11. Quantified Risk: Individual Risk

Individual risk has been calculated based on the consequence analysis and frequency analysis conducted using the methodology required by the NSW Department of Planning and Infrastructure. This included the adoption of the SAFEX frequencies, modified to account for the proposed safety controls and practices at the site. As discussed previously, it is believed that this approach is highly over-conservative and, as a result, the risk levels calculated in the following sections represent a significant over-estimation.

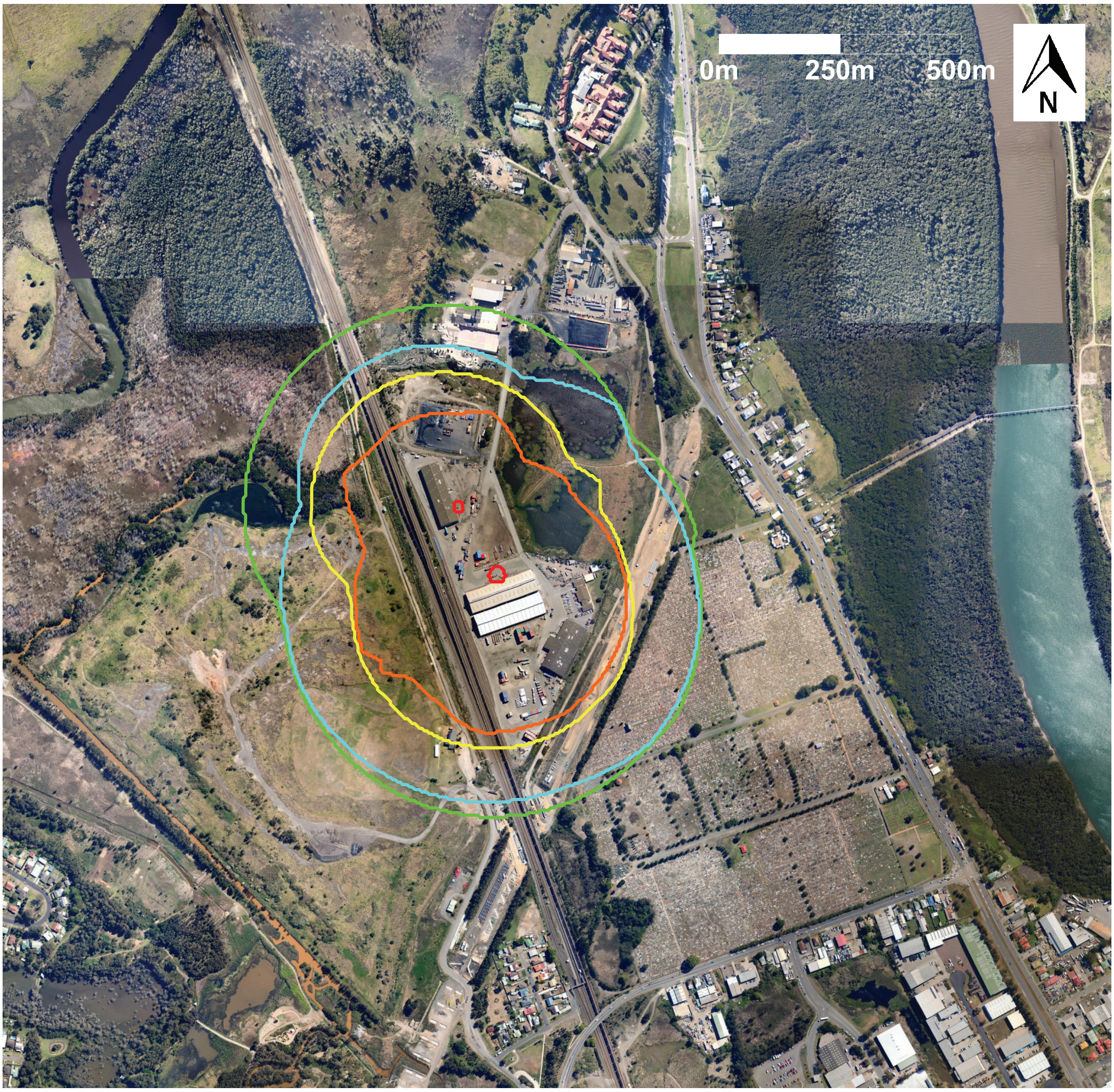
11.1 Individual fatality risk

Based on the consequence analysis and frequency analysis conducted, the individual fatality risk has been calculated with Individual Fatality Risk Contours presented in Figure 4 on the following page.

In analysing these risk contours the following comments are made in relation to the individual fatality risk criteria presented in HIPAP 4[30] :

- The individual fatality risk level contour for industrial sites is contained within the boundaries of the site and is localised to those areas where auger / conveyor operation and truck loading and unloading activities are conducted (North of Shed A and East of Shed C).
- The individual fatality risk level contour for sporting complexes and active open space areas extends over the Golf Driving Range to the west of the site. This contour is dominated by incidents involving storage operations in Shed A, Shed B and Shed C. The maximum risk level in areas used by the Gold Driving Range is 20×10^{-6} year, while the maximum risk at the property boundary is 30×10^{-6} per year. Refer to Figure 5.
- The individual fatality risk level contour at a level of five in a million per year (5×10^{-6} per year) does not extend to the nearest commercial development.
- The individual fatality risk level contour at a level of one in a million per year (1×10^{-6} per year) does not extend to the nearest residence.
- The individual fatality risk level contour at a level of half in one million per year (0.5×10^{-6} per year) does not extend to the nearest sensitive land use.

Figure 4: Individual Fatality Risk Contours



Green	0.5×10^{-6}
Blue	1×10^{-6}
Yellow	5×10^{-6}
Orange	10×10^{-6}
Red	50×10^{-6}

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Hazard Analysis (Rev 4)

12 December 2012

Crawfords Freightlines Pty Ltd
Lot 12 Old Maitland Road, Sandgate NSW

prepared by
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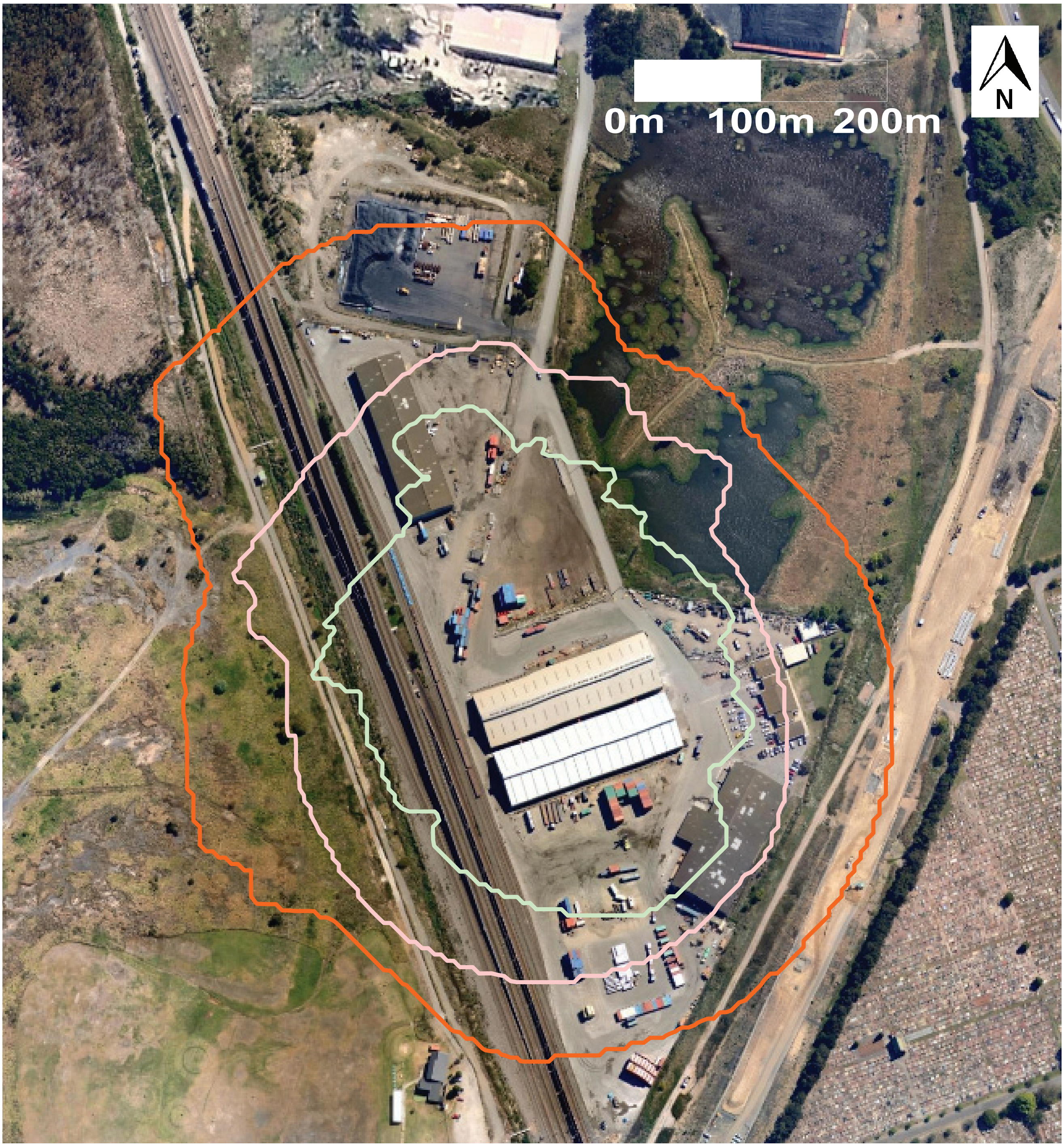
Individual Fatality Risk Contours

Figure 5: Individual Fatality Risk Contours - Golf Driving Range



(orange)	10×10^{-6}
(pink)	20×10^{-6}
(green)	30×10^{-6}

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Individual Fatality Risk Contours
GOLF DRIVING RANGE

11.2 *Injury risk*

11.2.1 Explosion overpressure

Based on the consequence analysis and frequency analysis conducted, the individual risk of injury due to explosion overpressure at a level of 7kPa has been calculated. The relevant Explosion Overpressure Risk Contour (50 x 10^{-6}) is presented in Figure 6.

The calculated risk contour shows that the following individual fatality risk criterion presented in HIPAP 4[30] is met:

- Incident explosion overpressure at residential and sensitive use areas should not exceed 7 kPa at frequencies of more than 50 chances in a million per year.

11.2.2 Toxic exposure criteria

Based on the results of the consequence modelling, the following conclusions can be made regarding the risk of injury due to the sustained release of ammonium nitrate decomposition products:

- There is no risk of injury due to the sustained release of ammonium nitrate decomposition products.
- This is a risk of irritation from nitrogen dioxide (NO_2) due to the sustained release of ammonium nitrate decomposition products from incidents in storage (Incident Reference 4) and on vehicles (Incident Reference 5).

Based on the consequence analysis and frequency analysis conducted, the individual risk of irritation due to toxic concentrations exceeding AEGL-1 (0.5ppm) of nitrogen dioxide (NO_2) has been calculated. The relevant Explosion Overpressure Risk Contour (50 x 10^{-6}) is presented in Figure 7. Concentrations above 0.5ppm only occur during high windspeed conditions. The weather data analysis, page 42, shows that for the high windspeed category of D12 more than 75% occur when the wind is blowing from the west and north-west. This explains the dominance of this contour to the east / south-east of the site.

Therefore, the following risk criteria presented in HIPAP 4[30] are met:

- Toxic concentrations in residential and sensitive use areas should not exceed a level which would be seriously injurious to sensitive members of the community following a relatively short period of exposure at a maximum frequency of 10 in a million per year.
- Toxic concentrations in residential and sensitive use areas should not cause irritation to eyes or throat, coughing or other acute physiological responses in sensitive members of the community over a maximum frequency of 50 in a million per year.

Figure 6: Explosion Overpressure Risk Contours (7 kPa)

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50 x 10^{-6}

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Overpressure Risk Contour 7 kPa (injury)

Figure 7: Toxic Gas Risk Contours (Irritation)

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50 x 10^{-6}

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Toxic Gas Risk Contour
Nitrogen Dioxide 0.5ppm (irritation)

11.3 Risk of property damage and accident propagation

Based on the consequence analysis and frequency analysis conducted, the risk of property damage and accident propagation due to explosion overpressure at a level of 14kPa has been calculated. The relevant Explosion Overpressure Risk Contour (50×10^{-6}) is presented in Figure 8 on the following page.

The calculated risk contour shows that the following individual fatality risk criteria presented in HIPAP 4[30] are met:

- Incident explosion overpressure at neighbouring potentially hazardous installations, at land zoned to accommodate such installations or at nearest public buildings should not exceed a risk of 50 in a million per year for the 14 kPa explosion overpressure level.

Figure 8: Explosion Overpressure Risk Contours (14 kPa)

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Overpressure Risk Contour 14 kPa (accident propagation)

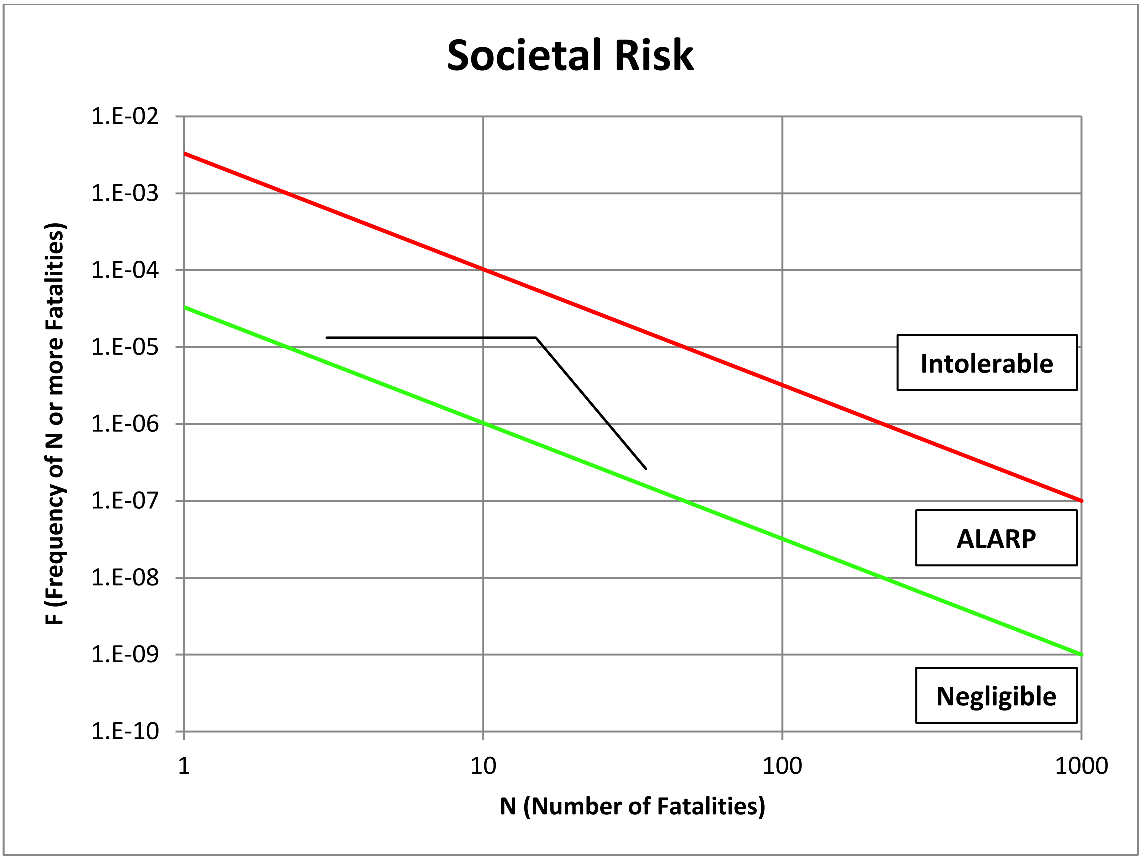
12. QUANTIFIED RISK: SOCIETAL RISK

The concept of Societal Risk is used when there is a risk of multiple fatalities occurring in one event. Societal Risk criteria are presented as FN-curves, obtained by plotting the frequency (F) at which such events result in the fatality of N or more people, against N.

Societal risk has been calculated based on the consequence analysis and frequency analysis conducted using the methodology required by the NSW Department of Planning and Infrastructure. This included the adoption of the SAFEX frequencies, modified to account for the proposed safety controls and practices at the site. As discussed previously, it is believed that this approach is highly over-conservative and, as a result, it is believed that the risk levels calculated for Societal Risk represent a significant over-estimation.

The following chart shows the level of Societal Risk compared with the indicative societal risk criteria set by NSW Department of Planning in HIPAP 4.[30]

Figure 9: Societal Risk



In analysing this graph the following comments are made:

- Above the intolerable level, an activity is considered undesirable, even if individual risk criteria are met. For this site, no incidents result in any point being located in the Intolerable region.
- Within the Negligible region, societal risk is not considered significant.
- Within the ALARP region, the emphasis is on reducing risks as far as possible towards the negligible line. Provided all other qualitative and quantitative criteria are met, Societal Risk is considered tolerable if within the ALARP region.

  For this site, quantitative risk criteria have been considered in the preceding sections and qualitative principles are considered in ***Section 14 Qualitative Risk Criteria*** (page 59). Controls have been implemented to reduce risk as far as reasonably practicable, as presented in ***Section 15 Achieving ALARP*** (page 61).

  Therefore, it is the considered that the risk is tolerable.

13. ENVIRONMENTAL RISK

In the case of impacts on the biophysical environment, the concern is generally related to whole systems or populations, rather than individual plants or animals.

The major environmental concern associated with the storage and handling of ammonium nitrate is in relation to increased levels of nitrogen. This may occur when spills of ammonium nitrate are washed into nearby waterways or underground water tables during rain events.

Ammonium nitrate has traditionally been used as a fertiliser, and any releases of ammonium nitrate into the environment may result in increased growth rates of vegetation, including increased algae growth in waterways. Excessive levels of nitrogen may kill vegetation, and excessive growth of algae in waterways can lead to eutrophication resulting in decreased oxygen levels and death of fish and other organisms.

To the east of the site is the south channel of the Hunter River; to the north through to the west of the site is Ironbark Creek; to the south-west of the site is the Shortland Wetlands Area incorporating the Hunter Wetlands Centre.

Reference should be made to the remainder of the Environmental Impact Statement for details of the potential environmental risks of the operation.

Based on this assessment, it is believed the following risk criteria set for the biophysical environment by the NSW Department of Planning in HIPAP 4[30] will be met:

- Industrial developments should not be sited in proximity to sensitive natural environmental areas where the effects (consequences) of the more likely accidental emissions may threaten the long-term viability of the ecosystem or any species within it.
- Industrial developments should not be sited in proximity to sensitive natural environmental areas where the likelihood (probability) of impacts that may threaten the long-term viability of the ecosystem or any species within it is not substantially lower than the background level of threat to the ecosystem.

14. QUALITATIVE RISK CRITERIA

Risk Criteria for Land Use Safety Planning – Hazardous Industry Planning Advisory Paper No. 4, New South Wales Department of Planning, 2011[30] proposes a set of qualitative principles for considering the acceptability of risks in relation to surrounding land uses. The application of these principles to the Crawfords site is discussed in the following sections.

14.1 Avoidable risks should be avoided

HIPAP 4 states:

> All 'avoidable' risks should be avoided. This necessitates the investigation of alternative locations and alternative technologies, wherever applicable, to ensure that risks are not introduced in an area where feasible alternatives are possible and justified.

Storage and handling of ammonium nitrate presents inherent hazards due to the chemical nature and physical properties of the product. The only way to avoid these risks is not to store or handle ammonium nitrate. However, as the supply of ammonium nitrate is a fundamental requirement for the ongoing feasibility of mining in the Hunter Valley (and other areas), it is not possible to avoid the storage and handling of ammonium nitrate. As it is, ammonium nitrate is used because of its inherent safety as opposed to older more traditional explosives, ie alternative technologies present a higher level of risk.

The current location of the site is ideal for the operations undertaken:

- It is in close proximity to both the Port of Newcastle and the Port of Sydney – the two sources of imported ammonium nitrate.
- It is on the rail line from Sydney and provided with a dedicated rail siding for off-loading of product.
- It is in close proximity to the Hunter Valley mining area, where the bulk of the ammonium nitrate is used.

Any alternative location would need to have similar characteristics, and therefore would likely have similar surrounding land uses, and achieve no significant reduction in risk.

14.2 Reduce risk wherever practicable

HIPAP 4 states:

> The risk from a major hazard should be reduced wherever practicable......In all cases, if the consequences (effects) of an identified hazardous incident are significant to people and the environment, then all feasible measures (including alternative locations) should be adopted so that the likelihood of such an incident occurring is made very low......

The consequences of the potential incidents identified in this hazard analysis are significant. Therefore, this principle requires that all feasible measures (including alternative locations) should be considered to reduce the likelihood of these incidents to a very low level. As discussed previously, the current location of the site is ideal for the operations undertaken, and any alternative locations having these characteristics are likely to be located in similar industrial areas within the Newcastle region, with similar levels of risk.

All feasible measures are taken at the site to reduce the likelihood of any incident occurring. These controls are discussed in ***Section 15 Achieving ALARP*** (page 61).

14.3 Consequences contained within installation boundaries

HIPAP 4 states:

> The consequences (effects) of the more likely hazardous events (ie those of high probability of occurrence) should wherever possible, be contained within the boundaries of the installation.

The likelihood of occurrence of all potential accidents identified in this hazard analysis is considered to be low. The more likely hazardous events (ie incidents involving ammonium nitrate on vehicles or in conveyors) have limited impact beyond the site boundaries.

14.4 Do not allow additional high risk developments

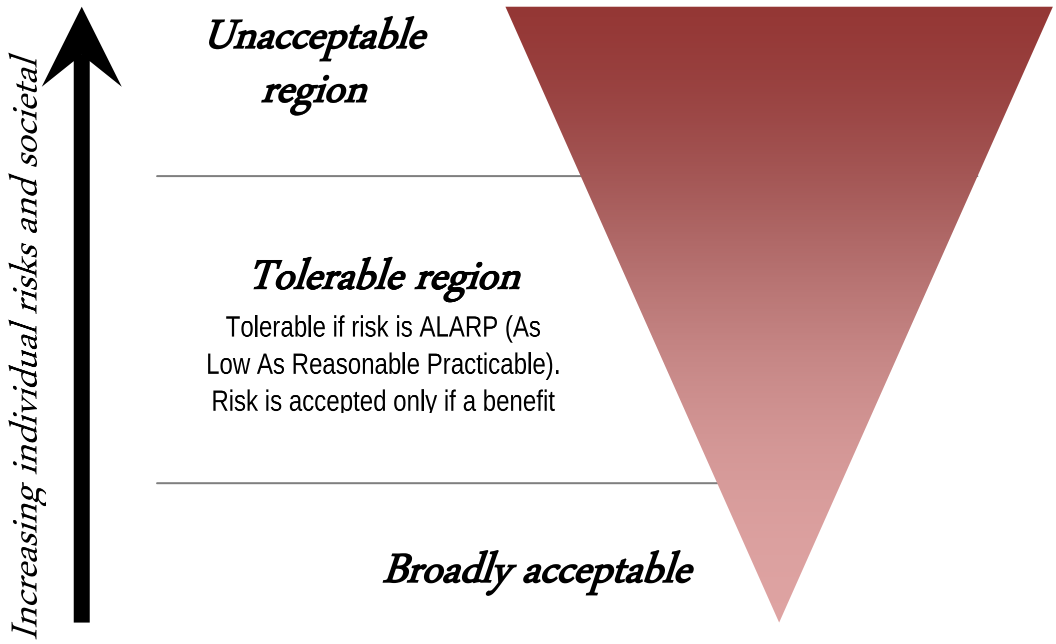
HIPAP 4 states:

> Where there is an existing high risk from a hazardous installation, additional hazardous developments should not be allowed if they add significantly to that existing risk.

Storage and distribution of ammonium nitrate has been undertaken at this site for many years, and prior to Crawfords occupying the site. The site has been licensed by WorkCover for this period. There are no other hazardous industries in the immediate vicinity.

15. ACHIEVING ALARP

The use of terms such as 'as low as reasonably practicable' (ALARP) or 'so far as is reasonably practicable' is a key concept in relation to the management of health and safety risks. The UK Health and Safety Executive provide guidance on "acceptable risk" in their publication *Reducing Risk, Protecting People: HSE's decision making process* (2001).[31] Their basic framework for assessing the tolerability of risk is described by the following diagram.



In New South Wales, the new *Work Health & Safety Act 2011* provides the following definition:

> *Reasonably practicable* means that which is, or was at a particular time, reasonably able to be done to ensure health and safety, taking into account and weighing up all relevant matters including:
>
> - The likelihood of the hazard or the risk concerned occurring.
> - The degree of harm that might result from the hazard or the risk.
> - What the person concerned knows, or ought reasonably to know, about the hazard or risk, and ways of eliminating or minimising the risk.
> - The availability and suitability of ways to eliminate or minimise the risk.
> - After assessing the extent of the risk and the available ways of eliminating or minimising the risk, the cost associated with available ways of eliminating or minimising the risk, including whether the cost is grossly disproportionate to the risk.

Interpretative guidelines released by Safe Work Australia for the *Model Work Health & Safety Act* provide the following guidance in determining what is 'reasonably practicable':

- First, consider what can be done. ***What is possible in the circumstances*** for ensuring health and safety? Then consider whether it is ***reasonable, in the circumstances to do all that is possible***.
- This means that ***what can be done should be done unless it is reasonable in the circumstances to do something less.***

The following table summarises the controls proposed to reduce risk so far as is reasonably practicable.

Reducing Risk 'So Far As Reasonably Practicable'			
1. Ammonium nitrate explosion (storage) 2. Ammonium nitrate explosion (truck)	4. Sustained release of ammonium nitrate decomposition products (storage) 5. Sustained release of ammonium nitrate decomposition products (truck)		
Control Description	Basis of Control	Control Status	Action required
Forklift design, inspection and maintenance	AS 4326	Implemented	Inspection and maintenance as per SMS
Vehicle licensing, inspection and maintenance	NHVAS, ADG Code	Implemented	Inspection and maintenance as per SMS
Non-combustible materials of construction	AS 4326	Implemented	Concreting of timber in Shed A & Shed B.
DG classification of product	ADG Code	Implemented	
No incompatible materials stored	AS 4326	Implemented	Inspection and audits as per SMS Management of Change as per SMS.
Separation of ammonium nitrate	AS 4326	Implemented	Inspection and audits as per SMS Management of Change as per SMS.
Site security	AS 4326, Explosives Act	Implemented	Inspection and maintenance as per Site Security Plan.
Vehicle fire extinguishers	AS 4326, ADG Code	Implemented	Inspection and maintenance as per SMS
Site fire protection	AS 4326	Implemented	Inspection and maintenance as per SMS
Site evacuation	AS 4326, WHS Reg	Implemented	Testing as per Site Emergency Plan.
Electrical equipment inspection	Industry best practice	To be implemented	Negotiations with property owner.
Installation of shrouded or open-rated metal halide lamps.	Industry best practice	To be implemented	Negotiations with property owner.
External emergency services	Available service	Available service.	Liaison with emergency services as per Site Emergency Plan.

Reducing Risk 'So Far As Reasonably Practicable'

3. Ammonium nitrate explosion (conveyor)

Control Description	Basis of Control	Control Status	Action required
DG classification of product	ADG Code	Implemented	
No incompatible materials stored	AS 4326	Implemented	Inspection and audits as per SMS Management of Change as per SMS.
Site fire protection	AS 4326	Implemented	Inspection and maintenance as per SMS
Conveyor design, inspection and maintenance	AS 4326, AEISG, AS 2187.2	Implemented	Inspection and maintenance as per SMS

16. MANAGEMENT SYSTEMS AND PLANS

16.1 Safety management system

The Safety Management System (SMS) implemented at the site is documented in the Safety Management System Manual. This document presents the framework and requirements of the Safety Management System, with detail of plans, forms, procedures, etc contained in a series of appendices to the document. This document, or elements of this document, are updated on an as-needs basis.

The SMS has undergone significant revision as part of the major hazard facility process. This revision has resulted in a site-specific SMS prepared in accordance with the NSW Department of Planning's *Hazardous Industry Planning Advisory Paper No. 9 – Safety Management System Guidelines*, January 2011 (HIPAP 9). This has resulted in significant changes to the SMS to incorporate site requirements for the Sandgate operations.

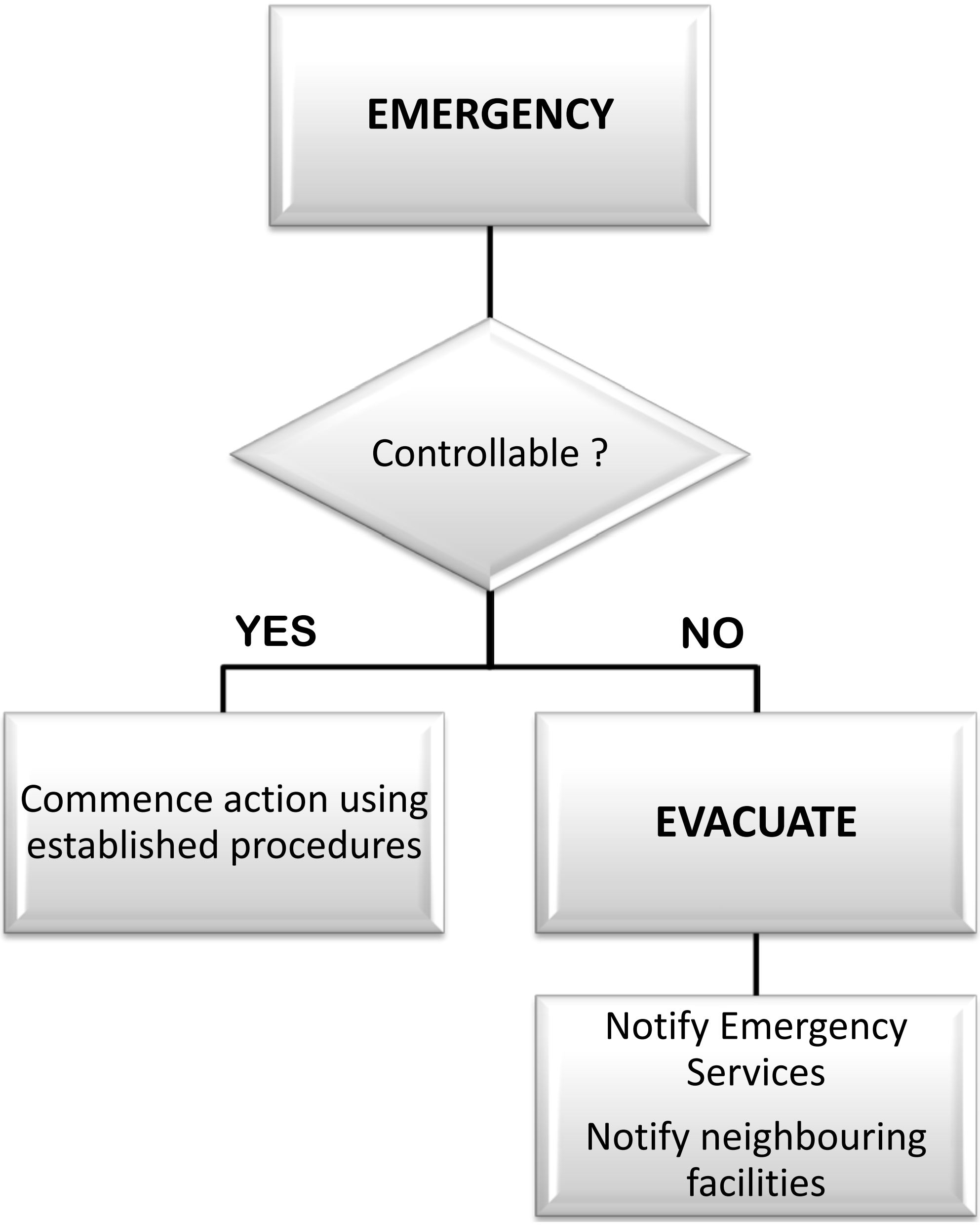
The basic framework of the SMS is as follows:

1. Management of the SMS
2. Hazard identification & risk assessment
3. Standard operating procedures
4. Process safety information
5. Contractor management
6. Pre-commissioning reviews
7. Equipment integrity
8. Safe work practices
9. Management of change
10. Incident reporting and investigation
11. Employee selection, training and education
12. Procurement
13. Emergency planning
14. Security
15. Auditing
16. Drug and alcohol testing procedures
17. Rail work fatigue management
18. Appendices

16.2 Emergency plan

The Site Emergency Plan has been prepared in accordance with the requirements of the NSW Department of Planning's *Hazardous Industry Planning Advisory Paper No. 1 – Emergency Planning*, January 2011 (HIPAP 1).[32] The Site Emergency Plan has been reviewed by Stuart Harvey, NSW Fire and Rescue representative on the WorkCover Major Hazard Facilities team.

The basic concept behind emergency response at the site is described by the following diagram.



The Site Emergency Plan defines an emergency as:

> any situation that has the potential to cause harm to any person, plant, equipment, building or enviroculture due to:
>
> - heat radiation
> - fire
> - fume emission
> - explosion
> - release of contaminants
> - major transport incident
> - malicious act
> - communicated threat
> - any combination of the above factors.

The types of emergencies covered by the Site Emergency Plan include:

- *Fire:* Organic or combustible products are not stored or transported with ammonium nitrate, however a fire in the vicinity of an ammonium nitrate store which may directly or indirectly affect the ammonium nitrate stores, or on a vehicle transporting ammonium nitrate may result in support of combustion or result in fume emission including toxic oxides of nitrogen.
- *Explosion or potential for explosion:* Caused by contamination of ammonium nitrate, self-sustaining or run away reaction caused by heating of the ammonium nitrate stack by fire in close proximity or explosion due to confinement of gases generated by heating of ammonium nitrate.
- *Major transport incident:* An incident involving ammonium nitrate due to a site vehicle or equipment fire, an external road or rail transport incident in the vicinity of the site, or any incident involving the nearby rail infrastructure.
- *Loss of containment:* Loss of containment of organic compounds such as fuel or oils, or chemical substances may become a contributing factor in an emergency event.
- *Subversive activities:* Subversive activities (such as sabotage, vandalism or arson) are detailed in the Site Security Risk Assessment and may result in an emergency situation.
- *Natural events:* Natural events which may occur including bush fire, lightning strike, earthquake, flood, and storm force winds.

Levels of emergency have been defined in the table on the following page.

Levels of Emergency		
Local	Site	External
An emergency where the impacts on people, property and the environment: – Are expected to be confined to a specific location within the site, and no escalation is expected. – Can be controlled by Crawfords response team. – Does not involve other site users.	An emergency where the impacts on people, property and the environment: – Are expected to spread to other sections of the site. – Cannot be controlled by Crawfords response team. – May impact other site users.	An emergency where the impacts on people, property and the environment: – Are expected to impact both the entire site and beyond the site boundaries.
Emergency Services May Be Required	Emergency Services Should Be Required	Emergency Services Will Be Required
Examples: – Ruptured bag in store or on vehicle. – Small fire not involving ammonium nitrate – Loss of containment not involving contamination of ammonium nitrate – Small fuel or oil leak from vehicle or equipment – A rail siding incident or derailment – A medical emergency.	Examples: – Fire in proximity to or involving ammonium nitrate. – Major fuel or oil leak with run off to ammonium nitrate or ecosystem. – Major vehicle incident. – Major rail siding incident. – A medical emergency where doubt regarding the welfare of the casualties exists.	Examples: – Fire involving ammonium nitrate stores or vehicles. – Any fire that cannot be controlled by Crawfords response team. – Any explosion or potential explosion. – Any fire with potential to generate oxides of nitrogen. – Major vehicle incident resulting in or with potential to result in injury, fire, explosion or major loss of containment. – Major rail siding incident resulting in or with potential to result in injury, fire, explosion or major loss of containment. – A medical emergency that cannot be managed beyond immediate first aid by site personnel.

The Site Emergency Plan contains procedures aimed at minimising the escalation and impact of likely emergencies. Procedures are included for:

- Fire (including a fire in the surrounding area, vehicle fire, forklift fire, conveyor fire, light vehicle fire, other tenant fire).
- Evacuation (including notification of other site tenants and surrounding neighbours).
- Bomb / Arson Threat (externally communicated threats).
- Medical Emergency.
- Personal / Security Threat by armed or unarmed persons (including verbal abuse and civil disturbance).
- Chemical Fire / Spill.

All personnel at the facility are provided with familiarisation and training in the Site Emergency Plan as follows:

- *Visitors and contractors:* At site induction.
- *Other site users:* Consultation and involvement in plan testing.
- *All Crawfords staff:* Consultation, review of plan and plan testing
- *Crawfords Area Wardens:* Consultation, review of plan, role specific training, plan testing.
- *Crawfords Chief Warden, Deputy Chief Warden, Deputy Emergency Controller:* Training to ensure fully conversant with all aspects of the plan, plan testing.
- *Crawfords Response Team:* Fire and spill control training including use of extinguishers, lay flat hoses, spill kits, product specific awareness training.
- *Neighbouring facilities:* Consultation.

The Site Emergency Plan is tested as follows:

- *Prior to release of final plan:* Desk-top exercise involving site stakeholders and consultation with community.
- *Every 6 months:* Evacuation drill; Review of neighbouring facilities and emergency contact details.
- Regular multi-agency exercises to test and review the plan.

16.3 Security plan

The site is secured against unauthorised access, and a Site Security Plan has been prepared and reviewed by Inspector Marilyn Hamilton, the NSW Police representative on the WorkCover Major Hazard Facilities team.

17. CONCLUSIONS

This Hazard Analysis has considered the risks associated with the storage and handling of ammonium nitrate in flexible bags at the Crawfords Freightlines storage and distribution centre at Lot 12 Old Maitland Road, Sandgate. Based on a review of the product hazards and past incidents, it has considered the risks of explosions and decomposition and release of toxic gases.

In determining safe storage conditions, and in conducting the consequence analysis and frequency analysis, consideration has been given to the approaches adopted in Australia by different states, and also international practice. However, in this Revision 4 of the Hazard Analysis, the methodology applied is that required by the NSW Department of Planning and Infrastructure. This included the adoption of the SAFEX frequencies, modified to account for the proposed safety controls and practices at the site. It is believed that this approach is highly over-conservative and, as a result, the risk levels calculated represent a significant over-estimation.

Consequences and impacts have been determined for a range of accident scenarios. These results have been combined with the likelihood of occurrence for each event based on approach required by the NSW Department of Planning and Infrastructure. The resulting contours for individual fatality risk, injury risk (explosion overpressure and toxic exposure) and risk of property damage and accident propagation have been determined.

The following conclusions are made regarding the relevant risk contours show specified by the NSW Department of Planning and Infrastructure in HIPAP 4:[30]

Individual fatality risk

- The individual fatality risk at a level of 50 in a million per year (50×10^{-6} per year) is contained within the boundaries of the site.
- The individual fatality risk in the area in use by the nearest sporting complex or active open space is no more than 20 chances in a million per year (20×10^{-6} per year).
- The individual fatality risk at the property boundaries of the nearest sporting complex or active open space is less than 30 chances in a million per year (30×10^{-6} per year).
- The individual fatality risk at the nearest commercial developments is less than five in a million per year (5×10^{-6} per year).
- The individual fatality risk at the nearest residence is less than one in a million per year (1×10^{-6} per year).
- The individual fatality risk at the nearest sensitive land use is less than half in one million per year (0.5×10^{-6}).

Injury risk

- The risk of injury due to explosion overpressure exceeding 7kPa at the nearest residence or sensitive land use is less than 50 chances in a million per year (50×10^{-6} per year).
- The risk of serious injury due to a relatively short exposure period to toxic concentrations at the nearest residence or sensitive land use is less than 10 in a million per year (10×10^{-6} per year).
- The risk of irritation to eyes or throat, coughing or other acute physiological responses in sensitive members of the community at the nearest residence or sensitive land use is less than 50 in a million per year (50×10^{-6} per year).

Risk of property damage and accident propagation

- The risk of property damage and accident propagation due to explosion overpressure exceeding 14kPa at the nearest potentially hazardous installations, or land zoned to accommodate such installations or the nearest public building is less than 50 in a million per year (50×10^{-6} per year).

Societal Risk has been calculated and presented as an FN-curve, by plotting the frequency (F) at which such events result in the fatality of N or more people, against N. The level of Societal Risk meets the indicative set by NSW Department of Planning and Infrastructure.

Reference should be made to the remainder of the Environmental Impact Statement for details of the potential environmental risks of the operation. Based on this assessment, it is believed the following risk criteria set for the biophysical environment by the NSW Department of Planning and Infrastructure will be met:

- Industrial developments should not be sited in proximity to sensitive natural environmental areas where the effects (consequences) of the more likely accidental emissions may threaten the long-term viability of the ecosystem or any species within it.
- Industrial developments should not be sited in proximity to sensitive natural environmental areas where the likelihood (probability) of impacts that may threaten the long-term viability of the ecosystem or any species within it is not substantially lower than the background level of threat to the ecosystem.

The Hazard Analysis demonstrates compliance with the qualitative principles for land use safety outlined in HIPAP 4.[30] Information has been provided on the controls to be implemented, the safety management system, emergency plan and security plan; providing a demonstration that risk has been reduced to 'As Low As Reasonably Practicable'.

The quantitative criteria specified in HIPAP 4[30] are met, except for sporting complexes and active open space areas in relation to the adjacent Golf Driving Range. The usage of this facility is relatively low and it is unlikely that any single individual would be present for more than several hours at a time, with typical attendance being no more than several times per week.

The risk to an individual based on the time they are present is likely to be lower than most risks experienced by the general community, and therefore should be considered as tolerable.

Under the Newcastle Local Environment Plan 2012, hazardous storage establishments are permitted with consent in the Heavy Industry Zone in which the Crawfords facility is located. The objectives of this Heavy Industry Zone are to:

- Provide suitable areas for those industries that need to be separated from other land uses.
- Encourage employment opportunities.
- Minimise any adverse effect of heavy industry on other land uses.
- Support and protect industrial land for industrial uses.

It is therefore considered that the proposed operation of the Crawfords facility as storage and distribution centre for ammonium nitrate is an appropriate use for this land, and that consent should be given for the proposed development.

CRAWFORDS Freightlines Pty Ltd

HEALTH & SAFETY essentials

Attachment A Typical Ammonium Nitrate MSDS

ABN: 81 008 668 371

MATERIAL SAFETY DATA SHEET

Ammonium Nitrate

Section 1 – Identification of the Material and Supplier

Product Name
Ammonium nitrate

Other names
Detapril, Nitropril, porous prill. Company product code 1720.

Recommended use
Production of explosives and fertiliser manufacture.

Company name
CSBP Limited

Address	State	Postcode
Kwinana Beach Road, KWINANA	Western Australia	6167

Telephone number	Emergency telephone number
(08) 9411 8777 (Australia), +61 8 9411 8777 (Overseas)	1800 093 333 (Australia), +61 8 9411 8444

Section 2 – Hazard Identification

Hazard Classification, including a statement of overall hazardous nature

HAZARDOUS SUBSTANCE.

Ammonium nitrate is not classified as hazardous and is not specified in the NOHSC List of Designated Hazardous Substances [NOHSC:10005(1999)].

DANGEROUS GOODS.

Ammonium nitrate is classified for physicochemical hazards and specified as dangerous in the Australian Code for the Transport of Dangerous Goods by Road and Rail (ADG Code), 6th Edition, (FORS, 1998).

Risk Phrases

Ammonium nitrate is classified as an oxidizing agent.

R22	Harmful if swallowed
R31	Contact with acid liberates toxic gas
R36	Irritating to eyes

Safety Phrases

Ammonium nitrate is classified as dangerous goods.

S14/S15	Keep away from heat, sources of ignition – No smoking, combustible material
S21	When using do not smoke
S29	Do not empty into drains
S41	In case of fire and /or explosion do not breathe fumes
S50	Do not mix with minerals acids, chlorine, oxidizing agents, alkalis, diesel, oils and greases.
S56	Dispose of this material and its container to hazardous o special waste collection point
S57	Use appropriate containment to avoid environmental contamination
S59	Refer to manufacturer for information on recovery/recycling
S60	This material and its container must be disposed of as hazardous waste

Poison Schedule

Ammonium nitrate is not listed as a poison in the Standard for the Uniform Scheduling of Drugs and Poisons.

Section 3 – Composition/Information on Ingredients

Chemical identity of ingredients	Proportion of ingredients	CAS Number for ingredients
Ammonium nitrate	99 % ($^{wt}/_{wt}$)	6484 -52-2
Moisture and additives	Remainder	

Section 4 – First Aid Measures

First Aid

Ammonium nitrate is moderately toxic if large amounts are swallowed. If more than a small quantity has been swallowed seek medical attention. Training on handling ammonium nitrate incidents using this MSDS should be provided before any ammonium nitrate handling or use commences.

First Aid Facilities

First aid procedures, equipment, medication and training for the treatment of injury by ammonium nitrate should be in place BEFORE the use commences.

Equipment in place should be:

- Safety shower and eyewash stations immediately accessible in the workplace;
- Eye-wash bottle;
- Fresh, clean cool drinking water;
- Oxygen;
- "Space" or thermal blankets for treating patients for shock;
- Personal protective equipment for use by first aid personnel.

FIRST AID PROCEDURES FOR DEALING WITH THIS PRODUCT AND EXPOSURE TO IT

1. Personal Protection By First Aid Personnel

First aid personnel providing first aid treatment to a patient injured by ammonium nitrate should observe the following precautions for their own personal protection:

- Avoid contact with ammonium nitrate by wearing protective gloves;
- Wear chemical goggles to prevent ammonium nitrate particles entering eyes;
- Wear P2 type canister respirator if rescue area is contaminated by airborne ammonium nitrate dust.

2. Swallowed

If person is conscious, rinse mouth thoroughly with water immediately and give water or milk to drink. DO NOT induce vomiting. Seek medical assistance if more than a small quantity has been swallowed, when relevant symptoms occur after swallowing.

3. Eyes

Immediately irrigate with copious quantities of water, while holding eyelids open, for at least 15 minutes. Seek medical attention if irritation persists.

4. Skin

Wash affected areas with copious amounts of water. Remove all contaminated clothing and launder before re-use.

5. Inhalation

Remove affected person from exposure to a well ventilated area. Keep warm and at rest. In emergency, if breathing is difficult give oxygen. If the affected person suffers cardiac arrest commence cardio-pulmonary resuscitation immediately. Seek urgent medical attention.

ADVICE TO DOCTOR.

This product contains nitrates, which may be reduced to nitrites by intestinal bacteria. Nitrites may affect the blood (methaemoglobinaemia) and blood vessels (vasodilation and a fall in blood pressure). Effects peak within 30 minutes. Clinical signs of cyanosis appear before other symptoms because of the dark pigmentation of methaemoglobin. Institute cardiac monitoring, especially in patients with coronary, artery or pulmonary disease.

Long Term Complications

No long term complications are known.

Further information about the treatment for exposure to this product can be obtained from the Poisons Information Centre on (08) 13 1126 (Australia only)

Section 5 – Fire Fighting Measures

Product flammability

Ammonium nitrate is not flammable under normal applications and is not considered a fire risk, but will support combustion in an existing fire by liberating oxygen – even if smothered. It is for this reason that fires involving ammonium nitrate cannot be extinguished by the prevention or air ingress (for example, smouldering with steam) because of the *in situ* provision of oxygen from the ammonium nitrate itself. Thermal decomposition may result in toxic gases, such as oxides of nitrogen and ammonia, being produced.

Suitable extinguishing media

Extinguish fires with large amounts of water.

Hazard from combustion products

Fire will cause ammonium nitrate to decompose giving off fumes of nitrogen oxides and ammonia.

Special protective precautions and equipment for fire fighters

Wear full protective clothing, including respiratory protection.

Inert chemical absorbent and substantial amounts of water will be required to clean up a large spill.

Portable showers and eyewash may also be needed.

Prevent run-off into drains and waterways.

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Section 6 – Accidental Release Measures

Emergency procedures

Hazardous conditions may result if an ammonium nitrate spill is managed improperly. Make plans in advance to handle possible emergencies, including obtaining stocks of inert absorbent materials, to avoid both human and environmental exposure. Always wear recommended personal protective equipment and respiratory protection.

Methods and Materials for containment and clean up

For all spills, evacuate unprotected personnel upwind and out of danger. Remove sources of heat and ignition. Restrict access to spill site. Any spillage should be contained and recovered. Do not allow to mix with sawdust and other combustible organic substances.

Small Leaks

If possible contain the area of the spill, sweep into a clean labelled open container and recycle.

Large Spills

If possible contain the area of the spill. A front end loader may be required to scoop up spill into a clean container. Depending on the degree and nature of contamination, dispose of by use as fertilizer on farm or authorised waste facility.

Wash down area and prevent run-off into drains, sewers or waterways. Soak up wet material using absorbent material such as vermiculite or sand and dispose at authorised waste facility.

Section 7 – Handling and Storage

Precautions for safe handling

Regulated dangerous goods as Oxidizing Agent Class 5·1.

Avoid excessive generation of dust. Avoid contamination by combustible (e.g., diesel oil, grease, etc.) and incompatible materials, which may cause fires. Avoid unnecessary exposure to the atmosphere to prevent moisture pick up, which makes the material difficult to handle. When handling ammonium nitrate over long periods use appropriate personal protective equipment, e.g., gloves.

Conditions for safe storage, including any incompatibilities

Store in accordance with Australian Standard AS 4326 *The storage and handling of oxidizing agents*.

Store away from sources of heat or fire, especially in a confined space – the heating may cause an explosion. Keep away from combustible materials and substances mentioned in *Precautions for safe handling* section above. Avoid storage and contamination with chlorine bleaches, pool chlorine and hypochlorites as a reaction, leading to the formation of explosive nitrogen trichloride, may occur. Dry ammonium nitrate has been reported to detonate in fires with dry ammonium sulfate. Ensure that ammonium nitrate fertiliser is not stored near hay, straw, grain, diesel oil, greases, etc., as these are incompatibles and may cause fires. Do not permit smoking and the use of naked lights in the storage area for ammonium nitrate. Restrict stack size for bagged product (according to local regulations). Any building used for the storage of ammonium nitrate should be dry and well ventilated. Where the nature of the bagged product and climatic conditions so require, store under conditions that will avoid breakdown by thermal cycling (wide variation in temperature). The product should not be stored in direct sunlight to avoid physical breakdown due to thermal cycling.

Section 8 – Exposure Controls/Personal Protection

National exposure standards

ES-TWA		ES-STEL		ES-Peak	
No data available	10 mg/m^3	No data available	No data available	No data available	No data available

Biological limit values

No data available.

Engineering controls

Avoid high dust concentration and provide ventilation where necessary.

Personal protective equipment

Personal protective equipment (PPE) should be used where other control measures are not practicable or adequate to control exposure. It should be chosen to prevent routine exposure and to protect workers in the case of accidental contact with ammonium nitrate.

Eye/face protection: Wear chemical safety glasses to prevent eye contact.

Skin protection: Wear PVC gloves when handling the product to prevent contact. Wear long trouser and long sleeves to prevent contact.

Respiratory protection: Use P2 type canister respirator where dust is a problem.

Personal hygiene: Change and wash clothing and PPE, if contaminated, or before storing and/or re-using. Wash hands and face thoroughly after handling and before work breaks, eating, drinking, smoking and using toilet facilities.

Section 9 – Physical and Chemical Properties

Appearance (colour, physical form, shape)
White odourless prills, with strong disagreeable acrid taste.

Odour
Odourless

pH
pH of 10% solution: > 4·6

Vapour pressure
Ammonium nitrate does not exert significant vapour pressure.

Vapour density
Not applicable.

Boiling point/range
Decomposes from 170 °C before boiling.

Freezing/melting point
170 °C.

Solubility
Solubility in water: 118·3 g/100g of water at 0 °C; slightly soluble in alcohol; not soluble in acetone.

Specific gravity or density
Bulk density: 755 ± 25 kg/m^3.

Flash point and method of detecting flash point
Ammonium nitrate does not give off flammable vapours.

Upper and lower flammable (explosive) limits in air
Ammonium nitrate is not flammable.

Ignition temperature
Not applicable.

Viscosity
Not applicable.

Section 10 – Stability and Reactivity

Chemical stability
When stored and handled in accordance with Australian Standard AS 4326 *The storage and handling of oxidizing agents*, ammonium nitrate remains stable.

Conditions to avoid
Store away from sources of heat or fire, especially in a confined space. Keep away from combustible materials and organic substances. Avoid storage and contamination with chlorine bleaches, pool chlorine and hypochlorites. Dry ammonium nitrate has been reported to detonate in fires with dry ammonium sulfate. Ensure that ammonium nitrate fertiliser is not stored near hay, straw, grain, diesel oil, greases. Do not permit smoking and the use of naked lights in the storage area for ammonium nitrate. Restrict stack size for bagged product (according to local regulations). Any building used for the storage of ammonium nitrate should be dry and well ventilated. Where the nature of the bagged product and climatic conditions so require, store under conditions that will avoid breakdown by thermal cycling (wide variation in temperature). The product should not be stored in direct sunlight to avoid physical breakdown due to thermal cycling. Avoid excessive generation of dust. Avoid contamination by combustible (e.g., diesel oil, grease, etc.) and incompatible materials. Avoid unnecessary exposure to the atmosphere to prevent moisture pick up.

Incompatible materials
Ammonium nitrate is incompatible with copper, zinc, or their alloys (i.e., bronze, brass, galvanised metals, etc.), aluminium powder and mild steel.

Hazardous decomposition products

When heated to decomposition (unconfined) ammonium nitrate produces nitrous oxides, white ammonium nitrate fumes and water.

Hazardous reactions

Contamination of ammonium nitrate with chlorine bleaches, pool chlorine and hypochlorites may result in the formation of explosive nitrogen trichloride. Dry ammonium nitrate has been reported to detonate in fires with dry ammonium sulfate. When mixed with strong acid ammonium nitrate produces toxic brown nitrogen dioxide gas. When molten, ammonium nitrate may decompose due to shock or pressure. Ammonium nitrate may react violently with nitrites, chlorates, chlorides and permanganates.

Section 11 – Toxicological Information

HEALTH EFFECTS

When handled in accordance with the guidelines in this material safety data sheet, ammonium nitrate should not present any health effects. If this product is mishandled, symptoms that may arise are:

Acute:

Ammonium nitrate has moderate toxicity if swallowed. It is not classified as hazardous according to criteria of WorkSafe Australia.

Inhalation:

High mist concentration of air-borne material may cause irritation to the nose and upper respiratory tract, symptoms may include coughing and sore throat. Prolonged exposure may be harmful.

Skin:

Prolonged contact may cause some irritation, including redness and itching.

Eye:

May cause irritation, redness and pan following contact due to abrasive nature of material.

Swallowed:

Presents moderate toxicity, unless large amounts are ingested. Large amounts give large to gastro-intestinal irritation, with symptoms such as nausea, vomiting and diarrhoea. Large amounts may also cause dilation of blood vessels by direct smooth muscle relaxation and methaemoglobinaemia (excessive conversion of haemoglobin to methaemoglobin, which is incapable of binding and carrying oxygen – methaemoglobin is formed when iron in the haem molecule is oxidised from the ferrous to the ferric state). Symptoms include dizziness, abdominal pain, vomiting, bloody diarrhoea, weakness, convulsions and collapse. LD_{50} (Oral, rat) = 2,217 mg/kg.

Chronic:

Prolonged or repeated exposure may cause drying of the skin with cracking and irritation that may lead to dermatitis.

Section 12 – Ecological Information

Ecotoxicity

Ammonium nitrate is a plant nutrient and large contamination may kill vegetation and cause poisoning in livestock and poultry.

Ammonium nitrate is of low toxicity to aquatic life and spills may cause algal blooms in static waters.

Persistence and degradability

When released into the soil, ammonium nitrate is not expected to evaporate significantly, but is expected to leach into groundwater. In damp soil the ammonium ion, NH_4^+, is adsorbed by the soil. When released into water, ammonium nitrate is expected to readily biodegrade; the nitrate ion, NO_3^-, is mobile in water. The nitrate ion is the predominant form of plant nutrition. It follows the natural nitrification/denitrification cycle to give nitrogen.

Mobility

Very soluble in water. The NO_3^- ion is mobile. The NH_4^+ ion is adsorbed by the soil.

Environmental fate (exposure)

Low toxicity to aquatic life. TL_m 96 between 10 – 100 ppm.

No effects on growth or feeding activities were observed in largemouth bass and channel catfish exposed to concentration of 400 mg NO_3^-/L.

<u>Acute Toxicity to Fish</u>

48 hr LC_{50} (*Cyprinus carpio*): 1·15 - 1·72 mg un-ionised NH_3/L; 95 – 102 mg total NH_3/L;

96 hr LC_{50} (Chinook Salmon, rainbow trout, bluegill): 420 -1,360 mg NO_3^-/L;

TL_m (Tadpoles): 910 mg NH_3/L.

<u>Chronic Toxicity to Fish</u>

7 day LC_{50} (Fingerling rainbow trout): 1,065 mg/L.

<u>Acute Toxicity to Aquatic Invertebrates</u>

EC_{50} (*Daphnia magna*): 555 mg/L; 124·9 mg total NH_3/L.

<u>Chronic Toxicity to Invertebrates</u>

Up to 7 days NOEC (*Bullia digitalis*): 300 mg/L.

Bioaccumulative potential

Ammonium nitrate does not show any bio-accumulation phenomena.

Section 13 – Disposal Considerations

Disposal methods and containers

Refer to local State Land Waste Management Authority. Depending on degree and nature of contamination, dispose of by use as fertiliser on farm or to authorised waste facility. Empty containers (bulka bags) must be decontaminated by rinsing thoroughly with water. Rinsing water needs to be disposed of carefully. Avoid contaminating waterways.

Special precautions for landfill or incineration

No data available.

Section 14 – Transport Information

UN Number

1942

UN Proper shipping name

Ammonium Nitrate

Class and subsidiary risk

5·1 Oxidizing Agent

Packing group

III

Special precautions for user

Not to be loaded with explosives (Class 1), flammable gases (Class 3), toxic gases (class 2·3), Flammable liquids (Class 3), flammable solids (Class 4·1), spontaneous combustible substances (Class 4·2), dangerous when wet substances (Class 4·3), organic peroxides (Class 5·2), toxic substances, where the toxic substances are fire risk substances (Class 6), radioactive substances (Class 7), corrosives (Class 8), miscellaneous dangerous goods, where the miscellaneous dangerous goods are fire risk substances (Class 9), and fire risk substances other than dangerous goods; however, exemptions apply.

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Section 15 – Regulatory Information

Australian regulatory information

Ammonium nitrate is not classified as hazardous and is not specified in the NOHSC List of Designated Hazardous Substances [NOHSC:10005(1999)].

Ammonium nitrate is not listed as a poison in the Standard for the Uniform Scheduling of Drugs and Poisons.

Additional national and/or international regulatory information

OSHA: Hazardous by definition of Hazard Communication Standard (40 CFR Part 370).

Section 16 – Other Information

Key / legend to abbreviations and acronyms used in the MSDS

NOHSC	National Occupational Health and Safety Commission
SUSDP	Standard for the Uniform Scheduling of Drugs and Poisons
ES-TWA	Exposure Standard – Time weighted average
ES-STEL	Exposure Standard – Short term exposure level
ES-Peak	Exposure Standard – Peak level
FORS	Federal Office of Road and Safety
LC_{50}:	Lethal concentration 50, median lethal concentration
LD_{50}	Lethal dose 50. The single dose of a substance that causes the death of 50% of an animal population from exposure to the substance by any route other than inhalation
$\%(^{wt}/_{wt})$	Percent amount on a weight per weight basis
$\%(^{wt}/_{vol})$	Percent amount on a weight per volume basis
PPM	Parts per million
Zone 1 Class 1	An area in which an explosive gas atmosphere can be expected to occur periodically or occasionally during normal operation. (More than 10 hours per year but less than 1000 hours per year)

Literature references

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Chemwatch www.chemwatch.net

Guidance for the Compilation of Safety Data Sheets for Fertilizer Materials, European Fertilizer Manufacturers Association, online at www.efma.org/Publications/Guidance/Index.asp

Sources for data

No data available.

Important Notes

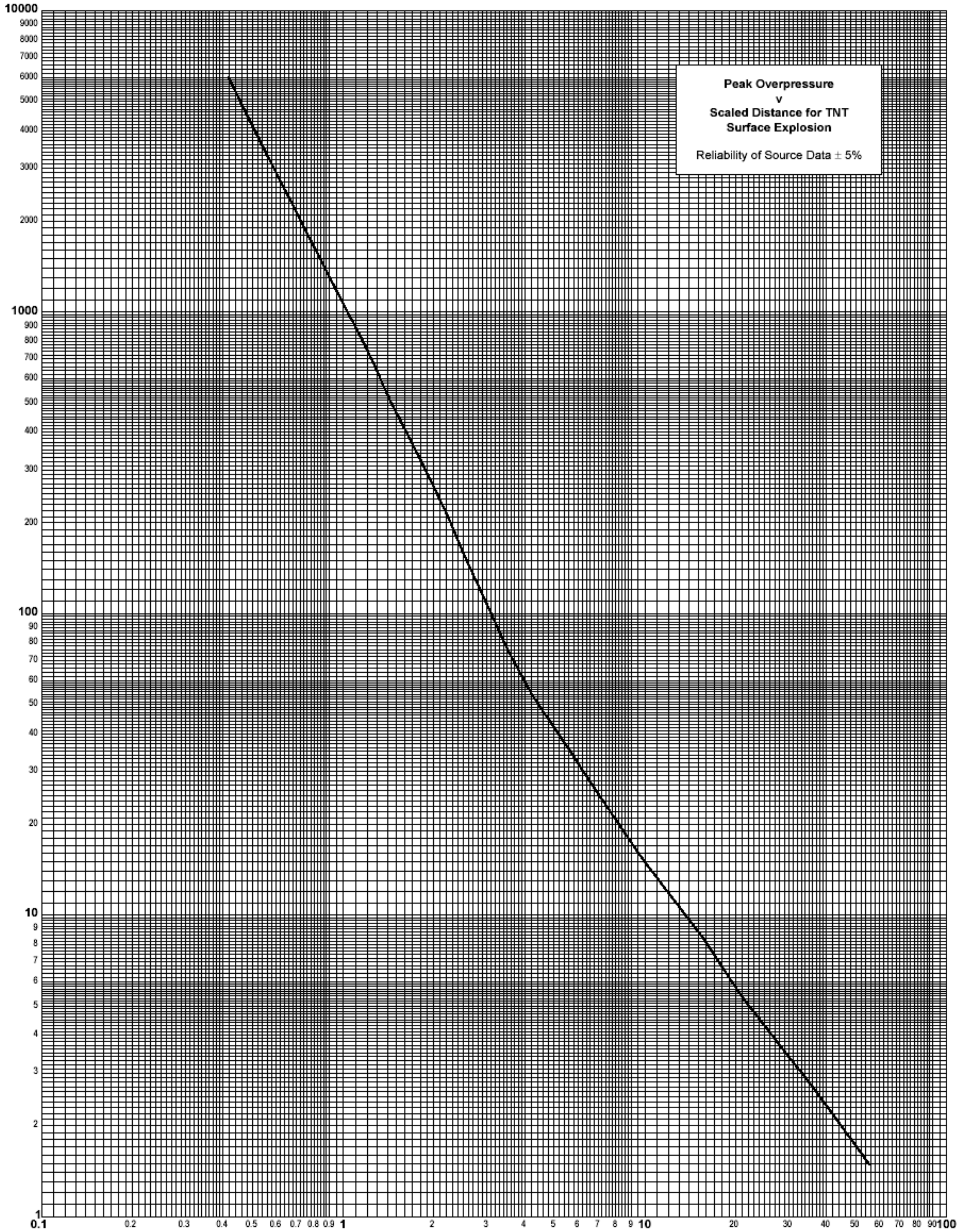
1. To the best of our knowledge this document complies with the National Code of Practice for the Preparation of Material Safety Data Sheets 2nd Edition [NOHSC:2011 (2003)].
2. This material safety data sheet summarises our best knowledge of the health and safety hazard information of the product and how to safely handle and use the product in the workplace. Each user should read this material safety data sheet and consider the information in the context of how the product will be handled and used in the workplace, including in conjunction with other products.
3. If clarification or further information is needed to ensure that an appropriate risk assessment can be made, the user should contact the Safety and Emergency Services Department, CSBP Limited on (08) 9411 8777 (Australia), +61 8 9411 8777 (Overseas).
4. Our responsibility for products sold, is subject to our terms and conditions, a copy of which is sent to our customers, and is also available on request.
5. CSBP reserves the right to make change to material safety data sheets without notice.

Attachment B Scaled Distance v Overpressure Graph

CRAWFORDS Freightlines Pty Ltd

hse HEALTH & SAFETY essentials

DEOP 103(AM1): OVERPRESSURE - K - FACTOR CONVERSION CHART



Peak

Side-On Overpressure (kPa

Scaled Distance from Explosion (K- Factor =D/Q1/3, m/kg1/3)

Attachment C Explosion Consequences

TNT EQUIVALENCY = 5% (SAFEX – Fire): Distance (metres) to Explosion Overpressure		Scenario 1-50% Store Shed A & B	Scenario 1-50% Store Shed C	Scenario 1-Store (Container Storage)	Scenario 2-Truck	Scenario 3-Auger
Quantity of Ammonium Nitrate (kg)		2 250 000	2 000 000	500 000	40 000	50
Equivalent Quantity of TNT (kg)		112 500	100 000	25 000	2 000	3
Over pressure and Effect						
3.5 kPa	90% glass breakage No fatality; very low probability of injury.	1472	1416	892	384	41
7 kPa	Damage to internal partitions and joinery, but can be repaired. Probability of injury is 10%. No fatality.	859	826	520	224	24
14 kPa	House uninhabitable and badly cracked.	502	483	304	131	14
21 kPa	Reinforced structures distort. Storage tanks fail. 20% chance of fatality to a person in a building.	386	371	234	101	11
35 kPa	House damaged beyond repair. Wagons and plant items overturned. Threshold of eardrum damage. 50% chance of fatality for a person in a building. 15% chance of fatality for a person in the open.	290	278	175	76	8
70 kPa	Threshold of lung damage 100% chance of fatality for a person in a building or in the open. Complete demolition of houses.	193	186	117	50	5

TNT EQUIVALENCY = 14% (UK Health & Safety Executive): Distance (metres) to Explosion Overpressure		Scenario 1-50% Store Shed A & B	Scenario 1-50% Store Shed C	Scenario 1-Store (Container Storage)	Scenario 2-Truck	Scenario 3-Auger
	Quantity of Ammonium Nitrate (kg)	2 250 000	2 000 000	500 000	40 000	50
	Equivalent Quantity of TNT (kg)	315 000	280 000	70 000	5 600	7
Over pressure and Effect						
3.5 kPa	90% glass breakage No fatality; very low probability of injury.	2075	1995	1257	542	58
7 kPa	Damage to internal partitions and joinery, but can be repaired. Probability of injury is 10%. No fatality.	1211	1164	734	316	34
14 kPa	House uninhabitable and badly cracked.	708	680	429	185	20
21 kPa	Reinforced structures distort. Storage tanks fail. 20% chance of fatality to a person in a building.	544	523	330	142	15
35 kPa	House damaged beyond repair. Wagons and plant items overturned. Threshold of eardrum damage. 50% chance of fatality for a person in a building. 15% chance of fatality for a person in the open.	408	393	247	107	11
70 kPa	Threshold of lung damage 100% chance of fatality for a person in a building or in the open. Complete demolition of houses.	272	262	165	71	8

TNT EQUIVALENCY = 16% (SAFEX - Contamination): Distance (metres) to Explosion Overpressure		Scenario 1-50% Store Shed A & B	Scenario 1-50% Store Shed C	Scenario 1-Store (Container Storage)	Scenario 2-Truck	Scenario 3-Auger
	Quantity of Ammonium Nitrate (kg)	2 250 000	2 000 000	500 000	40 000	50
	Equivalent Quantity of TNT (kg)	360 000	320 000	80 000	6 400	8
Over pressure and Effect						
3.5 kPa	90% glass breakage No fatality; very low probability of injury.	2170	2086	1314	566	61
7 kPa	Damage to internal partitions and joinery, but can be repaired. Probability of injury is 10%. No fatality.	1266	1218	767	330	36
14 kPa	House uninhabitable and badly cracked.	740	711	448	193	21
21 kPa	Reinforced structures distort. Storage tanks fail. 20% chance of fatality to a person in a building.	569	547	345	149	16
35 kPa	House damaged beyond repair. Wagons and plant items overturned. Threshold of eardrum damage. 50% chance of fatality for a person in a building. 15% chance of fatality for a person in the open.	427	410	259	111	12
70 kPa	Threshold of lung damage 100% chance of fatality for a person in a building or in the open. Complete demolition of houses.	285	274	172	74	8

TNT EQUIVALENCY = 25% (Western Australia): Distance (metres) to Explosion Overpressure		Scenario 1-50% Store Shed A & B	Scenario 1-50% Store Shed C	Scenario 1-Store (Container Storage)	Scenario 2-Truck	Scenario 3-Auger
Quantity of Ammonium Nitrate (kg)		2 250 000	2 000 000	500 000	40 000	50
Equivalent Quantity of TNT (kg)		562 500	500 000	125 000	10 000	13
Over pressure and Effect						
3.5 kPa	90% glass breakage No fatality; very low probability of injury.	2518	2421	1525	657	71
7 kPa	Damage to internal partitions and joinery, but can be repaired. Probability of injury is 10%. No fatality.	1469	1413	890	383	41
14 kPa	House uninhabitable and badly cracked.	859	825	520	224	24
21 kPa	Reinforced structures distort. Storage tanks fail. 20% chance of fatality to a person in a building.	660	635	400	172	19
35 kPa	House damaged beyond repair. Wagons and plant items overturned. Threshold of eardrum damage. 50% chance of fatality for a person in a building. 15% chance of fatality for a person in the open.	495	476	300	129	14
70 kPa	Threshold of lung damage 100% chance of fatality for a person in a building or in the open. Complete demolition of houses.	330	317	200	86	9

TNT EQUIVALENCY = 32% (Queensland, SAFEX - Projectiles): Distance (metres) to Explosion Overpressure		Scenario 1-50% Store Shed A & B	Scenario 1-50% Store Shed C	Scenario 1-Store (Container Storage)	Scenario 2-Truck	Scenario 3-Auger
Quantity of Ammonium Nitrate (kg)		2 250 000	2 000 000	500 000	40 000	50
Equivalent Quantity of TNT (kg)		720 000	640 000	160 000	12 800	16
Over pressure and Effect						
3.5 kPa	90% glass breakage No fatality; very low probability of injury.	2734	2628	1656	713	77
7 kPa	Damage to internal partitions and joinery, but can be repaired. Probability of injury is 10%. No fatality.	1595	1534	966	416	45
14 kPa	House uninhabitable and badly cracked.	932	896	565	243	26
21 kPa	Reinforced structures distort. Storage tanks fail. 20% chance of fatality to a person in a building.	717	689	434	187	20
35 kPa	House damaged beyond repair. Wagons and plant items overturned. Threshold of eardrum damage. 50% chance of fatality for a person in a building. 15% chance of fatality for a person in the open.	538	517	326	140	15
70 kPa	Threshold of lung damage 100% chance of fatality for a person in a building or in the open. Complete demolition of houses.	359	345	217	94	10

Attachment D Toxic Consequence Calculations

100% of storage / truck area

The results of the modelling for the decomposition of a single stack of ammonium nitrate (Incident Reference 4A) show:

- The maximum ground level concentration of NO_2 is 1.6ppm. This occurs at a maximum distance of 60 metres downwind. This is higher than AEGL-1 (irritation) of 0.5ppm.
- The maximum ground level concentration of NO is 12.5ppm. This occurs at a maximum distance of 60 metres downwind. This is much lower than the limit of 80ppm at which no health hazard occurs.
- A concentration of 0.5ppm NO_2 (AEGL-1, irritation) is exceeded at a maximum distance of 360 metres downwind from the source.
- AEGL-2 and AEGL-3 concentrations for NO_2 are not exceeded.
- These peak concentrations occur during high wind speed conditions (14.4 m/s).

The results of this modelling for the decomposition of a single vehicle trailer of ammonium nitrate (Incident Reference 5A) show:

- The maximum ground level concentration of NO_2 is 0.95ppm. This occurs at a maximum distance of 60 metres downwind. This is higher than AEGL-1 (irritation) of 0.5ppm.
- The maximum ground level concentration of NO is 7.2ppm. This occurs at a maximum distance of 60 metres downwind. This is much lower than the limit of 80ppm at which no health hazard occurs.
- A concentration of 0.5ppm NO_2 (AEGL-1, irritation) is exceeded at a maximum distance of 120 metres downwind from the source.
- AEGL-2 and AEGL-3 concentrations for NO_2 are not exceeded.
- These peak concentrations occur during high wind speed conditions (14.4 m/s).

These results are summarised in the table on the following page.

TOXIC GAS INCIDENTS – 100% AREA: Summary of Consequences				
	Conc	Location	Weather Conditions	
STACK (STORAGE)				
Maximum ground level concentration (NO_2)	1.6 ppm	60 metres downwind	Ambient temperature Wind speed Stability Category Mixing / Inversion height	25^{0}C 14.4 m/s C 3217 m
NO_2 AEGL-1 (irritation)	0.5 ppm	360 metres downwind		
NO_2 AEGL-2 (injury)	min 6.7 ppm	Not exceeded		
NO_2 AEGL-3 (fatality)	min 11 ppm	Not exceeded		
Maximum ground level concentration (NO)	12.5 ppm	60 metres downwind	Ambient temperature Wind speed Stability Category Mixing / Inversion height	25^{0}C 14.4 m/s C 3217 m
NO, No health effect	80 ppm	Not exceeded		
TRUCK				
Maximum ground level concentration (NO_2)	0.95 ppm	60 metres downwind	Ambient temperature Wind speed Stability Category Mixing / Inversion height	25^{0}C 14.4 m/s C 3217 m
NO_2 AEGL-1 (irritation)	0.5 ppm	120 metres downwind		
NO_2 AEGL-2 (injury)	min 6.7 ppm	Not exceeded		
NO_2 AEGL-3 (fatality)	min 11 ppm	Not exceeded		
Maximum ground level concentration (NO)	7.2 ppm	60 metres downwind	Ambient temperature Wind speed Stability Category Mixing / Inversion height	25^{0}C 14.4 m/s C 3217 m
NO, No health effect	80 ppm	Not exceeded		

10% of storage / truck area

The results of the modelling for the decomposition of a single stack of ammonium nitrate (Incident Reference 4B) show:

- The maximum ground level concentration of NO_2 is 0.17ppm. This occurs at a maximum distance of 60 metres downwind. This is less than the AEGL-1 (irritation) of 0.5ppm.
- The maximum ground level concentration of NO is 1.3ppm. This occurs at a maximum distance of 60 metres downwind. This is much lower than the limit of 80ppm at which no health hazard occurs.
- A concentration of 0.5ppm NO_2 (AEGL-1, irritation) is not exceeded. AEGL-2 and AEGL-3 concentrations for NO_2 are not exceeded.
- These peak concentrations occur during high wind speed conditions (14.4 m/s).

The results of this modelling for the decomposition of a single vehicle trailer of ammonium nitrate (Incident Reference 5B) show:

- The maximum ground level concentration of NO_2 is 0.1ppm. This occurs at a maximum distance of 60 metres downwind. This is less than the AEGL-1 (irritation) of 0.5ppm.
- The maximum ground level concentration of NO is 0.73ppm. This occurs at a maximum distance of 60 metres downwind. This is much lower than the limit of 80ppm at which no health hazard occurs.
- A concentration of 0.5ppm NO_2 (AEGL-1, irritation) is not exceeded. AEGL-2 and AEGL-3 concentrations for NO_2 are not exceeded.
- These peak concentrations occur during high wind speed conditions (14.4 m/s).

These results are summarised in the table on the following page.

TOXIC GAS INCIDENTS – 10% AREA: Summary of Consequences				
	Conc	Location	Weather Conditions	
STACK (STORAGE)				
Maximum ground level concentration (NO_2)	0.17 ppm	60 metres downwind	Ambient temperature Wind speed Stability Category Mixing / Inversion height	25^{0}C 14.4 m/s C 3217 m
NO_2 AEGL-1 (irritation)	0.5 ppm	Not exceeded		
NO_2 AEGL-2 (injury)	min 6.7 ppm	Not exceeded		
NO_2 AEGL-3 (fatality)	min 11 ppm	Not exceeded		
Maximum ground level concentration (NO)	1.3 ppm	60 metres downwind	Ambient temperature Wind speed Stability Category Mixing / Inversion height	25^{0}C 14.4 m/s C 3217 m
NO, No health effect	80 ppm	Not exceeded		
TRUCK				
Maximum ground level concentration (NO_2)	0.1 ppm	60 metres downwind	Ambient temperature Wind speed Stability Category Mixing / Inversion height	25^{0}C 14.4 m/s C 3217 m
NO_2 AEGL-1 (irritation)	0.5 ppm	Not exceeded		
NO_2 AEGL-2 (injury)	min 6.7 ppm	Not exceeded		
NO_2 AEGL-3 (fatality)	min 11 ppm	Not exceeded		
Maximum ground level concentration (NO)	0.73 ppm	60 metres downwind	Ambient temperature Wind speed Stability Category Mixing / Inversion height	25^{0}C 14.4 m/s C 3217 m
NO, No health effect	80 ppm	Not exceeded		

Attachment E Explosion Frequency Analysis

SAFEX Frequencies

As discussed in ***Section 9 Frequency Analysis – Explosions*** (page 45) SAFEX has presented a series of baseline event frequencies based on historical events for ammonium nitrate explosions at manufacturing sites.

The SAFEX document allows for the baseline event frequencies, which are based on historical incidents, to be reduced based on implementation of best practice control measures.

SAFEX recommend the use of dedicated storage facilities and sites to minimise the potential for contamination and shock impact with high velocity projectile that may be associated with manufacturing operations or explosives storage. Therefore, for a dedicated storage site like Crawfords, it is likely that the frequency of an explosion is lower than at manufacturing sites.

The following sections discuss the implementation of relevant best practice approaches and controls, as described in the SAFEX document, and the inherent controls associated with a dedicated storage site. The final section of this Attachment summarises the approach adopted in reducing the SAFEX baseline frequencies based on these control measures.

Proposed controls

Management systems and plans

As described in ***Section 16 Management systems and Plans*** (page 65) the facility has implemented a documented Safety Management System. This document presents the framework and requirements of the Safety Management System, with detail of plans, forms, procedures, etc contained in a series of appendices to the document. This document, or elements of this document, are updated on an as-needs basis (at least annually).

The document includes safety-related policies, consultative processes, audit and inspection programs, incident reporting and investigation requirements, contractor management, operating procedures, and training and induction requirements.

The Site Emergency Plan has been prepared in accordance with the requirements of the NSW Department of Planning's *Hazardous Industry Planning Advisory Paper No. 1 – Emergency Planning*, January 2011 (HIPAP 1).[33] The Site Emergency Plan has been reviewed by Stuart Harvey, NSW Fire and Rescue representative on the WorkCover Major Hazard Facilities team.

The site is secured against unauthorised access, and a Site Security Plan has been prepared and reviewed by Inspector Marilyn Hamilton, the NSW Police representative on the WorkCover Major Hazard Facilities team.

The site will be classified as a Major Hazard Facility (MHF) and will be licensed by NSW WorkCover.

Site design and construction

Buildings used for storing ammonium nitrate are large, open, single-story warehouses located at ground level with multiples means of access and egress. The buildings are used solely for storing ammonium nitrate – there are no offices within these buildings, flexible bags are not opened within the stores, and no transfer of ammonium nitrate occurs within the stores.

The buildings are constructed of non-combustible material:

- ***Shed A:*** Walls of corrugated metal sheeting (existing timber is to be coated with concrete). Roof is corrugated metal sheeting. Floor is concrete.
- ***Shed B:*** Walls of corrugated metal sheeting (existing timber is to be coated with concrete). Roof is a gel-coated polyester sheeting reinforced with heavy gauge woven glass matting suitable for use in corrosive environments. Floor is concrete.
- ***Shed C:*** Walls of corrugated metal sheeting. Roof is fibrous asbestos sheeting. Floor is concrete.

The entire site consists of hard-stand areas with no vegetation or grass in close proximity to the stores. Products stored in the "Outdoor Storage (General)" locations (refer to site map on page 4) is typically non-combustible (predominantly aluminium and steel). If combustible material is to be stored at the site (eg timber logs) this will be located only in areas well removed from the ammonium nitrate stores.

All buildings are provided with natural ventilation through gaps in walls, roof-joins, etc (ie the buildings are not well-sealed) with doors kept fully open when persons are working the stores.

Forklifts, vehicles and equipment

Three diesel-powered forklifts are used at the site to transfer ammonium nitrate bags from vehicles and shipping containers to storage, and vice-versa. These forklifts are the only vehicles taken into the store (ie trucks do not enter the stores) and meet the requirements of AS 4326 for internal combustion engines operated within ammonium nitrate stores, including:

- Diesel-powered forklifts.
- Forklifts provided with a battery isolation switch and an insulated cover over the battery terminals.
- Forklifts are fitted with a spark arrester.

Forklifts are garaged at least 10 metres from any store and are only started outside the store. Operators remain with the forklift whenever it is in the store.

Maintenance of the forklifts is scheduled after 250 hours-of-use and is conducted by Crawfords mechanics. Prestart checks, including checks for oil and fuel leaks, are conducted daily for each forklift.

Crawfords operates its own fleet of vehicles and conducts maintenance of these vehicles under the National Heavy Vehicle Accreditation Scheme (NHVAS). The accreditation scheme is a formal process for recognising operators who have good safety and management systems in place. As an accredited operator, Crawfords are subject to independent audits and must maintain:

- An in-house assurance system.
- Documented procedures that staff must follow to achieve compliance.
- Documents that prove compliance.

Crawfords are accredited in two of the four available modules: Mass Management and Maintenance Management. This requires them to ensure that vehicles are adequately maintained and comply with all applicable vehicle standards at all times, and provides them with an exemption of the requirement to have vehicles inspected annually for the purposes of registration.

A diesel-powered belt conveyor and an electric screw-conveyor (auger) are used to transfer ammonium nitrate from bags to bulk transport trailers. A number of Standards and Codes relating to the handling of ammonium nitrate, and the mixing of explosives, specify requirements for belt-conveyors and/or screw-conveyors (augers) used for ammonium nitrate. These include:

- AS 4326-2008 The storage and handling of oxidizing agents
- Australian Explosives Industry And Safety Group (AEISG): Code of good practice – Precursors for explosives, 1999 (Section 6).
- AS 2187.2-2006 Explosives – Storage and use – Use of explosives. (Section 3.4.1 provides general guidance on the design of mixing units, including those used for ammonium nitrate).

The design of the belt-conveyor and screw-conveyor meet the requirements of these standards. Maintenance of the conveyors is scheduled after 100 hours-of-use and is conducted by Crawfords mechanics. Prestart checks are conducted for each conveyor.

Preventing contamination

Ammonium nitrate is received in flexible bags only (1-1.25 tonne per flexible bag) on trucks from the Port of Newcastle, by rail in shipping containers from the Port of Sydney, or on trucks directly from local manufacturers. These products have been manufactured in Australia or overseas and have been packaged and transported by road, rail and/or sea as UN 1942 (ammonium nitrate with not more than 0.2% combustible material). For every shipment received, Crawfords require a Certificate of Analysis verifying that the properties of the ammonium nitrate supplied meet the required specification for classification as UN 1942.

The flexible bags are light-coloured (generally white) and any external contamination by oil, grease or fuel is easily identifiable when unloading from the ship, shipping container or truck. Any bags showing signs of possible contamination are segregated and assessed.

No other dangerous goods are stored at the Crawfords site. No other goods (of any nature) are stored within the ammonium nitrate storage areas. Bags remained closed in storage. The only time bags are opened is immediately prior to them being transferred to bulk trailers for dispatch direct to mine sites. There is no potential for contamination of the ammonium nitrate with any other chemical product once the product has arrived at the site.

Maintenance of the forklifts is scheduled after 250 hours-of-use and is conducted by Crawfords mechanics. Daily prestart checks, including checks for oil and fuel leaks, are conducted.

Stores are to be flood-protected to prevent flood-waters from entering the store. In the event of flood, this will prevent any organic flood debris from entering the stores.

The site is not licensed to store any explosive material (ie ammonium nitrate that may be contaminated with combustible or organic material). If any contaminated material is identified on arrival, the customer (Downer, Dyno, Orica) is contacted immediately and the product is removed from site to a suitable storage facility operated or designed by the customer.

Management of ignition / heat sources

In addition to the previously described controls in place to manage potential ignition / fire risks associated with vehicles and building construction materials, the further considerations and procedures in relation controlling ignition or heat sources are considered relevant to reducing the risk of heating, decomposition and explosion:

- Site rules and requirements, including no smoking and Work Permits for non-routine tasks, ensure that that ignition sources that might present a are managed.
- Applying the risk management approach outlined in *AS/NZS 1768 Lightning Protection*, and assuming the contents of the store to be non-flammable and non-explosive as specified in AS 4326, demonstrates the risk with no lightning protection is acceptable. The level of risk is calculated to be 10^{-8} which is three orders of magnitude lower than the acceptable risk recommended (10^{-5}). On this basis, the risks due to lightning are considered negligible.

Fire fighting equipment

Fire extinguishers are provided in buildings and on all vehicles. The primary purpose of these is for the fighting of fires in electrical or mechanical equipment. The site is provided with firewater system with booster stations located close to the Crawfords office and Shed C.

A series of three hydrants are located between Shed A & Shed B. The location of these hydrants is currently being reviewed, as access to them is through the corridor between Shed A & Shed B, which may present hazards to firefighters in the event of an emergency. It is likely that these hydrants will be relocated (or decommissioned and new hydrants installed) to allow for water application in the vicinity of Shed A and Shed B. Shed C is fitted with an external hydrant, and four internal hydrants (one located on each wall).

Dedicated storage site

SAFEX recommend the use of dedicated storage facilities and sites. Therefore, for a dedicated storage site like Crawfords, it is likely that the frequency of an explosion is lower than at manufacturing sites for the following reasons:

Contamination

Contamination is most likely to occur as part of the manufacturing process, or during packaging – all activities conducted at manufacturing sites. For example, the Toulouse incident is believed to have been caused by "off-spec" product that was placed into storage.

Product received at Crawfords has been manufactured and packaged elsewhere, and transported to the Crawfords site under relevant dangerous goods transport legislation (International Maritime Dangerous Goods Code, Australian Code for the Transport of Dangerous Goods by Road and Rail). In most cases, significant time has elapsed between manufacture and receipt at Crawfords, and any problems associated with contaminated product are likely to have become apparent prior to arrival at Crawfords.

All shipments received at Crawfords are accompanied by a Certificate of Analysis, confirming correct classification and quality of product.

Visual observation during loading / unloading at the Port and at Crawfords should identify any contamination that has occurred during transit.

Potential contamination from activities at the Crawfords site is limited to vehicles. Operators are present at all times and any contamination should be easily identifiable.

Operating practices are in place to ensure any product identified as contaminated is isolated and removed from site as soon as reasonably practicable.

Fire

Storage is conducted in buildings constructed of non-combustible material. No combustible materials are stored in the ammonium nitrate storage areas.

Any potential source of fire at the site (eg other products stored) is segregated by a significant distance from the ammonium nitrate storage areas.

External sources of fire are minimal and based on vegetation only. Based on the type, location and density of vegetation, any vegetation fire would have minimal heating effect on stored ammonium nitrate.

Projectiles

Crawfords does not undertake any storage of explosive materials, a practice often associated with ammonium nitrate storage. At ammonium nitrate manufacturing sites, there are numerous sources of potential explosion projectiles from the manufacturing process (eg high temperature and/or high pressure storage and processing vessels, potential explosions during manufacturing); or from the associated manufacturing of explosive materials.

At Crawfords, the only potential for projectiles from off-site site impacting on the ammonium nitrate storage would be a fire or explosion along the adjacent railway line or roadway, eg fuel tanker, LPG tanker. The chance of any single incident on the road or rail causing a projectile-initiated ammonium nitrate explosion at Crawfords is highly unlikely.

STORAGE: Explosion frequencies used in this Hazard Analysis

There are numerous papers that present a listing of historical accidents involving ammonium nitrate. It is generally acknowledged that many of these historical accidents, particularly those resulting in explosion, are no longer credible scenarios given current practices.

A quick scan through the listing of historical incidents in the table on page 12 shows that very few, if any, of these incidents would be considered credible at the Crawfords site. Even reviews of more recent incidents (1991 to 2007)[34] show that less than half of these are relevant to the Crawfords operations, and of these, more than half can be further eliminated as not credible – and none of these incidents resulted in explosion.

The two incidents on which the SAFEX frequencies are based (contamination by off-spec manufactured product at manufacturing site, fire in combustible warehouse) are not considered credible scenarios for Crawfords.

Based on this and the previous discussions regarding safety practices and inherent controls, the following approach has been adopted in defining explosion scenario frequencies for this Hazard Analysis:

- Base explosion frequencies used in this study are those presented in the SAFEX document.
- The base explosion frequencies have been adjusted to reflect the control measures in place at the Crawfords site compared with the approaches and practices represented by historical incidents.
- For explosions in storage areas initiated by contamination, the frequencies used for this Hazard Analysis are assumed to be 10% of the SAFEX baseline frequencies (refer to previous sections for discussion on inherent and implemented controls that prevent contamination of ammonium nitrate).
- For explosions in storage areas initiated by fire, the frequencies used for this Hazard Analysis are assumed to be 20% of the SAFEX baseline frequencies (refer to previous sections for discussion on inherent and implemented controls that prevent exposure of ammonium nitrate to heat or fire).
- For explosions in storage areas initiated by projectiles, the frequencies used for this Hazard Analysis are assumed to be 1% of the SAFEX baseline frequencies due to the absence of any explosion events, other than incidents which may occur on the nearby road or rail.

TRUCKS: Explosion frequencies used in this Hazard Analysis

Without any specific incident frequency for truck incidents occurring at storage sites being available, the following approach has been adopted:

- For scenarios involving explosions on trucks, the SAFEX baseline frequencies have been used for incidents initiated by contamination and fire without any adjustment.
- For explosions involving trucks initiated by projectiles, the frequencies used for this Hazard Analysis are assumed to be 1% of the SAFEX baseline frequencies due to the absence of any explosion events, other than incidents which may occur on the nearby road or rail.
- For each location, an estimate of the time a truck may be present has been determined by Crawfords by considering the number of trucks per day, and the duration of loading / unloading. Incident frequencies have been adjusted to reflect the reduction in risk due to the intermittent nature of truck presence at the site.

AUGER: Explosion frequencies used in this Hazard Analysis

Without any specific incident frequency for auger or conveyor incidents occurring at storage sites being available, the following approach has been adopted:

- For explosions involving the auger or conveyor, a factor of 10 has been applied to the total baseline storage frequency presented by SAFEX. The highest TNT equivalency (32%) has also been applied to these explosions. This recognises the higher risks due to friction and heat associated with moving and rotating equipment and potential for confinement within the equipment.
- For each location, an estimate of the time an auger or conveyor may be operating has been determined by Crawfords by considering the number of bulk truck loadings per day, and the duration of loading. Incident frequencies have been adjusted to reflect the reduction in risk due to the intermittent nature of auger or conveyor operating at the site.

Attachment F Risk Analysis

The map below and tables on the following pages summarises the scenarios that have been modelled in conducting the risk analysis.

LIST OF SCENARIOS – STORAGE: Shed A (4500 tonne)								
Scenario	Initiating Event	TNT Equivalency	Quantity of AN	Base Frequency (per 2500 tonnes)	Frequency reduction due to quantity less than 2500 tonnes		Frequency reduction due to inherent and implemented controls	
					Factor	Frequency	Factor	Frequency
Shed A – East	Contamination	16%	2 250 tonne (50% of store)	25×10^{-6}	$\frac{2250}{2500} = 0.9$	22.5×10^{-6}	0.1	2.25×10^{-6}
	Fire (no pallets)	5%	2 250 tonne (50% of store)	25×10^{-6}	$\frac{2250}{2500} = 0.9$	22.5×10^{-6}	0.2	4.5×10^{-6}
	Projectiles	32%	2 250 tonne (50% of store)	5×10^{-6}	$\frac{2250}{2500} = 0.9$	4.5×10^{-6}	0.01	4.5×10^{-8}
Shed A – West	Contamination	16%	2 250 tonne (50% of store)	25×10^{-6}	$\frac{2250}{2500} = 0.9$	22.5×10^{-6}	0.1	2.25×10^{-6}
	Fire (no pallets)	5%	2 250 tonne (50% of store)	25×10^{-6}	$\frac{2250}{2500} = 0.9$	22.5×10^{-6}	0.2	4.5×10^{-6}
	Projectiles	32%	2 250 tonne (50% of store)	5×10^{-6}	$\frac{2250}{2500} = 0.9$	4.5×10^{-6}	0.01	4.5×10^{-8}

LIST OF SCENARIOS – STORAGE: Shed B (4500 tonne)								
Scenario	Initiating Event	TNT Equivalency	Quantity of AN	Base Frequency (per 2500 tonnes)	Frequency reduction due to quantity less than 2500 tonnes		Frequency reduction due to inherent and implemented controls	
					Factor	Frequency	Factor	Frequency
Shed B – East	Contamination	16%	2 250 tonne (50% of store)	25×10^{-6}	$\frac{2250}{2500} = 0.9$	22.5×10^{-6}	0.1	2.25×10^{-6}
	Fire (no pallets)	5%	2 250 tonne (50% of store)	25×10^{-6}	$\frac{2250}{2500} = 0.9$	22.5×10^{-6}	0.2	4.5×10^{-6}
	Projectiles	32%	2 250 tonne (50% of store)	5×10^{-6}	$\frac{2250}{2500} = 0.9$	4.5×10^{-6}	0.01	4.5×10^{-8}
Shed B – West	Contamination	16%	2 250 tonne (50% of store)	25×10^{-6}	$\frac{2250}{2500} = 0.9$	22.5×10^{-6}	0.1	2.25×10^{-6}
	Fire (no pallets)	5%	2 250 tonne (50% of store)	25×10^{-6}	$\frac{2250}{2500} = 0.9$	22.5×10^{-6}	0.2	4.5×10^{-6}
	Projectiles	32%	2 250 tonne (50% of store)	5×10^{-6}	$\frac{2250}{2500} = 0.9$	4.5×10^{-6}	0.01	4.5×10^{-8}

LIST OF SCENARIOS – STORAGE: Shed C (4000 tonne)								
Scenario	Initiating Event	TNT Equivalency	Quantity of AN	Base Frequency (per 2500 tonnes)	Frequency reduction due to quantity less than 2500 tonnes		Frequency reduction due to inherent and implemented controls	
					Factor	Frequency	Factor	Frequency
Shed C – North	Contamination	16%	2 000 tonne (50% of store)	25×10^{-6}	$\frac{2000}{2500} = 0.8$	20×10^{-6}	0.1	2×10^{-6}
	Fire (no pallets)	5%	2 000 tonne (50% of store)	25×10^{-6}	$\frac{2000}{2500} = 0.8$	20×10^{-6}	0.2	4×10^{-6}
	Projectiles	32%	2 000 tonne (50% of store)	5×10^{-6}	$\frac{2000}{2500} = 0.8$	4×10^{-6}	0.01	4×10^{-8}
Shed C – South	Contamination	16%	2 000 tonne (50% of store)	25×10^{-6}	$\frac{2000}{2500} = 0.8$	20×10^{-6}	0.1	2×10^{-6}
	Fire (no pallets)	5%	2 000 tonne (50% of store)	25×10^{-6}	$\frac{2000}{2500} = 0.8$	20×10^{-6}	0.2	4×10^{-6}
	Projectiles	32%	2 000 tonne (50% of store)	5×10^{-6}	$\frac{2000}{2500} = 0.8$	4×10^{-6}	0.01	4×10^{-8}

LIST OF SCENARIOS – STORAGE: Shipping Containers (500 tonne)								
Scenario	Initiating Event	TNT Equivalency	Quantity of AN	Base Frequency (per 2500 tonnes)	Frequency reduction due to quantity less than 2500 tonnes		Frequency reduction due to inherent and implemented controls	
					Factor	Frequency	Factor	Frequency
Shed C Compound	Contamination	16%	500 tonne	25×10^{-6}	$\frac{500}{2500} = 0.2$	5×10^{-6}	0.1	0.5×10^{-6}
	Fire (with pallets)	5%	500 tonne	50×10^{-6}	$\frac{500}{2500} = 0.2$	10×10^{-6}	0.2	2×10^{-6}
	Projectiles	32%	500 tonne	5×10^{-6}	$\frac{500}{2500} = 0.2$	1×10^{-6}	0.01	1×10^{-8}

LIST OF SCENARIOS – TRUCK: Bag Loading and Unloading								
Scenario	Initiating Event	TNT Equivalency	Quantity of AN	Base Frequency	Frequency reduction due to time on-site per year		Frequency reduction due to inherent and implemented controls	
					Factor	Frequency	Factor	Frequency
East of Shed A Unloading – ship	Contamination	16%	40 tonne	25×10^{-6}	0.05	1.25×10^{-6}	–	1.25×10^{-6}
	Fire (with pallets)	5%	40 tonne	50×10^{-6}	0.05	2.5×10^{-6}	–	2.5×10^{-6}
	Projectiles	32%	40 tonne	5×10^{-6}	0.05	0.25×10^{-6}	0.01	2.5×10^{-9}
North of Shed A Loading – Bags	Contamination	16%	40 tonne	25×10^{-6}	0.05	1.25×10^{-6}	–	1.25×10^{-6}
	Fire (with pallets)	5%	40 tonne	50×10^{-6}	0.05	2.5×10^{-6}	–	2.5×10^{-6}
	Projectiles	32%	40 tonne	5×10^{-6}	0.05	0.25×10^{-6}	0.01	2.5×10^{-9}
East of Shed C Unloading – Ship Loading – Bags	Contamination	16%	40 tonne	25×10^{-6}	0.05	1.25×10^{-6}	–	1.25×10^{-6}
	Fire (with pallets)	5%	40 tonne	50×10^{-6}	0.05	2.5×10^{-6}	–	2.5×10^{-6}
	Projectiles	32%	40 tonne	5×10^{-6}	0.05	0.25×10^{-6}	0.01	2.5×10^{-9}

LIST OF SCENARIOS – BULK LOADING: Auger and Trucks

Scenario	Initiating Event	TNT Equivalency	Quantity of AN	Base Frequency	Frequency reduction due to operating time / time on-site per year		Frequency reduction due to inherent and implemented controls	
					Factor	Frequency	Factor	Frequency
North of Shed A Auger	Auger	32%	50 kg	7.5×10^{-4} $10 \times (25 \times 10^{-6} + 50 \times 10^{-6})$	0.1	7.5×10^{-4}	–	7.5×10^{-4}
South-East of Shed C Auger	Auger	32%	50 kg	7.5×10^{-4} $10 \times (25 \times 10^{-6} + 50 \times 10^{-6})$	0.05	3.75×10^{-5}	–	3.75×10^{-5}
North of Shed A Loading Truck – Bulk	Contamination	16%	40 tonne	25×10^{-6}	0.1	2.5×10^{-6}	–	1.25×10^{-6}
	Fire (with pallets)	5%	40 tonne	50×10^{-6}	0.1	5×10^{-6}	–	2.5×10^{-6}
	Projectiles	32%	40 tonne	5×10^{-6}	0.1	5×10^{-7}	0.01	5×10^{-9}
South-East of Shed C Loading Truck – Bulk	Contamination	16%	40 tonne	25×10^{-6}	0.05	1.25×10^{-6}	–	1.25×10^{-6}
	Fire (with pallets)	5%	40 tonne	50×10^{-6}	0.05	2.5×10^{-6}	–	2.5×10^{-6}
	Projectiles	32%	40 tonne	5×10^{-6}	0.05	2.5×10^{-7}	0.01	2.5×10^{-9}

Explosions: Probability of fatality

The table below summarises the assumptions used in determining the risk of fatality due to explosion overpressure.

INDIVIDUAL RISK: Probability of Fatality from Explosion Overpressure		
Explosion Overpressure	Outdoors	Indoors*
21 kPa (3 psi)	1% chance of fatality	20% chance of fatality
35 kPa (5 psi)	15% chance of fatality	50% chance of fatality
70 kPa (10 psi)	100% chance of fatality	100% chance of fatality

* Used in the calculation of Societal Risk

Societal Risk: Population Data

Residential locations that could be affected by an explosion include the residential strip along the highway to the east of the site (30 residences), and the residences located directly to the south of the site (21 residences). Census data (2011) for these two areas shows number of persons per residence as 2.3 and 2.4 respectively.

Due to the small number of residences impacted and the large areas of open space present in the census districts, an estimate of the number of houses affected by each incident has been made rather than using a population density and area affected. The number of houses has been multiplied by 2.4 to determine the number of people affected.

It has been assumed that persons are indoors at all times.

CRAWFORDS Freightlines Pty Ltd

Attachment G References

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