing for temporary storage near a charge site are:
1. Minimising risks associated with the interaction of the equipment at the job site. Control options may include physical or visual barriers;
  2. Signage and notifications are to be managed such that all temporary stores are properly signed and notified when product is physically in the store;
  3. The quantity of ANE in the temporary storage area should be kept to the minimum quantity required to minimise charge vehicle movements. A maximum of 24 hours supply coverage is recommended. Product is to be removed from temporary stores when:
    - a. Charging operations are completed or are to be suspended for an extended period
    - b. Product security cannot be maintained;
  4. Product must be kept secure. Control options include direct supervision or the locking of all access valves to prevent unauthorised access when the storage is unattended;
  5. The location of temporary ANE stores is to be communicated to all personnel who may be working in the area where the temporary store is located;
  6. Fire risk substances/objects to be excluded;
  7. Fire protection to be provided; and
  8. Housekeeping to be maintained to a high standard.
- c) Gasser solution is to be stored in a manner where the risk of unplanned mixing with ANE is eliminated. For temporary stores it is recommended that gasser solutions be stored in a separate location to ANE.

### 9.4 Operation Of Underground ANE Storage Facilities

Refer also to Section 3.

Safe operating procedures / work instructions should be developed and documented. These procedures should cover:

- Security / access control procedures to prevent unauthorised access and enable authorised access;
- Traffic management plan;
- Product transfer by exchanging bulk containers (i.e. no pumping);
- Product transfer by transfer pumping;

- Product transport within the underground operation;
- Emergency response to incidents such as spillage, unexplained loss, degradation, fire and explosion;
- Stock control;
- Waste management.

#### 9.4.1 Procedure: Security / Access Control

ANE is classified as a security sensitive product and as such must be managed in a manner that prevents unauthorised access and enables authorised access.

Only authorised persons are to have unsupervised access to ANE. Authorised persons are to be recorded in a register of authorised persons.

Security procedures need to detail the security measures in place to control access to the ANE, including:

1. A register of authorised persons
  - a. Authorised person requirements: personnel with unsupervised access to ANE must have obtained the relevant security clearance from the state regulatory authority and be authorised by the company controlling the storage; and
  - b. Management of the register, including maintaining the register, ensuring personnel are removed from register when no longer authorised;
2. A register of secure keys, including an access log for sign in and sign out of keys;
3. Security checks to detect tampering;
4. Stock reconciliation to detect unexplained loss.

#### 9.4.2 Procedure: ANE transfer by bulk container exchange

ANE transfer procedures need to detail the control measures to ensure safe handling of bulk containers. These measures should include:

1. Managing interactions with other plant during the transfer process;  
(Example where transfer vehicle blocks access during product transfer operations.)
2. Requirement to isolate area during transfer operations in order to manage interactions with other plant;
3. Managing interactions between mobile plant and storage units. Ensuring storage design considers traffic management;
4. Ensuring transfer mobile plant (e.g. crane, forklift) is suitable for operation within the ANE store;
5. Adequate restraint of containers.

#### 9.4.3 Procedure: ANE transfer by pumping

The requirements and recommendations detailed in Section 8 apply to all ANE pumping, including underground. In addition, for ANE pumping in an underground operation, it is recommended that inherently safe pumps, such as air driven diaphragm pumps, are utilised. These have the benefit of stalling on dead head and do not require pump protection systems to be installed and maintained.

The following factors need to be considered in formulating appropriate procedures:

- transfer vehicles to be segregated from any Class 1 products;
- transfer vehicles to be attended during transfer operations;
- transfer vehicle to be secured against movement and orientated to allow for quick egress during transfer operations;
- only one product to be transferred at a time;
- storage tank capacities to be checked prior to transfer;
- no maintenance or calibration work to be undertaken in the storage area; and
- transfer operation duration to be kept to a minimum.

#### 9.4.4 Procedure: ANE transport within the underground operation

The transport of ANE in an underground mine must be controlled in a manner that reduces the risk of significant incident to As Low As Reasonably Practicable (ALARP). Whilst the risk of a significant incident is low frequency the potential high consequence makes ALARP an appropriate risk control target.

The transport of ANE underground needs to be conducted without other dangerous goods or explosives being carried on the same vehicle, at the same time as ANE.

Procedures for the underground transport of ANE need to detail the control measures to ensure safe transport. Such control measures should include:

- Driver training. All personnel responsible for the transport of ANE must be trained in appropriate emergency response for transport scenarios;
- Driver authorisation to have unsupervised access to security sensitive products;
- Site induction;
- Pre-start equipment checks;
- Emergency response for transport scenarios;
- Incident reporting;
- Traffic management / route planning / interaction management;
- Vehicle requirements (safety equipment, PPE, fire extinguishers, placarding);
- Emergency information (ANE Emergency Procedure Guide – refer to HB76 handbook, Safety Data Sheets, etc.);
- Compliance with the MPU Code of Practice, where applicable;
- Load limits;
- Load restraint;
- Product / load security.

As the transport may be conducted by a contractor or site personnel, where appropriate the procedures need to include mine site inductions, mine specific PPE requirements and the mine's specifications for vehicles operating underground.

#### 9.4.5 Procedure: ANE Emergency Response

An Emergency Response Plan (ERP) shall be in place and shall include as a minimum:

1. Signage (containing emergency contact numbers);
2. An area evacuation plan;
3. Appropriate fire risk management plans;
4. Procedures to address any reasonably foreseeable emergency, including fires;
5. Procedures that address the loss of normal communication systems;
6. Identification of unexplained loss;
7. Testing of safety systems (including procedures and acceptance criteria) and emergency response; and
8. Emergency response drills.

Persons expected to assist in an emergency shall be trained to an appropriate level. The ERP shall be reviewed (and updated as appropriate) as required, e.g. after an incident or when improvements are identified, or at least annually. The review shall demonstrate the effectiveness of actions taken at the premises and all associated communications, but physical evacuation, and actual operation of equipment (such as fire extinguishers) are not required. The results of the review must be documented.

#### Emergency scenarios

Foreseeable emergencies for all underground ANE operations, including the following scenarios, should be addressed in the emergency procedures:

- ANE spills – containment, recovery, disposal of waste and clean up;
- Reaction with incompatible chemicals or reactive ground;
- Fires impacting ANE either in storage or during transport, including consideration of:



- Where ANE is heated to combustion large quantities of smoke and noxious fume will be produced.
- In the event of an uncontrolled fire (with a substantial source of fuel such as MPU diesel tanks) capable of engulfing any ANE, it shall be assumed that the ANE may explode.
- Where an incident relates to a fire involving ANE transport, existing mine emergency procedures for vehicle fire may need adjusting to include the need to consider evacuation beyond the potential blast radius;
- Explosion following the escalation of a fire emergency; and
- The blast radius will depend on the quantity of product detonating and the size and number of intersecting tunnels in the region. This is extremely difficult to predict. Consider evacuation to twice Protected Works Class B distances.

#### 9.4.6 Waste Management Procedure

The requirement to minimise waste shall be incorporated in the relevant site operating procedures.

The storage of waste shall be minimised, with regular review and management of waste inventory, including prompt disposal.

Waste ANE shall be noted in stock reconciliation and shall be secured from unauthorised access.

Note where waste ANE has been treated with an appropriate surfactant and diluted to less than 45% AN content it no longer has security requirements.

Waste materials shall be kept in separate, labelled and lidded containers constructed of compatible material and stored in appropriate secure locations. No other waste (e.g. gasser, clean-up rags, combustible material, etc.) is to be stored or mixed with the ANE waste.

Wastes shall be removed and/or disposed of in accordance with site procedures which must recognise environmental, organisational, and legislative guidelines.



## 10 PERSONNEL

Each employee (and contractor) handling ANE shall be covered by a training program with demonstrated competency assessments. The minimum requirements are described in this Section. Personnel issues relating to security are described in Section 11.

### 10.1 Framework

The organisation should implement a framework to ensure personnel tasked with ANE responsibilities are appropriate and competent. The following is recommended:

- a) Position Descriptions for relevant roles should include:
  - responsibilities, authorities, and reporting;
  - minimum educational or industry experience standards;
  - training requirements for each job classification;
  - physical and mental health requirements.
- b) The training and assessment system should be documented. Verification of the competency of personnel in understanding standard operating procedures should be undertaken on a regular basis.

### 10.2 Specific On-Site Training Requirements

Training requirements should include:

- Induction program for all employees, contractors, and visitors;
- Training in standard operating procedures, site specific work instructions, and site security including clearances;
- Awareness of all hazards on site, and controls in place;
- Emergency response and evacuation procedures;
- Specific training in ANE handling equipment (e.g. pumps, valves, pump systems, hydraulic power units and compressors) including operating conditions, limitations and potential hazards;
- Appropriate skills training and licensing of employees as required for operating specialised equipment e.g. forklifts, boilers and cranes. An annual review and renewal of training and licensing requirements shall take place;
- The recognition of hazardous chemicals and their incompatibilities in the workplace;
- Site specific personal protective equipment (PPE) requirements, including training in the proper use and care of the equipment;
- Spill prevention, waste minimisation and disposal;
- The location and proper use of all emergency equipment including fire extinguishers, fire hoses, alarms, first aid stations and eye wash stations;
- Confined space entry requirements (if applicable);
- For personnel whose position descriptions include maintenance: the use of approved parts, modifications, hot work system, 'lock out', 'tag out' and decontamination procedures.

### 10.3 Drivers (Including contractor drivers)

Considerations should include:

- Drivers transporting ANEs shall be qualified and authorised to relevant federal, state and territory requirements;
- Drivers transporting ANEs shall be trained in appropriate emergency response;
- Drivers required to unload or load ANEs from storage tanks unsupervised shall be trained in the procedures and shall be authorised in writing by the operator of the relevant storage tank(s). They shall be trained in pump hazards (refer Section 8.3f ) if loading or offloading involves pumping.



### 10.4 Recommended Training for Underground Situations

The following Training and Competency Matrix is recommended:

Competency or Site Procedure	Transport operator	Transfer Pump operator	Charge vehicle Operator	Emergency Response Team
RIIBLA205D Store, handle and transport explosives	✓	✓	✓	✓
RIIBLA303D RIIBLA304D Conduct u/g shotfiring			✓ <sup>(1)</sup>	
RIIBLA203D Conduct mobile mixing of explosives			✓	
Pumping Operations.		✓	✓	
Site Transport procedures	✓		✓	
Operation of Charge vehicle			✓	
Emergency Response	✓	✓	✓	✓

Notes: (1) The 'Conduct Shotfiring Operations' units of competency may be required where the MPU operator is charging whilst unsupervised.

## 11 SECURITY REQUIREMENTS

The operator of a licensed ANE premises is required to have a security plan in place. The security plan must meet the requirements of (and may require approval by) the relevant statutory authority, and should form part of the application to the authorities to store or manufacture the ANE.

ANEs require security plans under relevant statutory regulations. A security risk assessment shall be conducted to determine the level of controls required. When conducting an assessment it is important to take into consideration the potential threats, vulnerabilities, and criticality of the potential security risk. The risk assessment should be conducted by a cross section of the workforce where available. Should the number of personnel be limited due to location then the organisation should have the security risk assessment reviewed by business specialists.

The principal objectives of the security plan are:

- to provide a controlled process in place to manage the operational environment of the premises daily security activities;
- to provide secure storage of ANE (including ANE in hoses, waste, etc.);
- to enable theft to be detected quickly and advised to the authorities;
- to identify and report security related incidents.

The security plan will have four main elements:

1. Security Risk Assessment;
2. Personnel management;
3. Site security (physical requirements); and
4. Procedures governing the above.

Detailed requirements for the security plan elements are described in locally applicable regulations and guides.

### 11.1 Procedure: Stock Control

Procedures for stock control and reporting need to be specified and should cover:

- Stock records– product In / Out / On Hand and stock reconciliation;
- Stock rotation and shelf life;
- Quantity restrictions;
- Reporting requirements including unexplained loss.

## 12 WASTE MANAGEMENT AND ENVIRONMENTAL CONTROLS

### 12.1 General

- a) Waste management and environmental protection programs shall be incorporated into the design and operation of every premises. These shall be in place before commencement of operations.
- b) The organisation shall comply with all relevant environmental regulations and licence conditions.
- c) All procedures shall give priority to the minimisation of waste.

### 12.2 Storage of Waste

- a) Waste ANE shall meet the security provisions of SSAN and this Code unless it is known to no longer meet the requirements for inclusion as SSAN. In addition, all waste materials shall be kept in separate, labelled and sealed containers. Such materials shall be properly separated by the distance required by dangerous goods legislation based on the compatibility of the materials. Each separate area shall be placarded and located so as to prevent cross contamination if a spill occurs. A common drainage system shall not be used in areas where incompatible materials are stored.
- b) All waste shall be contained in order to prevent it contaminating the environment.
- c) To eliminate the security issues in storing waste ANE it may be appropriate to reduce its ammonium nitrate content to less than 45% by dissolving it in water or other suitable compatible medium. In so doing the compatibility of this waste with other waste materials and with other chemicals must be carefully considered.
- d) The storage of waste shall be minimised, with regular review and management of waste inventory.

### 12.3 Calibration

The calibration of equipment shall be undertaken so as to minimise the amount of waste produced. One way to minimise waste is to calibrate each component separately. All waste materials produced during the calibration process shall be stored in a designated waste area.

Containers used to store such waste material shall be compatible with the material being kept, and shall be sealed and labelled.

Special consideration shall be given to any explosives which may be created during the calibration process.

### 12.4 Recycling

A recycling program should be used to reprocess non-explosive materials generated during calibration or operation. This should be controlled by strict guidelines to ensure all safety precautions are taken prior to the commencement of the process.

### 12.5 Environmental discharges

As a part of the waste management and environmental protection program discharges to air, ground and water shall be identified and minimised. As required by legislation, licences shall be obtained.

### 12.6 Disposal

Wastes shall be removed and/or disposed of in accordance with applicable environmental, organisational, and legislative guidelines. Disposal may require a licence or disposal through an appropriately licensed contractor.

## 13 TRANSPORT

### 13.1 General

Transport safety of ANEs is regulated by the Australian Code for the Transportation of Dangerous Goods by Road & Rail (ADG Code). Security issues with ANEs are not regulated by the ADG Code but are controlled by jurisdiction specific regulations. It is the responsibility of everyone involved in the transport of an ANE to comply with regulations and the ADG Code.

Mobile Processing Units (MPUs) that are used to transport and blend an ANE with other ingredients to create an explosive shall comply with the AEISG MPU Code, and may require an additional licence from the appropriate regulatory authority for explosives.

The organisation offering a material that is classified as an ANE for transport shall ensure that the prime contractor involved for the haulage of the material holds the appropriate licences or approvals to transport ANEs. The equipment and processes used by the contractor should be reviewed by the organisation offering the material for shipment in order to ensure that they are suitable for the task and are maintained in a safe condition.

Any vehicle transporting an ANE shall comply with applicable federal, state or territory regulations regarding authorised weight limits. The maximum design limit recommended by the manufacturer of the equipment shall not be exceeded.

When being transported by water, an ANE shall be handled in accordance with the recommendations of the relevant port authority. Additional separation and segregation requirements may apply while the ANE is on the wharf and aboard the ship. Containers are to comply with the IMDG Code and other IMO requirements for the class of material being transported.

### 13.2 Emergencies

The emergency procedure guide (EPG) or Dangerous Goods Initial Emergency Response Guide HB76 shall be used as a basis for managing a hazardous situation involving an ANE.

In the event of an uncontrolled fire involving a transport vehicle carrying ANE, the ANE should be treated as if it were an explosive. The area around the fire should be evacuated for a distance of at least 1 kilometre. Shorter distances can be set if exact quantities of ANE (and other relevant materials on the vehicle) are known. In such cases evacuation distances shall be calculated by the same method as described in Section 6.

The fighting of a fire involving a vehicle carrying an ANE should only be attempted while the fire is controllable and has not engulfed the tank that contains the ANE. Steps may be taken to keep the tank cool while fighting the fire.

There shall be a procedure in place to deal with any spillage during the loading, unloading and transport of the ANE.

### 13.3 Transport routes

Routes for vehicles transporting ANEs shall be reviewed and documented to ensure minimum impact on the community both in normal duties and in times of emergencies.

## 14 APPLICATIONS FOR NEW ANE PREMISES

Licence applications for new ANE premises must meet the requirements of the relevant regulatory authorities. Where practicable it is recommended that applications are presented under the sections detailed below. These sections correspond with those of this Code. Each section should address the general conformance or otherwise of the new proposal to the requirements of the Code and highlight specific areas of interest or unique features of the proposal.

It is recognised that applications will vary in size and level of detail owing to their different scopes. Unusual requirements should be discussed prior to submitting a proposal.

### SECTION

1. Scope: A review of the proposal detailing location, equipment, processes, inventories, products, amenities, etc.
2. Definitions: Generally as per Code.
3. Safety and Security Management
4. Standards, Codes & Regulations: Listing of key standards, codes and regulations reviewed for the proposal.
5. Design, Layout & Materials of Construction: Include a list of materials, maximum inventory and methods of handling.
6. Location: including assessment per Section 6
7. Risk Assessment(s): Discussion of any significant findings (including list of critical machine systems).
8. Pumps Management: List of the type and number of process and delivery pumps on site and their protective systems, and description of the Pump management System.
9. Underground: if relevant, include a description and the specific risk assessments for any underground store of ANE
10. Personnel
11. Security
12. Waste Management & Environmental Controls
13. Transport



## 15 AUDITING

The following should be considered targets for regular review and auditing as determined by the site risk assessment.

1. Security of ANE. Authorised and unauthorised access controls;
2. Bulk transport from surface to underground store and charge site;
3. Use of temporary ANE stores underground;
4. Fixed ANE stores;
5. Charge vehicle (i.e. MPU) storage and transport;
6. ANE stock control;
7. Emergency response.

The site should define an audit schedule to ensure regular checks at appropriate intervals are undertaken. The audit schedule should define:

- Audit target – including relevant procedures;
- Audit trigger – scheduled intervals, after incident etc.;
- Audit tools – prescribed checklists, supporting documentation to be used;
- Auditor – role responsible for performing the audit;
- Reporting and corrective action requirements.

A compliance checklist has been included at Appendix H for guidance.

## APPENDIX A: ANE CLASSIFICATION, RISK, AND EVACUATION

### A1 ANE CLASSIFICATION

The generally accepted framework for classifying dangerous goods is embodied in the United Nations publication “Recommendations on the Transport of Dangerous Goods Model Regulations” and the companion publication “Manual of Tests and Criteria”. While this system applies to transport, it is accepted by many competent authorities as providing an excellent insight into the behaviour of a material in storage as well as transport situations.

To be accepted into UN3375 classification (for transport) a substance must have passed at least tests (a), (b) and (c) of UN Test Series 8 (from the UN Manual of Tests and Criteria). To pass these tests the material must meet defined criteria for:

- a) thermal stability;
- b) insensitivity to shock; and
- c) insensitivity to the effect of intense heat under confinement

This test series reliably distinguishes between explosives and ANEs.

### A2 EXPLOSION RISKS ASSOCIATED WITH ANES

As illustrated by having passed the UN test series, ANEs are very insensitive to overheating and shock, and very difficult to initiate. They are designed so that they require further processing before they become explosives. This Code recognises that due to their very low sensitivity, the only credible way for ANEs to explode by accident is through prolonged and intense fire engulfment. The only known case where this has happened occurred when an explosion at a Class 1 explosives plant ruptured nearby diesel tanks and set fire to the diesel, which was contained within a secondary containment bund. A tank of ANE in the same bund was engulfed by this intense fire, and exploded after approximately 75 minutes. This event led to a ban on having fuel tanks within the same bund walls as ANE tanks, as well as other fire-risk minimization requirements of this Code. (The event pre-dated the development of the UN 3375 definition, and it is not known whether the material would have conformed.) This explosion was not instantaneous, and nor would any similar event be – that is, it would be a “With-Warning” explosion, rather than a “No-Warning” explosion. The provisions of this Code should ensure that any such fire engulfment will be extremely unlikely to actually happen – but history has a way of inventing new and previously unanticipated scenarios – so it is prudent to assume that, despite all of our efforts, it MAY still somehow be possible for a major fire to engulf an ANE storage. However, even if this happens, there is no physical way for a substantial quantity of ANE to be heated beyond decomposition temperature instantly, or in a very short time.

It may also be possible for contamination to eventually lead to an explosion (of ANE) but while this may be theoretically possible it has never been observed in practice and is extremely unlikely in the absence of extremely good and large scale mixing. If such an explosion were actually possible it would be a “With Warning” explosion which would be adequately managed by the provisions of this Code.

A limited explosion of ANE is also possible through no flow pumping, but in these scenarios only limited quantities of ANE are exposed to the heating effects. Precautions against no flow pumping are detailed in Section 8.

It is possible that the sensitivity of ANE to heat and impact may be increased if the ANE has dried out or crystallised. Alternatively, sensitivity may be decreased under these circumstances.

In the absence of definitive knowledge it is prudent to prevent ANE from drying out and/or crystallising, and procedures to ensure regular inspection and appropriate cleaning must be implemented, as required by Section 3.4. (Note that unnecessary cleaning should be avoided to limit generation of waste.)

### A3 EVACUATION

The underlying philosophy of this Code is that any credible explosion of ANE could only happen after





prolonged and intense fire engulfment. For such 'With-Warning' explosions, evacuation may be an acceptable mechanism to reduce the consequences (to people) of an accidental explosion of ANEs, provided the anticipated evacuation scenario is credible.

A credible evacuation scenario is one with a high likelihood that within target 30 / maximum 45 minutes of the evacuation being initiated there is no person in a building inside Protected Works Class B distance and no person in the open inside Protected Works Class A distance. (Note that 45 minutes is seen as conservative in relation to the 75 minute timeframe of the only known real explosion.)

Whether evacuation is credible can only be assessed on a site-specific basis. In assessing the acceptability of credible evacuation to manage risk it should be noted that, in general, explosion effects drop off sharply with distance. This means that un-evacuated people close to the ANE premises are at disproportionately greater risk than un-evacuated people who are almost at the required distance. For example a cluster of homes at 90% of the required evacuation distance may be more acceptable than one or two homes at, say, 30% of the required distance. It is likely that, in many circumstances, even a partial evacuation would reduce risk very substantially.

## APPENDIX B: SEPARATION DISTANCES

This table of distances is drawn from the same source (NATO Tables) and uses the same formulae as the 1998 version of AS 2187.1 and, as such, the distances are identical to those detailed in Table 3.2.3.2 in that version of AS 2187.1. Table notes and formulae are detailed below.

ADJUSTED NEQ (kg)	SEPARATION DISTANCES (METRES)								
	PROTECTED WORKS CLASS A	PROTECTED WORKS CLASS B		VULNERABLE FACILITIES	OTHER EXPLOSIVES STORAGES		ASSOCIATED WORKS		
		UNMOUNDED	MOUNDED		UNMOUNDED	MOUNDED	PROCESS BUILDINGS	AN STORAGE	
Formula->	A		B	C	D	E	F	G	
500	63	180	95	360	39	20		64	15
1000	100	180	150	450	48	24		80	18
2000	160	240	240	560	61	31		105	23
3000	205	305	305	650	70	35		120	26
5000	255	380	380	760	83	42		140	31
7500	295	435	435	870	94	47		155	35
10000	320	480	480	960	105	52		175	39
15000	370	550	550	1100	122	61		200	45
20000	405	610	610	1220	135	66		220	49
30000	460	690	690	1380	150	75		250	56
40000	510	760	760	1520	165	83		275	62
50000	550	820	820	1640	180	89		295	67
75000	625	940	940	1880	205	103		340	77
100000	690	1040	1040	2080	225	115		375	84
140000	770	1160	1160	2320	250	125		420	94
180000	840	1260	1260	2520	275	140		455	105
200000	870	1300	1300	2600	285	145		470	110
250000	940	1400	1400	2800	305	155		510	115



**NOTES**

1. Adjusted NEQ means (see definitions) "The mass of TNT that would produce an equivalent explosive effect to the inventory under consideration".
2. Where a mound exists between a PES and an ammonium nitrate store, the separation distance may be reduced to –
  - a. 5m for  $Q \leq 5000$  kg;
  - b. 10m for  $Q > 5000 \leq 50000$ kg; and
  - c. 20m for  $Q > 50000$ kg.

Where Q is the aggregated TNT equivalent quantity of the PES.

3. For further information, refer to Australian Standard AS2187.1, Section 3.

**FORMULAE USED**

(D = distance in metres, Q = Adjusted NEQ)

Ref	Formula
A	$D = 1.0 Q^{2/3}$ for $Q \leq 2500$ kg $D = 3.6 Q^{1/2}$ for $2500 < Q \leq 4500$ kg $D = 14.8 Q^{1/3}$ for $Q > 4500$ kg
B	$D = 1.5 Q^{2/3}$ for $Q \leq 2500$ kg $D = 5.5 Q^{1/2}$ for $2500 < Q \leq 4500$ kg $D = 22.2 Q^{1/3}$ for $Q > 4500$ kg
C	$D = 44.4 Q^{1/3}$
D	$D = 4.8 Q^{1/3}$
E	$D = 2.4 Q^{1/3}$
F	$D = 8.0 Q^{1/3}$
G	$D = 1.8 Q^{1/3}$

These formulae may be used to calculate distances for quantities other than those listed in the table.

## APPENDIX C: EXAMPLES OF ASSESSING ACCEPTABILITY OF PROPOSED LOCATIONS

### C.1: Introduction

This appendix includes several worked examples to illustrate how Section 6 of this Code should be applied when assessing proposals for the location of ANE storages. All of the examples are based on a common (imaginary) site, which is shown as an aerial photo on figure C.1 (next page).

There are 4 examples:

- A: Single ANE tank
- B: Small depot with magazines
- C: Large depot with magazines
- D: Large depot with magazines and ANFO manufacturing

The figure shows visually the relative locations of various features relevant to the examples.

In the figure:

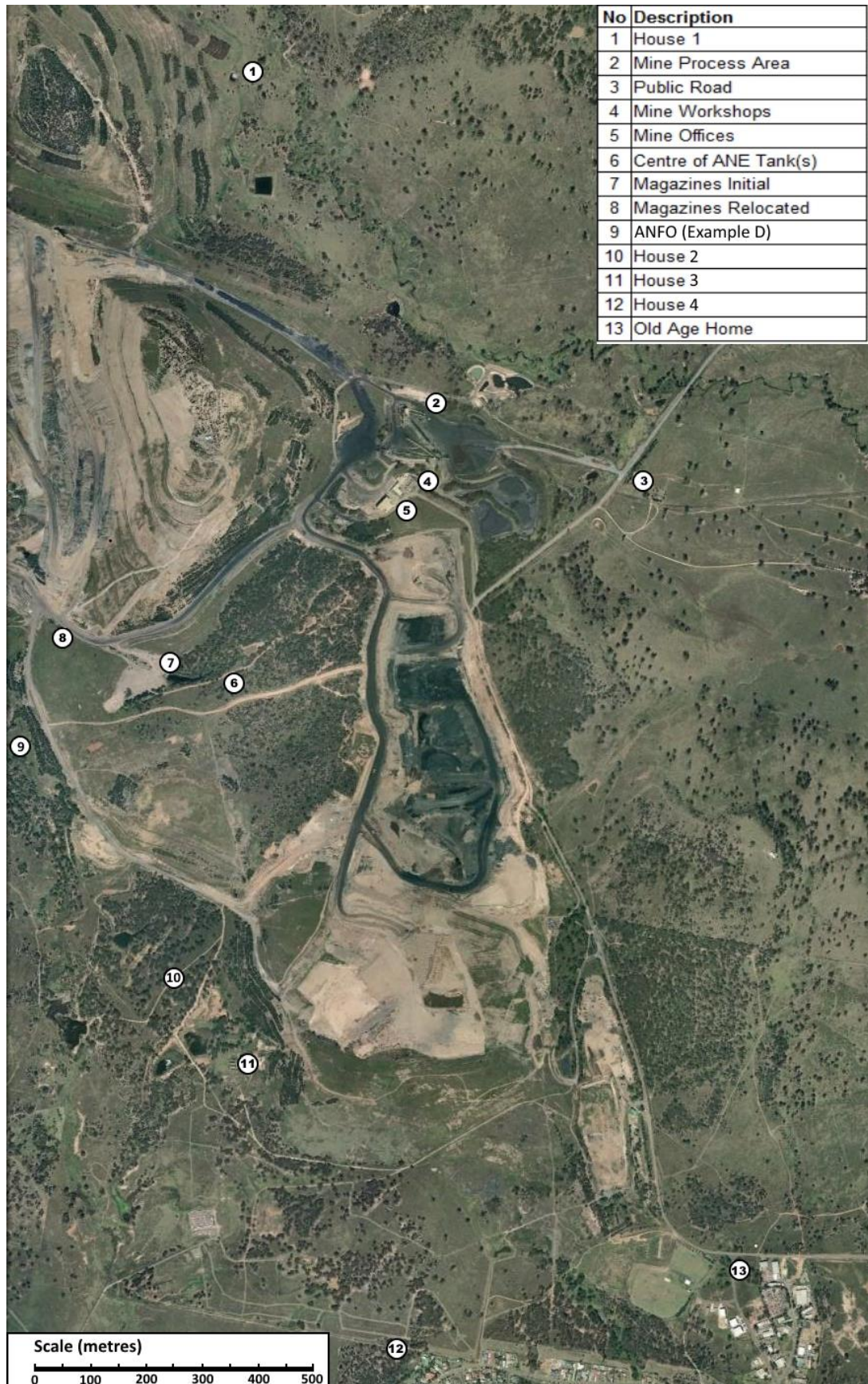
- location 6 is the centre of the (first) ANE storage tank
- location 7 is the initial magazine location (Example B)
- Location 8 is the relocated magazine location (Examples B, C and D)
- Location 12 is House 4, which is the closest house in the residential area of the nearby town, which has a population of around 1000

Note that some features shown in the figure are not present for some of the examples (eg there are no magazines in Example A).

To avoid repeating common distance measurements in each example most are tabulated in table C.1 below the figure.

To assist in determining suitable sites for AN, ANE and explosives storages, an assessment template has been included at Appendix I.

Figure C.1



**Table C.1: Distances for Figure C.1**

No		1	2	3	4	5	6	7	8	9	10	11	12	13
	Description	House 1	Mine Process Area	Public Road	Mine Workshops	Mine Offices	Centre of ANE Tank 1	Magazines Initial	Magazines Relocated	ANFO	House 2	House 3	House 4 (Town)	Old Age Home
1	House 1	na	682	980	799	815	1095	1065	1070	1274	1606	1775	2321	2316
2	Mine Process Area	682	na	415	125	152	548	587	713	887	1049	1175	1671	1635
3	Public Road	980	415	na	407	434	790	877	1047	1184	1193	1250	1619	1431
4	Mine Workshops	799	125	407	na	35	447	504	654	811	935	1054	1546	1521
5	Mine Offices	815	152	434	35	na	412	469	621	777	902	1024	1522	1509
6	Centre of ANE Tank 1	1095	548	790	447	412	na	122	320	400	517	680	1252	1398
7	Magazines Initial	1065	587	877	504	469	122	na	199	309	545	733	1326	1506
8	Magazines Relocated	1070	713	1047	654	621	320	199	na	204	618	831	1440	1675
9	ANFO	1274	887	1184	811	777	400	309	204	na	481	702	1313	1616
10	House 2	1606	1049	1193	935	902	517	545	618	481	na	221	832	1176
11	House 3	1775	1175	1250	1054	1024	680	733	831	702	221	na	612	981
12	House 4 (Town)	2321	1671	1619	1546	1522	1252	1326	1440	1313	832	612	na	624
13	Old Age Home	2316	1635	1431	1521	1509	1398	1506	1675	1616	1176	981	624	na

**NOTE:** In this table the distances to the magazine locations (7 and 8) are measured to the centre of the magazine compound, and may be slightly different to the distances used in the detailed assessments, which are the closest relevant "edge-to-edge" distance.



**C.2: Example A - Single ANE tank**

**C.2.1 The Proposal**

The proposed ANE premises are located on a remote mine and consist of a fenced yard containing a single ANE tank of 40,000 kg capacity, with an associated diaphragm pump plus air compressor, plus a tank containing 250l of effects chemicals. There are no mounds. There are no other facilities in the ANE premises. The ANE tank will supply a single MPU and will be replenished by tanker (25 t deliveries). Expected throughput is 2,500 t per annum. The supplier advises that the ANE has a Mass Strength of 75% of TNT. The site is not permanently attended, and the normal peak occupancy is 2.

**C.2.2 Assessment**

**Step 1: Identify PES, categorised as No Warning and With Warning**

The only PES is the ANE tank. As detailed in Section 6 Step 1, an inventory of ANE is considered as the potential source of a With Warning explosion.

**Step 2: Determine the size of each potential explosion including knock-ons**

Adjust PES weight to TNT equivalent	Supplier advises ANE mass strength = 75% of TNT. Therefore the adjusted NEQ for this PES is 40,000 * 0.75 = 30,000 kg
Other storage within Table 6.1 knock-on distance?	There are no other storages, therefore the final aggregated explosion size for this PES is 30,000 kg.
More PES?	There are no other PES

**Step 3: Identify the relevant exposed sites that could be affected by an explosion**

The area to be considered is the entire area within at least the "vulnerable facilities" distance for the biggest potential explosion. In this case the only potential explosion is 30,000 kg TNT equivalent. For this the Vulnerable Facilities distance (from Appendix B) is 1380m.

All of the exposed sites within (or close to) this distance are listed in Step 4 below.

**Step 4: Check whether separation distances and/or evacuation arrangements comply**

First, consider required distances for a 30,000 kg With Warning PES without any reductions based on evacuation. In the table below:

- All distances are in metres
- "Required" distances are taken from Table 6.3 and Appendix B
- "Actual" distances are as detailed in Table C 1. These are measured from the centre of the proposed ANE tank location to the closest part of the relevant Exposed Site. (Strictly speaking these should be measured from the closest edge of the ANE tank, but the difference is negligible.)

Type	Exposed Site	Distance from ANE Tank		
		Required	Actual	Met?
ANE Associated Works	None	-	-	-
Protected Works Class A	Public road	460	790	Y
Protected Works Class B	Mine offices	690	412	N
	Mine workshops	690	447	N
	Mine process area with large quantities of dangerous goods	690	548	N
	House 1	690	1095	Y
	House 2	690	517	N
	House 3	690	680	N
	Town (House 4)	690	1252	Y



Type	Exposed Site	Distance from ANE Tank		
		Required	Actual	Met?
Vulnerable Facilities	Old Age home in town	690	1398	Y

There are 5 locations where the required "full" distance is not met. For these we need to check whether the required distance may be reduced, and if so, under what conditions:

All of the unmet distances are for PWB ES's, for which the required separation from a With Warning PES is (table 6.3):

" PWB distance, but may be reduced if evacuation is credible to:

- if there is a mound, Process Buildings distance
- if there is no mound, 50% PWB.

The required separation may be further reduced (or eliminated, subject to note 1 below) if evacuation is credible AND the owner of the protected works and any occupiers, are involved in the relevant emergency response procedures/plans.."

In this case it is believed that evacuation is credible, since three of the locations to be evacuated are part of the mine and managed within its security/headcount controls, and there are only two other single houses to be evacuated. There is no mound, so the requirement can be reduced to 50% of the PWB distance.

(Note that further reductions in required distance would be available either by installing a mound (which would allow reduction to Process Distance - 250 m in this case) or by the involvement of the owners / occupiers of the relevant Exposed Site(s) in emergency response procedures. The latter, however, is not normally recommended for ES which are residential premises.)

We can now check the distances which were initially unmet to see whether they meet the reduced distance requirements:

Exposed Site (ES)	ES Type	Condition	Met?	New Required distance		Actual	Met?
				Type	m		
Mine offices	PWB	Evacuation must be credible	Y	50% PWB	345	412	Y
Mine workshops			Y			447	Y
Mine process area with large quantities of dangerous goods			Y			548	Y
House 2			Y			517	Y
House 3			Y			680	Y

### C.2.3 Conclusion

The location of the proposed ANE premises is acceptable provided there is an effective evacuation plan in place.



### C.3: Example B - Small depot plus magazines

#### C.3.1 The Proposal

This proposal is a small expansion of example A. The layouts of the proposed ANE Depot and magazine compounds are illustrated in Figure C.3.1.

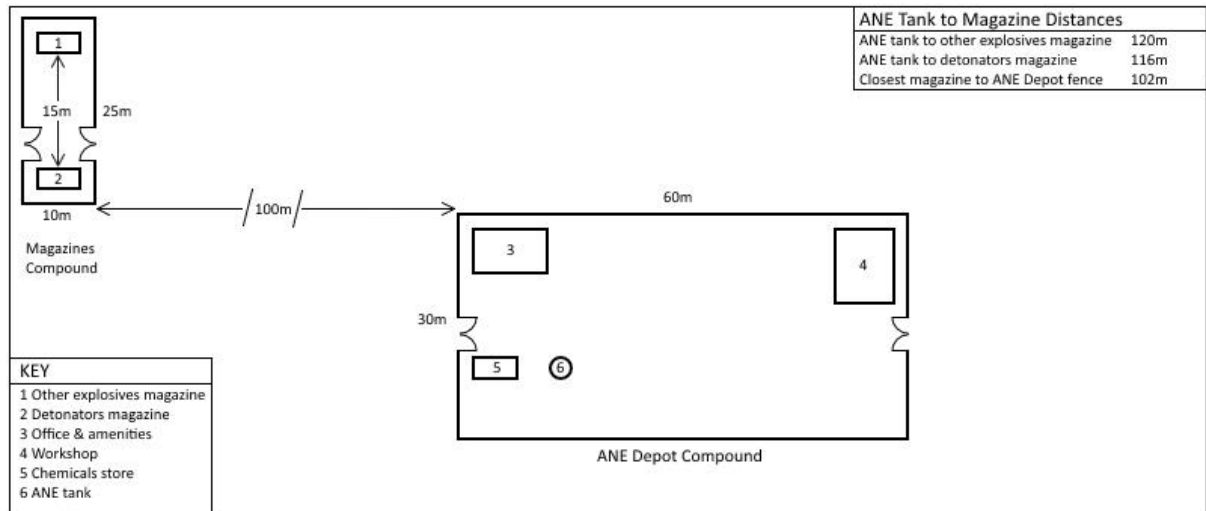


FIGURE C 3.1

The proposed premises now consist of:

- ANE Depot Compound - a fenced compound which now contains:
  - A single ANE tank of 40,000 kg capacity (in the same place as in example A), with an associated electrically driven gear pump.
  - A 250 l effects chemicals storage tank
  - Space for MPU parking
  - A small office and ablutions facility (demountable building)
  - A small covered workshop area for MPU maintenance
- Magazine Compound - This is a separate fenced area, and is proposed to be positioned at location 7 in Figure C 1. It contains two unrounded magazines 15m apart – one for 10,000 detonators and one for 10,000 kg of blasting explosives. As detailed in Table C.1 the centre of the compound is 122 m from the centre of the ANE tank. Other distances are detailed in Figure C.3.1 above. (Tank to magazine distances are edge-to-edge, not centre-to-centre.) Expected explosives usage is 100 t per annum. The blasting explosives can be a mix of detonating cord, packaged explosives, cast boosters and bagged ANFO. The average mass strength is 100% of TNT.
- There are no mounds at either compound.
- The ANE tank will supply a single MPU and will be replenished by tanker (25 t deliveries). Expected throughput is 2500 t per annum. The supplier advises the ANE has a Mass Strength of 75% of TNT
- Both fenced areas are operated by the same organisation and are located on the mine site.

The depot has a maximum peak occupancy of four persons and is occupied intermittently depending on work patterns. The activity level is medium (ref Table 6.2).

#### C.3.2 Assessment

##### Step 1: Identify PES, categorised as No Warning and With Warning

There are 3 PES:

- High explosives magazine - potential No Warning explosion
- Detonator magazine - potential No Warning explosion
- ANE tank - potential With Warning explosion

##### Step 2: Determine the size of each potential explosion including knock-ons



Now, for each PES, consider whether other inventories are within knock-on range, and calculate final aggregated size.

PES	Adjust PES weight to TNT equivalent	Other storage within Table 6.1 knock-on distance?
High explosives magazine (No Warning)	10,000 kg at 100% = 10,000 kg TNT equivalent	From App B, the unbounded distance to prevent knock-on to other explosives for 10,000 kg is 105 m, therefore the detonator magazine 15 m away will aggregate, to give explosion size 10,010 kg. Unbounded distance to AN or ANE for a 10,010 kg explosion is 39 m therefore ANE tank 116 m away (from the closest part of the combined explosion) will not aggregate.
Detonator magazine (No Warning)	10,000 dets at 1g = 10 kg TNT equivalent	AS 2187 requires a minimum unbounded separation of 10 m from detonators to other explosives to avoid aggregation. There is a 15 m separation in this case, therefore there will be no aggregation, and the explosion size is 10 kg.
ANE tank (With Warning)	Supplier advises ANE mass strength = 75% of TNT. Therefore the adjusted NEQ for this PES is $40,000 * 0.75 = 30,000$ kg	Unbounded distance to explosives for 30,000 kg is 150 m, therefore the magazines 116 m and 120 m away will aggregate, to give explosion size 40,010 kg.

Summary: there are 3 explosion scenarios:

- 10,010 kg No Warning from High explosives magazine and detonator magazine aggregated
- 10 kg No Warning from detonator magazine
- 40,010 kg With Warning from ANE tank + both magazines aggregated

**Step 3: Identify the relevant exposed sites that could be affected by an explosion**

The area to be considered is the entire area within at least the "vulnerable facilities" distance for the biggest potential explosion. In this case the biggest potential explosion is 40,010 kg TNT equivalent. For this the Vulnerable Facilities distance (from Appendix B) is 1520 m.

Exposed sites within this distance are detailed in step 4 below.

**Step 4: Check whether separation distances and/or evacuation arrangements comply**

First, consider separation distances for the No Warning explosions. Only the 10,010 kg explosion originating at the high explosives magazine is significant - distances required for a 10 kg explosion at the detonator magazine will be much less and need not be considered independently. The table below shows the required distances for a 10,010 kg no warning explosion, and the actual distances, for each ES. In the table:

- All distances are in metres
- "Required" distances are taken from Table 6.3 and Appendix B
- "Actual" distances are as detailed in Figure C.3.1 or Table C.1. (The latter are measured from the centre of the magazine compound to the closest part of the relevant Exposed Site. Strictly speaking these should be measured from the edge of the closest magazine, but the difference is negligible.)

Type	Exposed Site	Distance (m) from aggregated explosion		
		Required	Actual	Met?
ANE Associated Works, Activity level Medium	ANE Depot	240 (ie 50% PWB = 480/2)	102	N
Protected Works Class A	Public road	320	877	Y
Protected Works Class B	Mine offices	480	469	N
	Mine workshops		504	Y
	Mine process area with large quantities of dangerous goods		587	Y
	House 1		1065	Y
	House 2		545	Y
	House 3		733	Y
	Town (House 4)		1326	Y
Vulnerable Facilities	Old Age home in town	960	1506	Y

**Distances are not met from the High explosives magazine to the ANE Depot, or to the mine offices. Because this is a No Warning explosion scenario there is no alternative mechanism or option to achieve compliance, so the proposal as it stands is a FAIL, and there is no need to continue the assessment.**

### C.3.3 Revised Proposal

Because the initial proposal is not acceptable, it is revised by relocating the magazine area to location 8 (ref Figure C 1). The layouts within the two compounds are the same, but there is now a greater distance between them, as illustrated in Figure C.3.3

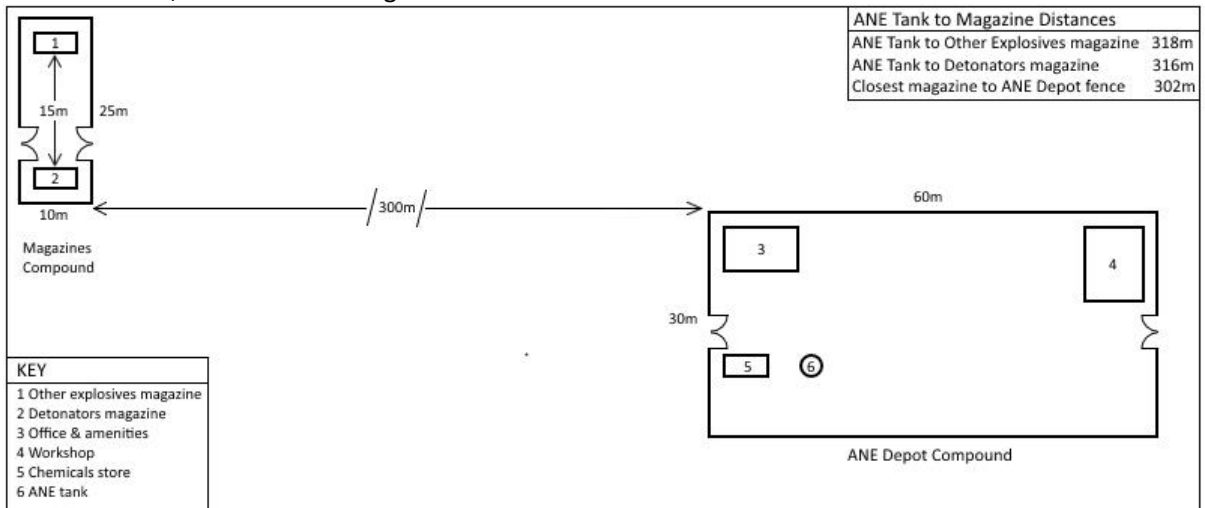


FIGURE C 3.3

The assessment can now be re-done with the magazines at the new location.

### C.3.4 Revised Assessment

#### Revised Step 1: Identify PES, categorised as No Warning and With Warning

We still have the same 3 PES:

- High explosives magazine - potential No Warning explosion
- Detonator magazine - potential No Warning explosion
- ANE tank - potential With Warning explosion



**Revised Step 2: Determine the size of each potential explosion including knock-ons**

PES	Adjust PES weight to TNT equivalent	Other storage within Table 6.1 knock-on distance?
High explosives magazine (No Warning)	10,000 kg at 100% = 10,000 kg TNT equivalent	Unmounded distance to other explosives for 10,000 kg is 105 m, therefore detonator magazine 15 m away will aggregate, to give explosion size 10,010 kg. Unmounded distance to AN or ANE for a 10,010 kg explosion is 39 m therefore ANE tank 316 m away will not aggregate.
Detonator magazine (No Warning)	10,000 dets at 1g = 10 kg TNT equivalent	AS 2187 requires a minimum unbounded separation of 10 m from other explosives to avoid aggregation. There is a 15 m separation in this case, therefore there will be no aggregation, and the explosion size is 10 kg.
ANE tank (With Warning)	Supplier advises ANE mass strength = 75% of TNT. Therefore the adjusted NEQ for this PES is 40,000 * 0.75 = 30,000 kg	Unmounded distance to explosives for 30,000 kg is 150 m, therefore the magazines 314 m and 316 m away will not aggregate, so the final explosion size is 30,000 kg.

Summary: there are 3 explosion scenarios:

- 10,010 kg No Warning from High explosives magazine and detonator magazine aggregated
- 10 kg No Warning from detonator magazine
- 30,000 kg With Warning from ANE tank

**Revised Step 3: Identify the relevant exposed sites that could be affected by an explosion**

The area to be considered is the entire area within at least the "vulnerable facilities" distance for the biggest potential explosion. In this case the biggest potential explosion is 30,000 kg TNT equivalent. For this the Vulnerable Facilities distance (from Appendix B) is 1380 m.

Exposed sites within this distance are detailed in step 4 below.

**Revised Step 4: Check whether separation distances and/or evacuation arrangements comply**

First, consider separation distances for the No Warning explosions. Only the 10,010 kg explosion originating at the other explosives magazine is significant - distances required for a 10 kg explosion at the detonator magazine will be much less and need not be considered independently. The table below shows the required distances for a 10,010 kg no warning explosion, and the actual distances, for each ES. In the table:

- All distances are in metres
- "Required" distances are taken from Table 6.3 and Appendix B
- "Actual" distances are as detailed in Figure C.3.1 or Table C.1. (The latter are measured from the centre of the magazine compound to the closest part of the relevant Exposed Site. Strictly speaking these should be measured from the edge of the closest magazine, but the difference is negligible.)



Type	Exposed Site	Distance from aggregated explosion		
		Required (App B)	Actual	Met?
ANE Associated Works, Activity level Medium	ANE Depot	240 (ie 50% PWB = 480/2)	302 (to fence)	Y
Protected Works Class A	Public road	320	1047	Y
Protected Works Class B	Mine offices	480	621	Y
	Mine workshops		654	Y
	Mine process area with large quantities of dangerous goods		713	Y
	House 1		1070	Y
	House 2		618	Y
	House 3		831	Y
	Town (House 4)		1440	Y
Vulnerable Facilities	Old Age home in town	960	1675	Y

With the magazines relocated all distances are now met for the No Warning explosions.

Now consider the With Warning explosion - initially looking at separation distances without any reductions based on evacuation. The table below shows the required distances for a 30,000 kg With Warning explosion, and the actual distances, for each ES.

Type	Exposed Site	Distance from ANE Tank		
		Required (App B)	Actual	Met?
ANE Associated Works	None	-	-	-
Protected Works Class A	Public road	460	790	Y
Protected Works Class B	Mine offices	690	412	N
	Mine workshops		447	N
	Mine process area with large quantities of dangerous goods		548	N
	House 1		1095	Y
	House 2		517	N
	House 3		680	N
	Town (House 4)		1252	Y
Vulnerable Facilities	Old Age home in town	690	1398	Y

There are 5 locations where the required "full" distance is not met. For these we need to check whether the required distance may be reduced, and if so, under what conditions:

All of the unmet distances are for PWB ES's, for which the required separation from a With Warning PES is (table 6.3):

" PWB distance, but may be reduced if evacuation is credible to:

- if there is a mound, Process Buildings distance
- if there is no mound, 50% PWB.

The required separation may be further reduced (or eliminated, subject to note 1 below) if evacuation is credible AND the owner of the protected works and any occupiers, are involved in the relevant emergency response procedures/plans."



In this case it is believed that evacuation is credible, since three of the locations to be evacuated are part of the mine and managed within its security/headcount controls, and there are only two other single houses to be evacuated. There is no mound, so the requirement can be reduced to 50% of the PWB distance.

(Note that further reductions in required distance would be available either by installing a mound (which would allow reduction to Process Distance - 250 m in this case) or by the involvement of the owners / occupiers of the relevant Exposed Site(s) in emergency response procedures. The latter, however, is not normally recommended for ES which are residential premises.)

We can now check the distances which were initially unmet to see whether they meet the reduced distance requirements:

Exposed Site (ES)	ES Type	Condition	Met?	New Required distance		Actual	Met?
				Type	m		
Mine offices	PWB	Evacuation must be credible	Y	50% PWB	345	412	Y
Mine workshops			Y			447	Y
Mine process area with large quantities of dangerous goods			Y			548	Y
House 2			Y			517	Y
House 3			Y			680	Y

### C.3.4 Conclusion

The location of the proposed ANE premises and magazine area (revised location) are acceptable under this Code provided there is an effective evacuation plan in place.

(Note that the magazine proposal must also be assessed separately under locally applicable regulations and standards for explosives (typically AS 2187).)

## C.4 : Example C - Large Depot plus magazines

### C.4.1 The Proposal

This proposal is a further expansion of example B, as illustrated in Figure C4.1.

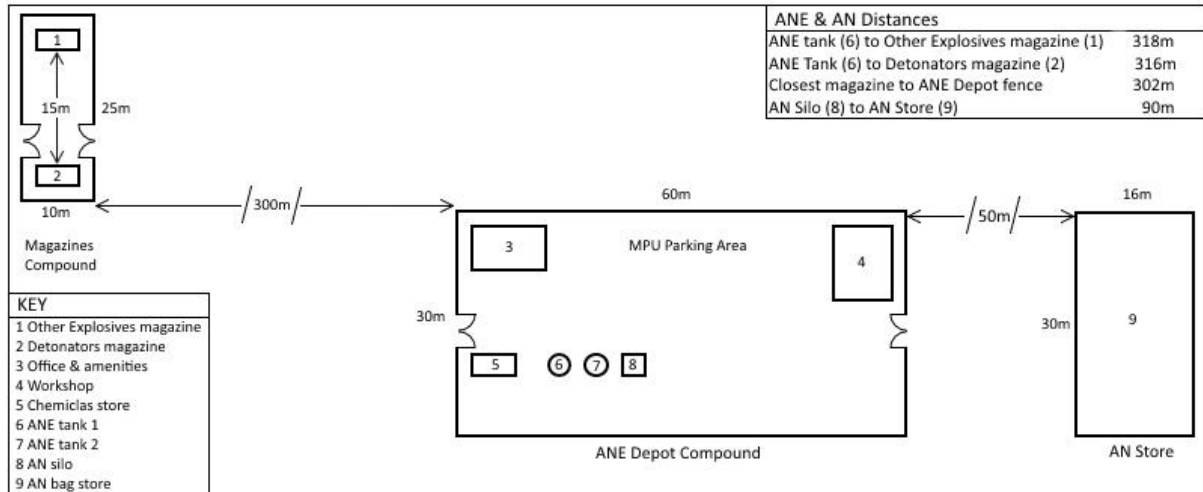


FIGURE C.4.1

The first ANE tank and the magazines (relocated) are in the same locations as for Example B. But the ANE depot now includes:

- two overhead ANE tanks of 40,000 kg capacity each, approximately 2 m apart;
- an overhead Ammonium Nitrate (AN) silo of 125,000 kg capacity, 2 m from the second ANE tank;
- an effects chemicals storage area holding up to 2000 kg of dry effects chemicals plus a 1000 litre storage tank;
- associated electrically driven materials handling equipment (pumps, augers, bucket elevators);
- parking locations for 4 MPUs;
- office and ablutions facilities (demountable buildings);
- a workshop shed for MPU maintenance plus shipping containers for storage of spare parts.

In addition there is now a 300 t AN Store (bag shed) located 50 m from the ANE depot fence.

4 MPUs will operate out of the depot. ANE will be replenished by tanker (40 t deliveries). Expected throughput is 5,000 t per annum. AN will be delivered in bags (40 t deliveries) and stored in the AN store. The overhead AN silo will be replenished by bags carried by forklift from the AN store to a hopper with an auger feeding a bucket elevator. Expected AN throughput is 5000 t per annum.

The supplier advises the ANE has a mass strength of 75% of TNT. The whole site is operated by the same organisation and is located on a mine site.

The depot has a maximum peak occupancy of 15 persons and is permanently occupied during day shift 6 days/week. The activity level is high (ref Table 6.2).

### C.4.2 Assessment

#### Step 1: Identify PES, categorised as No Warning and With Warning

There are 4 PES:

- high explosives magazine - potential No Warning explosion
- detonator magazine - potential No Warning explosion
- ANE tank 1 - potential With Warning explosion
- ANE tank 2 - potential With Warning explosion

#### Step 2: Determine the size of each potential explosion including knock-ons



PES	Adjust PES weight to TNT equivalent	Other storage within Table 6.1 knock-on distance?
High explosives magazine (No Warning)	10,000 kg at 100% = 10,000 kg TNT equivalent	Unmounded distance to prevent knock-on to other explosives for 10,000 kg is 105 m, therefore the detonator magazine 15 m away will aggregate, to give explosion size 10,010 kg. Unmounded distance to AN or ANE for a 10,010 kg explosion is 39 m. The closest ANE tank is 314 m away and the other ANE tank, the AN Silo and the AN store are farther, therefore none of these will aggregate.
Detonator magazine (No Warning)	10,000 dets at 1g = 10 kg TNT equivalent	AS 2187 requires a minimum unbounded separation of 10 m from other explosives to avoid aggregation. There is a 15 m separation in this case, therefore there will be no aggregation, and the explosion size is 10 kg.
ANE tank 1 (With Warning)	Supplier advises ANE mass strength = 75% of TNT. Therefore the adjusted NEQ for this PES is 40,000 * 0.75 = 30,000 kg	First iteration: Unmounded distance to ANE or AN for a 30,000 kg NEQ is 56m, therefore both ANE Tank 2 and the AN Silo will aggregate. ANE tank 2 NEQ is the same as tank 1 = 30,000 kg. The mass strength for sympathetically initiated AN is 32% (ref Sect 6) so the AN silo has NEQ 32% of 125,000 kg = 40,000 kg. The NEQ for ANE tanks 1 and 2 plus the AN silo is 30,000 + 30,000 + 40,000 = 100,000 kg. Second iteration: For a 100,000 kg explosion the (unmounded) distance to prevent knock on to explosives is 225 m. The magazines at 314 m and 316 m will therefore not aggregate. For a 100,000 kg explosion the (unmounded) distance to prevent knock on to ANE or AN is 84 m, therefore the AN store 90 m from the AN Silo will not aggregate. An explosion originating at ANE tank 1 will be with warning, and will knock-on to ANE tank 2 and the AN Silo, with a final aggregated NEQ of 100,000 kg.
ANE tank 2 (With Warning)	30,000 kg (as per ANE tank 1)	An explosion originating at ANE tank 2 will be with warning, and will knock-on to ANE tank 1 and the AN Silo, with a final aggregated NEQ of 100,000 kg. Although this explosion originates at the second ANE tank the eventual aggregated explosion is the same as for the first ANE tank.

Summary: there are 3 explosion scenarios:

1. 10,010 kg No Warning from High explosives magazine and detonator magazine aggregated
2. 10 kg No Warning from detonator magazine
3. 100,000 kg With Warning originating at ANE tank 1 or 2, involving both ANE tanks plus the AN silo

**Step 3: Identify the relevant exposed sites that could be affected by an explosion**

The area to be considered is the entire area within at least the "vulnerable facilities" distance for the biggest potential explosion. In this case the biggest potential explosion is 100,000 kg TNT equivalent. For this the Vulnerable Facilities distance (from Appendix B) is 2080 m.

Exposed sites within this distance are detailed in step 4 below.

**Step 4: Check whether separation distances and/or evacuation arrangements comply**

First, consider separation distances for the No Warning explosions. Only the 10,010 kg explosion originating at the High explosives magazine is significant - distances required for a 10 kg explosion at the detonator magazine will be much less and need not be considered independently. The table below shows the required distances for a 10,010 kg no warning explosion, and the actual distances, for each ES. In the table:

- All distances are in metres





- "Required" distances are taken from Table 6.3 and Appendix B
- "Actual" distances are as detailed in Figure C.4.1 or Table C.1. (The latter are measured from the centre of the magazine compound to the closest part of the relevant Exposed Site. Strictly speaking these should be measured from the edge of the closest magazine, but the difference is negligible.)

Type	Exposed Site	Distance from aggregated explosion		
		Required (App B)	Actual	Met?
ANE Associated Works: high activity level	ANE Depot	240 (ie 50% PWB = 480/2)	302 (to fence)	Y
Protected Works Class A	Public road	320	1047	Y
Protected Works Class B	Mine offices	480	621	Y
	Mine workshops		654	Y
	Mine process area with large quantities of dangerous goods		713	Y
	House 1		1070	Y
	House 2		618	Y
	House 3		831	Y
	Town (House 4)		1440	Y
Vulnerable Facilities	Old Age home in town	960	1675	Y

All Distances are met for the No Warning explosions.

Now consider the With Warning explosion - initially looking at separation distances without any reductions based on evacuation. Although ANE tanks 1 and 2 are separate PES's, both generate the same final aggregated explosion, therefore only that explosion needs to be assessed. The table below shows the required distances for a 100,000 kg With Warning explosion, and the actual distances, for each ES.

Type	Exposed Site	Distance from 100,000 kg Aggregated Explosion		
		Required (App B)	Actual*	Met?
ANE Associated Works	None	-	-	-
Protected Works Class A	Public road	690	790	Y
Protected Works Class B	Mine offices	1040	412	N
	Mine workshops		447	N
	Mine process area with large quantities of dangerous goods		548	N
	House 1		1095	Y
	House 2		517	N
	House 3		680	N
	Town (House 4)		1252	Y
Vulnerable Facilities	Old Age home in town	1040	1398	Y



(\*Strictly speaking the actual distances should be measured from the closest part of the aggregated explosion, but in this case the three inventories which aggregate are only a few metres apart, so the error introduced by using the measurements from the centre of ANE tank 1 are negligible.)

There are 5 locations where the required "full" distance is not met. For these we need to check whether the required distance may be reduced, and if so, under what conditions:

All of the unmet distances are for PWB ES's, for which the required separation from a With Warning PES is (table 6.3):

" PWB distance, but may be reduced if evacuation is credible to:

- if there is a mound, Process Buildings distance
- if there is no mound, 50% PWB.

The required separation may be further reduced (or eliminated, subject to note 1 below) if evacuation is credible AND the owner of the protected works and any occupiers, are involved in the relevant emergency response procedures/plans."

In this case it is believed that evacuation is credible, since three of the locations to be evacuated are part of the mine and managed within its security/headcount controls, and there are only two other single houses to be evacuated. There is no mound, so the requirement can be reduced to 50% of the PWB distance.

(Note that further reductions in required distance would be available either by installing a mound (which would allow reduction to Process Distance - 375 m in this case) or by involvement of the owners / occupiers of the relevant Exposed Site(s) in emergency response procedures. The latter, however, is not normally recommended for ES which are residential premises.)

We can now check the distances which were initially unmet to see whether they meet the reduced distance requirements:

ES	ES Type	Condition	Met?	New Required separation distance		Actual	Met ?
				Type	m		
Mine offices	PWB	Evacuation must be credible	Y	50% PWB	520	412	N
Mine workshops			Y			447	N
Mine process area with large quantities of dangerous goods			Y			548	Y
House 2			Y			517	N
House 3			Y			680	Y

So, even at the reduced separation distance allowed if evacuation is credible, there are still 3 exposed sites where further reduction is required. If we used mounds the required separation for the PWB ES's would reduce to the Process Buildings distance, which would be 375 m, and would be met for all of the ES's.

### C.4.3 Conclusion

We first need to note that the magazines part of the proposal must also be assessed separately under locally applicable regulations and standards for explosives (typically AS 2187).

Beyond that, in a situation like this some judgement is required. The proposal would be acceptable under this code if, in addition to a credible evacuation plan, mounds are installed to give additional protection to the Mine Offices, Mine Workshops, and House 2. But it would not be simple to provide mounds that protected three different ES from a PES which itself consists of three large inventories, which are very tall since they are all overhead tanks/silos.

Alternatively, the proposal would be acceptable without mounds if:

- there is a credible evacuation plan covering an area at least 1040m in all directions around the ANE tanks & AN Silo, AND



- the Mine company are involved in the relevant emergency response procedures/plan, AND
- the owner / occupiers of House 2 are involved in the relevant emergency response procedures/plan.

(Note that it would be possible to mix the two approaches and have a mound for some of the ES, and owner / occupier involvement in emergency response procedures for others.)

It may well be that the mine company has good access/headcount control and good evacuation arrangements in place, and this may be the basis for deciding that evacuation of their facilities is credible. But the mine company need to recognise that an evacuation will close down these facilities, even if it is triggered by a false alarm. They may decide that moving the ANE premises to a less demanding location is a better option.

Similarly it is preferable to adjust the layout if practicable, rather than ask residential occupants to be involved with emergency response procedures. However, in a case like this where the required reduction is extremely small (3m) an approach to the owners / occupiers may be justified, especially if the ANE Depot location is already at or near optimum. A mound could also be used for this ES, especially if the topography over the intervening distance is favourable.

### C.5 : Example D - Large Depot plus magazines plus ANFO manufacturing

#### C.5.1 The Proposal

This proposal is a further expansion of example C, as illustrated in Figure C.5.1.

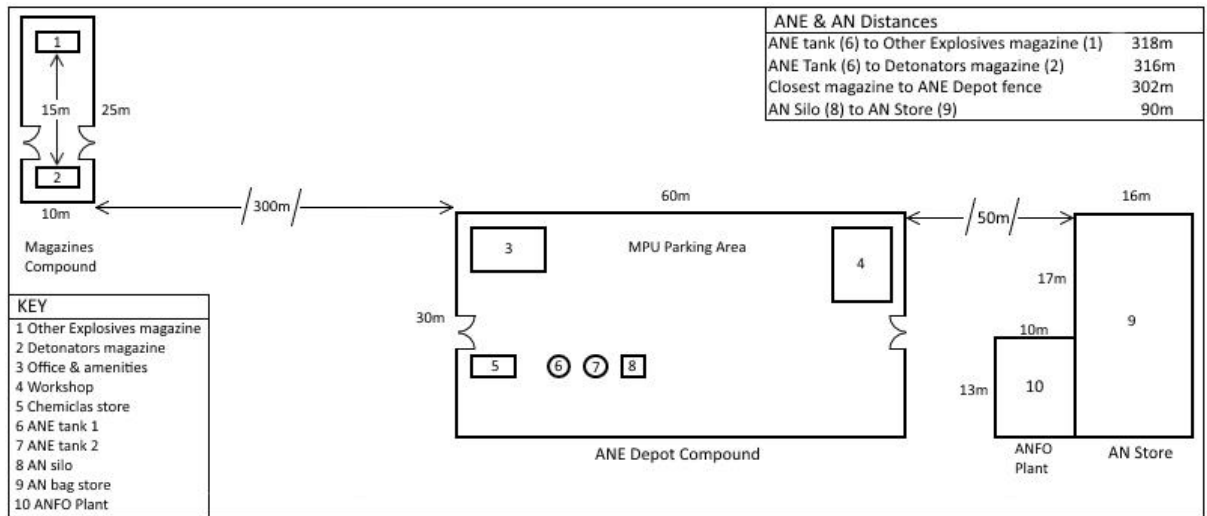


FIGURE C 5.1

In this example everything is identical to example C, except that an ANFO manufacturing operation has been added, in a building adjoining the AN shed as shown. The ANFO manufacturing building contains:

- A storage location for 5,000 kg of AN in bags
- A 1000 l process fuel tank
- ANFO manufacturing and bagging equipment
- A storage location for 5,000 kg of ANFO in bags on pallets
- Forklift access to the AN and ANFO storage areas

The proposed ANFO manufacturing operation will be an intermittent batch operation, using the same operators as the depot. The building inventory limits will be 5,000 kg each of AN and ANFO. It is intended that the building will be kept empty between batches. The composition of the ANFO will be 94% by weight AN plus 6% by weight process fuel (normally dyed diesel), so a 5,000 kg batch will require 4,700 kg of AN plus 300 kg of process fuel. At the start of a batch up to 5,000 kg of AN will be brought by forklift into the ANFO Plant. Most of this will be processed into the finished 5,000 kg of ANFO, which will be packaged into 25 kg bags on pallets, or into Flexible Intermediate Bulk Containers (FIBC's, also known as bulka bags). At the end of a batch the finished ANFO will be moved to the "High Explosives" magazine, or taken away from the site. Surplus AN will be returned to the AN Store.

#### C.5.2 Assessment

##### Step 1: Identify PES, categorised as No Warning and With Warning

In addition to the 4 PES identified in Example C we must now consider the ANFO plant. Since this will have explosives present during batch manufacture, it will be a no-warning PES, so in total we now have 5 PES:

- ANFO plant - potential No Warning explosion
- High explosives magazine - potential No Warning explosion
- detonator magazine - potential No Warning explosion
- ANE tank 1 - potential With Warning explosion
- ANE tank 2 - potential With Warning explosion

##### Step 2: Determine the size of each potential explosion including knock-ons



PES	Adjust PES weight to TNT equivalent	Other storage within Table 6.1 knock-on distance?
<p>ANFO Plant (No Warning)</p>	<p>Worst case is 5,000 kg finished ANFO. Take this as 100% TNT equivalence (this errs on the side of caution).</p>	<p>First iteration:</p> <p>Inside a small manufacturing building it is impractical to consider that inventories are reliably separated from each other, since there is a constant flow of materials through the manufacturing process. Therefore we need to assume that in any explosion all of the ANFO and all of the AN in the building will explode. Since the building limits are 5,000 kg of each we will take the worst case explosion as 5,000 kg ANFO @ 100% + 5,000 kg AN @ 50% = 7,500 kg TNT equivalent. (Under this Code (sect 6) the TNT Equivalence of sympathetically initiated AN would be 32%, but in this case we are dealing with AN in close proximity to explosives, so the 50% quoted in AS 2187 is more appropriate.)</p> <p>Second iteration:</p> <p>For a 7,500 kg explosion the unrounded distance to prevent knock-on to AN is 35 m (from Appendix B). Since the ANFO plant is adjoining the AN Store an explosion will knock on to all the AN in the store (up to 300 t). Once again we need to choose between the 32% and 50% equivalence. Because the explosives (ANFO) are in an adjoining building, we will again use the AS 2187 figure of 50%, giving a new total of 7,500 + 300,000 @ 50% = 157,500 kg TNT equivalent.</p> <p>Third iteration:</p> <p>For a 157,500 kg explosion the unrounded distance to prevent knock-on to AN or ANE is 97 m (from Appendix B - formula in table notes). The AN Silo in the depot is 90 m away therefore it (and the 2 adjacent ANE tanks) will also aggregate. Once again we need to choose between the 32% and 50% equivalence for AN. In this case, because the explosion is remote from the AN Silo we will use the 32% figure from this Code, so the AN silo has adjusted NEQ = 32% of 125,000 kg = 40,000 kg. The ANE supplier advises it has mass strength = 75% of TNT. Therefore the adjusted NEQ for each of the ANE tanks is 40,000 * 0.75 = 30,000 kg. The adjusted NEQ for ANE tanks 1 and 2 plus the AN silo is 30,000 + 30,000 + 40,000 = 100,000 kg, so the new aggregated total is 257,500kg.</p> <p>Fourth iteration:</p> <p>There is no more AN or ANE, but we need to consider whether the explosion would aggregate to either or both magazines, which are 316 m and 318 m away from the closest ANE tank. (Note that this is measured from the closest part of the aggregated explosion, rather than from the PES itself, which in this case is the ANFO plant.) For a 257,500 kg explosion the unrounded distance to prevent knock-on to explosives is 305 m (from Appendix B - formula in table notes). Therefore the magazines will not aggregate.</p> <p>Conclusion:</p> <p>An explosion originating at the ANFO plant will be a no-warning, and will knock-on to the AN Store, the AN silo and the 2 ANE Tanks, with a final aggregated adjusted NEQ of 257,500 kg.</p>



It is obvious by now that the proposed location of the ANFO plant is likely to be unacceptable, so rather than completing Step 2 for any of the other explosion scenarios, we will move on to steps 3 and 4 for the ANFO PES.

**Step 3: Identify the relevant exposed sites that could be affected by an explosion**

The area to be considered is the entire area within at least the "vulnerable facilities" distance for the biggest potential explosion. In this case we are considering a 257,500 kg explosion. For this the Vulnerable Facilities distance is 2825 m (from Appendix B, using the  $D = 44.4Q^{1/3}$  formula in the table notes).

Exposed sites within this distance are detailed in step 4 below.

**Step 4: Check whether separation distances and/or evacuation arrangements comply**

The table below shows the required distances for a 257,500 kg no warning explosion, and the actual distances, for each ES. In the table:

- All distances are in metres
- "Required" distances are taken from Table 6.3 and Appendix B (Distances shown are for 250,000 kg. We could calculate more accurate figures for a 257,500 kg explosion by using the formulas in the table notes, but the difference will be marginal.)
- "Actual" distances should be measured from the closest part of the aggregated explosion to the closest part of the relevant Exposed Site, but in this example, for simplicity, and because the result is unaffected, they are measured from the first ANE tank.

Type	Exposed Site	Distance from aggregated explosion		
		Required (App B)	Actual	Met?
ANE Associated Works - activity level High	ANE Depot	700 (ie 50% PWB = 1400/2)	0	N
Protected Works Class A	Public road	940	790	N
Protected Works Class B	Mine offices	1400	412	N
	Mine workshops		447	N
	Mine process area with large quantities of dangerous goods		548	N
	House 1		1095	N
	House 2		517	N
	House 3		680	N
	Town (House 4)		1252	N
Vulnerable Facilities	Old Age home in town	2800	1398	N

**The required distances are not met to ANY of the exposed sites from this large explosion. Because this is a No Warning explosion scenario there is no alternative mechanism or option to achieve compliance, so the proposal as it stands is a FAIL, and there is no need to continue the assessment.**

**C.5.3 Finding a suitable location**

If we want to find a suitable location for the proposed ANFO plant we could simply keep choosing locations then working through the assessment until, by trial and error, we find somewhere suitable. However a more efficient approach is to start by calculating all the distances that will be required, then plot these as "exclusion zones" on the site layout. Then the ANFO plant can be located anywhere that is not in an exclusion zone. But this approach will only work if we first decide that the ANFO plant will be far enough away from all other inventories that there will be no aggregation. So, on that basis, and with all other aspects of the ANFO plant unchanged, the requirements we have to consider are:

1. The risk to the ANFO plant if one of the other PES explodes



- The risk arising from a 7,500 kg (TNT equivalent) no-warning explosion at the ANFO plant

**C.5.3.1 Risk TO the ANFO plant if one of the other PES explodes:**

There are two requirements we need to consider - first the distance required because there are people working at the ANFO plant and second the distance to ensure there is no knock-on.

**Distance required because there are people working at the ANFO plant**

From Example C there are 3 other explosion scenarios:

- 10,010 kg No Warning from High explosives magazine and detonator magazine aggregated
- 10 kg No Warning from detonator magazine
- 100,000 kg With Warning originating at ANE tank 1 or tank 2, and involving both ANE tanks plus the AN silo

Scenario 3 is with-warning, so it should be feasible to rely on evacuation if the ANFO plant is manned. Scenario 2 (10 kg no-warning) will require smaller distances than scenario 1 (10,010 kg), therefore the constraining distance is that required for the 10,010 kg explosion.

The ANFO plant will be a process building, and, according to AS 2187, will need to be separated from the potential 10,010 kg magazine explosion by a distance of 175 m with a mound. If there is no mound the process building distance cannot be used and PWB would apply - ie 480 m.

**Distance to ensure there is no knock-on**

To prevent sympathetic initiation of any ANFO Plant inventory will require:

- From the 10,010 kg magazine PES: 52 m mounded or 105 m unounded.
- From a 100,000 kg explosion originating at either of the ANE tanks: 115 m mounded or 225 m unounded.

**Summary**

Minimum distance from closest magazine: 175 m mounded or 480 m unounded

Minimum distance from each ANE tank: 115 m mounded or 225 m unounded

**C.5.3.2 Risk FROM an explosion at the ANFO plant**

Worst case explosion at the ANFO plant is 7,500 kg (TNT equivalent) no-warning. For that size explosion the required separation distances are:

Separation requirements FROM 7,500 kg explosion at ANFO Plant (ref table 6.3 & App B)			
TO	Characteristics	Separation	
		Requirement	M
Explosives magazines	With mound	Explosives distance	47
	No Mound		94
AN and ANE inventories	With mound (Note 2 – Appendix B)	AN Storage distance	10
	No Mound		35
ANE Depot	High activity ANE Associated Works	50% PWB	217.5
Public Road	PWA	PWA	295
Office, houses	PWB	PWB	435
Old age home	Vulnerable Facilities	Vulnerable Facilities	870



**C.5.3.3 Most demanding distance requirement**

If we now consider the ANFO plant in relation to each other location, in both directions, we can identify the most demanding requirement:

Location	TO ANFO (m)	FROM ANFO (m)	Requirement (m)
Closest magazine	175 mounded or 480 unmounded	47 mounded or 94 unmounded	175 mounded or 480 unmounded
ANE tanks	115 mounded or 225 unmounded	10 mounded or 35 unmounded	115 mounded or 225 unmounded
ANE Associated Works (Depot)	na	217.5	217.5
Public Road	na	295	295
Office, houses	na	435	435
Old age home	na	870	870

We can now visually plot these distances as circles around the relevant locations, which will define all of the areas where the ANFO plant can NOT be positioned, and from that we can then identify a suitable location. See Figure C.5.2 below, which illustrates that location 9 would be acceptable, and is reasonably close to the ANE Depot and the magazines.

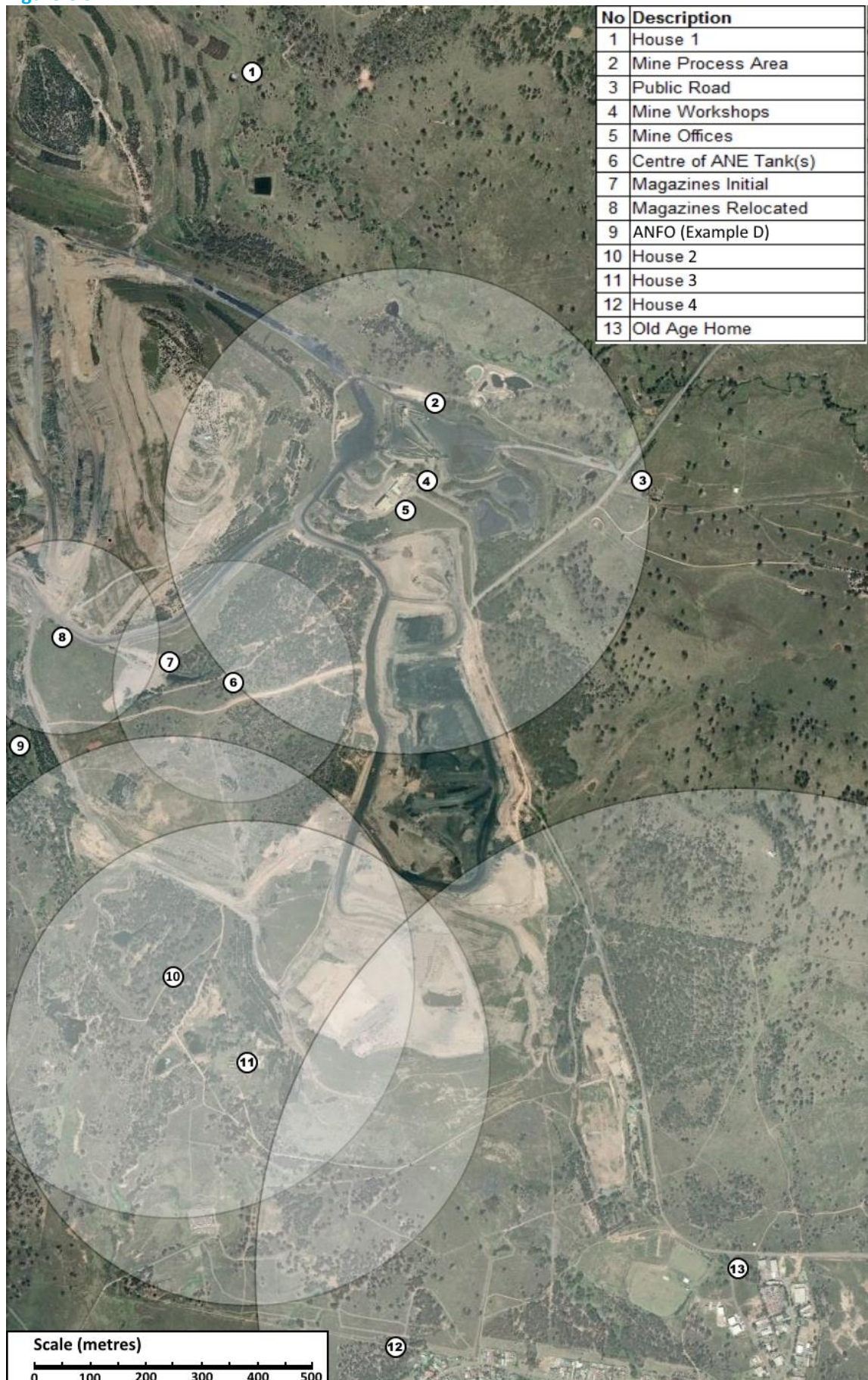
Note that for simplicity only the 175 m circle is plotted around the magazines - ie we are assuming there will be a mound. It is obvious that if this circle were increased from 175 m to 480 m radius location 9 would become unacceptable, and we would be forced to look elsewhere.

Also, only one circle is shown around the ANE depot (location 6). Strictly speaking there should be 5 circles - one of 225m radius centred on each ANE tank (the unmounded distance), plus one of 115m centred on each ANE tank (the mounded distance) plus one of 217.5m from the depot fence. But putting in a mound in order to use the smaller circles would make no difference to the overall required distance, since we would still need 217.5m from the depot fence, and this is practically the same as the 225m required from each of the ANE tanks - so we will simply use the 217.5m circle

Finally, circles are only shown around the locations relatively close to the depot & magazine, on the assumption that the ANFO plant should be as close as practicable to the magazines and ANE Depot. (eg there is no circle around House 1, or the public road, etc.)



Figure C.5.2





#### C.5.4 Conclusion

Location 9 is outside all of the circles and if the proposed ANFO plant is positioned there it will meet all applicable separation distances, provided there is a mound between it and the magazines. The rest of the assessment will be identical to Example C, which was an acceptable proposal.



## APPENDIX D: STANDARDS AND CODES REFERENCED

### Australian Standards

AS1768:2007	Lightning Protection
AS1939:1990	Degrees of protection provided by enclosures for electrical equipment (IP Code)
AS1940:2004	The storage and handling of flammable and combustible liquids
AS2187.0:1998	Explosives – Storage, transport and use – Terminology.
AS2187.1:1998	Explosives – Storage, transport and use – Storage.
AS4326:2008.	The storage and handling of oxidizing agents.
AS/NZS 4804:2001	Occupational health and safety management systems - General guidelines on principles, systems and supporting techniques
AS/NZS 60079 Series	Electrical apparatus for explosive gas atmospheres
AS/NZS 61241 Series	Electrical apparatus for use in the presence of combustible dust
HB167:2006	Standards Australia Handbook Security risk management
IEC 61508	Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems (E/E/PE, or E/E/PES)
IEC 61511	Functional safety - Safety instrumented systems for the process industry sector

### Codes

Safe Storage of Solid Ammonium Nitrate: Code of Practice; Resources Safety, WA Department of Mines & Petroleum

Storage Requirements for Security Sensitive Ammonium Nitrate (SSAN): IB53; Explosives Inspectorate, Queensland Department of Mines and Energy

Good Practice Guide GPG 02: Storage of Solid Technical Grade Ammonium Nitrate; SAFEX



## APPENDIX E: DESCRIPTION OF UN3375 SUBSTANCE

The following terms are copied from the ADG Code Seventh Edition 2007 (and are identical to the text in the UN RECOMMENDATIONS ON THE TRANSPORT OF DANGEROUS GOODS, 18th revised edition).

### Proper Shipping name:

AMMONIUM NITRATE EMULSION or SUSPENSION or GEL, intermediate for blasting explosives.

### Special provision 309:

This entry applies to non sensitized emulsions, suspensions and gels consisting primarily of a mixture of ammonium nitrate and fuel, intended to produce a Type E blasting explosive only after further processing prior to use.

The mixture for emulsions typically has the following composition: 60-85% ammonium nitrate; 5-30% water; 2-8% fuel; 0.5-4% emulsifier agent; 0-10% soluble flame suppressants and trace additives. Other inorganic nitrate salts may replace part of the ammonium nitrate.

The mixture for suspensions and gels typically has the following composition: 60 - 85% ammonium nitrate, 0-5% sodium or potassium perchlorate, 0-17% hexamine nitrate or monomethylamine nitrate, 5-30% water, 2-15% fuel, 0.5-4% thickening agent, 0-10% soluble flame suppressants, and trace additives. Other inorganic nitrate salts may replace part of the ammonium nitrate.

Substances must satisfactorily pass Test Series 8 (a), (b) and (c) of the Manual of Tests and Criteria, Part I, Section 18 and be approved by the competent authority.



## APPENDIX F: GLOSSARY OF TERMS AND ABBREVIATIONS

ADG Code	Australian Code for the Transport of Dangerous Goods by Road & Rail
AEISG	Australian Explosives Industry and Safety Group
AN	Ammonium Nitrate
AS	Australian Standard
COAG	Council of Australian Governments
ERP	Emergency Response Plan
ES	Exposed Site
LPG	Liquid Petroleum Gas
MHF	Major Hazards Facility
MPU	Mobile Processing Unit
MSER	Manufacture and Storage of Explosives Regulations
SDS	Safety Data Sheet
NEQ	Net Explosive Quantity
NPSH	Net Positive Suction Head
PES	Potential Explosion Site
PMV	Politically Motivated Violence
PPE	Personal Protective Equipment
PWA	Protected Works Class A
PWB	Protected Works Class B
QD	Quantity Distance
SMP	Safety Management Plan
SMS	Safety Management System
SOP	Standard Operating Procedure
SSAN	Security Sensitive Ammonium Nitrate
TNT	Tri-Nitro Toluene
UN	United Nations
UK	United Kingdom



## APPENDIX G: RISK ASSESSMENT CONSIDERATIONS

ANE storage and transport risks to be considered in risk assessment.

Following is non-exhaustive list of risks to be considered.

Refer to AS4360 Appendix D Sources of risk and impact as example.

### TRANSPORT

1. Vehicle fire carrying ANE and subsequent generation of large volumes of smoke and fume.
  - a. Consider locations in proximity to infrastructure
  - b. Consider consequence of subsequent explosion
2. Other vehicle fire in proximity to ANE storage.
3. Vehicle accident with consequential loss of ANE containment.
4. Puncturing of ANE bulk transfer units during transfer operations.
5. Loss of containment of gasser solution
6. Waste contamination with other substances.

### STORAGE

1. Interaction with mobile plant
2. Unplanned mixing with gasser solution
3. Product security – unauthorised access, unexplained loss
4. Product aging
5. Ignition source in proximity to ANE store
6. Fire in ANE store
7. Explosion in ANE store

### TRANSFER

1. Pumping Errors
  - a. Reverse flow
  - b. Incorrect flow
  - c. No flow
  - d. Spillage
2. Gasser solution spills and loss of containment
3. Pump and hose failures
4. Unauthorised personnel
5. Pump maintenance

### UNDERGROUND

Consequences of Vehicle fire or other incidents on refuge chambers and critical mine infrastructure

## APPENDIX H: COMPLIANCE CHECKLIST

<b>Company Name:</b>	
Location of Proposed/Existing Storage or Handling Facility:	

### Details of Proposed/Existing Storage of Ammonium Nitrate Emulsions, Suspension or Gels

Class/ Division	UN No	Name of Dangerous Good	Quantity(kL)	Description of Storage (Package)	ID Number(if applicable)

### Compliance Details:

SECTION 3 SAFETY AND SECURITY MANAGEMENT SYSTEM	Relevant Requirements	Describe what is proposed/actual to demonstrate compliance	Complies (Y/N/NA)
3.1 SAFETY POLICY			
3.2 SAFETY AND SECURITY MANAGEMENT PLAN (SSMP)			
3.3 TRAINING			
3.4 PROCEDURES			
3.5 EMERGENCY RESPONSE PLAN (ERP)			
3.6 OTHER			

<b>SECTION 4 LICENSING AND REGULATORY REQUIREMENTS</b>	<b>Relevant Requirements</b>	<b>Describe what is proposed/actual to demonstrate compliance</b>	<b>Complies (Y/N/NA)</b>
LICENSING AND REGULATORY REQUIREMENTS			

<b>SECTION 5 ANE PREMISES DESIGN, LAYOUT AND MATERIALS OF CONSTRUCTION</b>	<b>Relevant Requirements</b>	<b>Describe what is proposed/actual to demonstrate compliance</b>	<b>Complies (Y/N/NA)</b>
5.1 GENERAL			
5.2 FIRE			
5.3 LAYOUT			
5.4 DESIGN OF ANE TANKS			
5.5 ELECTRICAL/ POWER			
5.6 LIGHTNING			
5.7 GOOD/BEST PRACTICES			

<b>SECTION 6 REQUIREMENTS FOR THE LOCATION OF ANE PREMISES</b>	<b>Relevant Requirements</b>	<b>Describe what is proposed/actual to demonstrate compliance</b>	<b>Complies (Y/N/NA)</b>
6.1 STEPS IN DETERMINING ACCEPTABLE SITE LOCATIONS			
6.1.1 POTENTIAL EXPLOSION SITES (PES)			
6.1.2 SIZE OF EACH POTENTIAL EXPLOSION			
6.1.3 EXPOSED SITES			
6.1.4 REQUIRED MINIMUM DISTANCES			



<b>SECTION 7 RISK ASSESSMENT</b>	<b>Relevant Requirements</b>	<b>Describe what is proposed/actual to demonstrate compliance</b>	<b>Complies (Y/N/NA)</b>
7.1 SITE			
7.2 PLANT			
7.3 OPERATIONAL REQUIREMENTS			
7.4 ADDITIONAL ISSUES FOR UNDERGROUND STORAGE, TRANSPORT OR USE OF ANES			

<b>SECTION 8 ANE PUMPS &amp; HOSES</b>	<b>Relevant Requirements</b>	<b>Describe what is proposed/actual to demonstrate compliance</b>	<b>Complies (Y/N/NA)</b>
8.1 PUMP HAZARDS			
8.2 PUMP SELECTION			
8.3 GENERAL REQUIREMENTS			
8.4 PUMP PROTECTIVE SYSTEMS			
8.4.1. GENERAL			
8.4.2. PUMP PROTECTIVE ELEMENTS			
8.5 PUMP OPERATION			
8.6 PUMP MANAGEMENT SYSTEM			
8.7 PUMP SIGNIFICANT INCIDENTS			
8.8 HOSE ASSEMBLIES			

SECTION 9 ANE UNDERGROUND	Relevant Requirements	Describe what is proposed/actual to demonstrate compliance	Complies (Y/N/NA)
9.2 SAFETY & SECURITY MANAGEMENT SYSTEM			
9.3 REQUIREMENTS FOR UG ANE STORAGE FACILITIES			
9.3.1 ANE STORAGE IN THE CLASS 1.1D MAGAZINE			
9.3.2 REQUIREMENTS FOR ANE STORAGES:			
DETERMINATION OF APPROPRIATE STORAGE AMOUNTS.			
DETERMINATION OF ANE STORAGE LOCATION.			
REQUIREMENTS FOR INFRASTRUCTURE FOR ANE STORAGES.			
ACCESS			
UNPLANNED MOVEMENT			
SECURITY			
DRAINAGE			
SPILL RECOVERY			
GROUND CONDITIONS			
FIRE FIGHTING EQUIPMENT			
ADDITIONAL SAFETY EQUIPMENT			
SIGNAGE AND NOTIFICATION			

SECTION 9 ANE UNDERGROUND	Relevant Requirements	Describe what is proposed/actual to demonstrate compliance	Complies (Y/N/NA)
DOCUMENTATION			
LIGHTING			
VENTILATION			
TEMPORARY ANE STORES			
GASSER SOLUTION STORAGE IN TEMPORARY ANE STORES:			
PARKING OF UNATTENDED MPU			
9.4 OPERATION OF UNDERGROUND ANE STORAGE FACILITIES			
9.4.1 PROCEDURE: SECURITY / ACCESS CONTROL			
9.4.2 PROCEDURE: ANE TRANSFER BY BULK CONTAINER EXCHANGE			
9.4.3 PROCEDURE: ANE TRANSFER BY PUMPING			
9.4.4 PROCEDURE: ANE TRANSPORT WITHIN THE UNDERGROUND OPERATION			
9.4.5 PROCEDURE: ANE EMERGENCY RESPONSE			
EMERGENCY SCENARIOS			
9.4.6 PROCEDURE: STOCK CONTROL			

<b>SECTION 9 ANE UNDERGROUND</b>	<b>Relevant Requirements</b>	<b>Describe what is proposed/actual to demonstrate compliance</b>	<b>Complies (Y/N/NA)</b>
9.4.7 WASTE MANAGEMENT PROCEDURE			
9.5 AUDITING.			

<b>SECTION 10 PERSONNEL</b>	<b>Relevant Requirements</b>	<b>Describe what is proposed/actual to demonstrate compliance</b>	<b>Complies (Y/N/NA)</b>
10.1 FRAMEWORK: POSITION DESCRIPTIONS FOR RELEVANT ROLES			
10.2 SPECIFIC ON-SITE TRAINING REQUIREMENTS			
10.3 DRIVERS (INCLUDING CONTRACTOR DRIVERS)			
10.4 RECOMMENDED TRAINING FOR UNDERGROUND SITUATIONS			

<b>SECTION 11 SECURITY REQUIREMENTS</b>	<b>Relevant Requirements</b>	<b>Describe what is proposed/actual to demonstrate compliance</b>	<b>Complies (Y/N/NA)</b>
SECURITY REQUIREMENTS			

<b>SECTION 12 WASTE MANAGEMENT AND ENVIRONMENTAL CONTROLS</b>	<b>Relevant Requirements</b>	<b>Describe what is proposed/actual to demonstrate compliance</b>	<b>Complies (Y/N/NA)</b>
12.1 GENERAL			
12.2 STORAGE OF WASTE			
12.3 CALIBRATION			

12.4 RECYCLING			
12.5 ENVIRONMENTAL DISCHARGES			
12.6 DISPOSAL			

<b>SECTION 13 TRANSPORT</b>	<b>Relevant Requirements</b>	<b>Describe what is proposed/actual to demonstrate compliance</b>	<b>Complies (Y/N/NA)</b>
13.1 GENERAL			
13.2 EMERGENCIES			
13.3 TRANSPORT ROUTES			

**Areas of Non-conformance and Action Plan**

Non Conformance Number	Section Number	Action Plan	Action by	Due Date	Completion Date	Comments

**Compliance check summary**

This **proposed / existing** - storage of (describe storage) - complies/does not comply with the AEISG Code of Practice - Ammonium Nitrate Emulsions, Suspensions or Gels.

Name of assessor/s ..... Date .....

Signature/s ..... Date of next review .....

## APPENDIX I: ASSESSMENT TEMPLATE

### ASSESSMENT TEMPLATE FOR SURFACE ANE, AN AND EXPLOSIVES STORAGES

#### Site Details

Company Name:	
Location/Site Address:	
Description of Proposed Storage:	
Licence Number (If Known):	
Name of Assessor:	Date:

#### **STEP 1: Identify and categorise all Potential Explosion Sites (PES)**

List all PES on site:

\_\_\_\_\_

Categorise into 'No Warning' and 'With Warning' sites.

'No Warning': \_\_\_\_\_

'With Warning': \_\_\_\_\_

**STEP 2: Calculate size of each PES (including possible knock-on effects)**

**'No Warning' explosion site(s)**

Possible knock-on to other storages	Required Separation (m)	Actual Separation (m)	Result *
HE to other HE			
HE to Detonators			
HE to ANE			
HE to AN			
HE to any other contributing storage			
HE to any other contributing storage			

\* Where result is to aggregate (because of insufficient separation distances), need to repeat process using the new aggregated amount.

Possible knock-on to other storages	Required Separation (m)	Actual Separation (m)	Result *
HE to other HE			
HE to Detonators			
HE to ANE			
HE to AN			
HE to any other contributing storage			
HE to any other contributing storage			

\* Where result is to aggregate (because of insufficient separation distances), need to repeat process using the new aggregated amount.

Resultant HE (PES): \_\_\_\_\_

**'With Warning' explosion site(s)**

For ANE storages need to calculate the adjusted TNT equivalent weight strength.

Weight (of ANE) x TNT equivalent weight strength: \_\_\_\_\_

Possible knock-on to other storages	Required Separation (m)	Actual Separation (m)	Result *
ANE to other ANE			
ANE to HE			
ANE to AN			
ANE to any other contributing storage			
ANE to any other contributing storage			

\* Where result is to aggregate (because of insufficient separation distances), need to repeat process using the new aggregated amount.

Possible knock-on to other storages	Required Separation (m)	Actual Separation (m)	Result *
ANE to other ANE			
ANE to HE			
ANE to AN			
ANE to any other contributing storage			
ANE to any other contributing storage			

\* Where result is to aggregate (because of insufficient separation distances), need to repeat process using the new aggregated amount.

Resultant ANE (PES): \_\_\_\_\_



**STEP 3: Identify Exposed Sites (ES) (where people are present)**

Categorise exposed sites within vulnerable separation distances (generally of largest PES)

Type of Protected Works	Details	Closest PW to PES	Distance to PES (m)
ANE associated works (AW)			
Class A P.W. (PWA)			
Class B P.W. (PWB)			
Vulnerable Facility (VF)			

Categorise ANE associated works according to activity level (and number of people).

- Depot Details \_\_\_\_\_
- Activity Level \_\_\_\_\_

**STEP 4: Check Separation Distance for each PES to ES Combination**

PES to ES Combination	Required Separation (m)	Actual Separation (m)	Result #
HE to ANE associated works			
HE to closest PWA			
HE to closest PWB			
HE to closest VF			
ANE (largest) to HE A.W.			
ANE to closest PWA			
ANE to closest PWB			
ANE to closest VF			
ANE to any other ES			

# A **FAIL** for a 'HE to ES' combination means storage does not comply.

For an ANE PES to ES combination, where evacuation is possible and credible, storage may still be acceptable.

**STEP 5: Conclusion and determination**

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Name of Assessor/s: \_\_\_\_\_

Date: \_\_\_\_\_

Signature/s: \_\_\_\_\_

Dangerous Goods Consultant Approval No: \_\_\_\_\_  
\_\_\_\_\_

Contact No:

Email Address: \_\_\_\_\_



The Australian Explosives Industry and Safety Group (AEISG) is an incorporated association of Australasian explosives manufacturers and suppliers originally formed in 1994. Since then, the AEISG membership has grown and currently includes:

- Applied Explosives Technology Pty Ltd
- Davey Bickford Australia Pty Ltd
- Downer EDI Mining – Blasting Services Pty Ltd
- Dyno Nobel Asia Pacific Pty Limited
- Johnex Explosives
- Maxam Explosives (Australia) Pty Ltd
- Nitro Sibir Australia Pty Ltd
- Orica Australia Limited
- Platinum Blasting Services
- Redbull Powder Company Ltd
- Thales Australia

The goal of AEISG is to continuously improve the level of safety and security throughout our industry in the manufacture, transport, storage, handling and use of explosives and related materials throughout Australasia.

One of the strategies adopted by AEISG in this regard is to identify areas where improved standards of operation need to be consistently applied and then develop and issue appropriate codes of practice which capture industry best practice in these areas.

AEISG Codes of Practice are adopted by members for the benefit of their employees, their customers and the general community. They are also made available free of charge on the AEISG website, [www.aeiscg.org.au](http://www.aeiscg.org.au), for use by any interested parties.

Contact Details: [info@aeiscg.org.au](mailto:info@aeiscg.org.au)

