Stockton Community Group Inc. Submission Ammonium Nitrate Storage Separation Distances Review

Background

The Stockton community have been very concerned with the storage of large quantities of potentially explosive ammonium nitrate at the Orica ammonium nitrate (AN) plant on Kooragang Island (KI) close to the Stockton communities and many other communities in Newcastle area. We therefore welcome a review and changes to the existing storage distances in NSW to bring them closer to the WA regulations. We consider the WA regulations to be based on more rigorous and accepted blast radius principles, and therefore be suitable and applicable to urban environments.

Large stockpiles of AN potentially explosive material are stored in amounts not allowed in other states close to communities in Newcastle. These stockpiles range from 6000 to 12,000 tonnes, depending on production at the Orica plant on KI. In particular:

- Past community concerns have been dismissed in NSW
- We are likely the world record holder for amount of AN stored close to a city centre.
- We believe offsite storage is a simple & doable solution.
- All the AN is used by the local mining industry (little/no export)

Issues

Ammonium Nitrate Explosion Risk poses an interesting mathematical equation:
Risk = ***very small probability of occurrence*** * ***catastrophic consequence***
This is similar Risk issue to what the Nuclear industry and munitions industries have to face, and while the Risk may become small it is never zero, nor are the consequences minor
Simple Solution: You can avoid the risk by reducing &/or moving the volumes

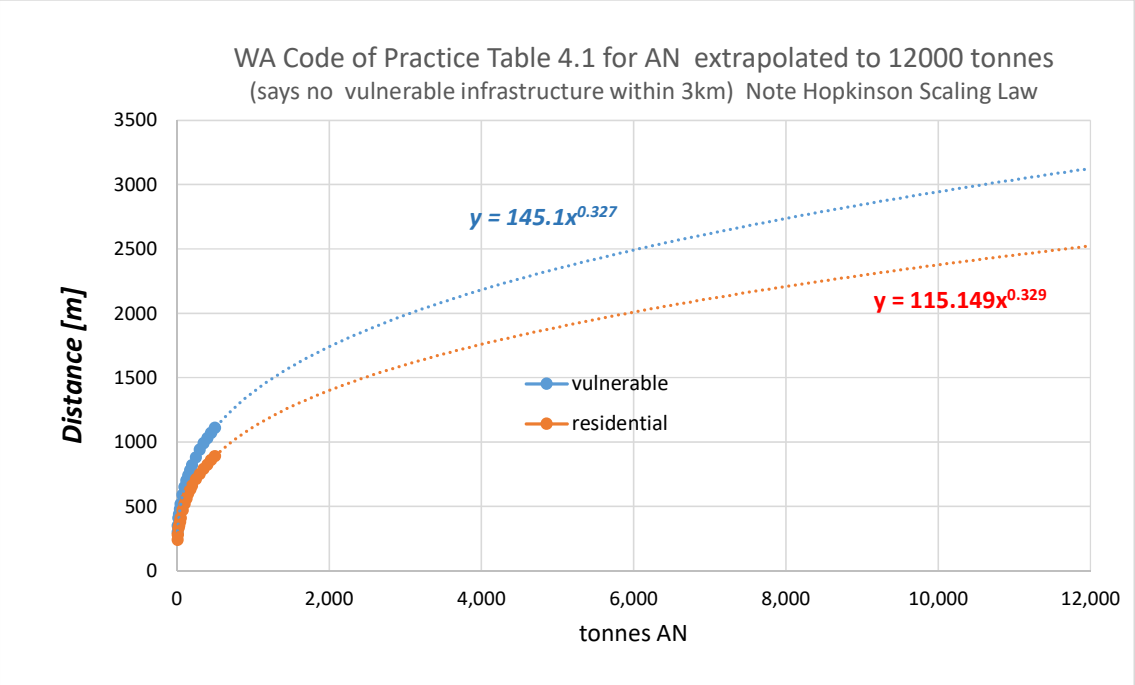
Salient Facts:

- Australia delegates to the states local restrictions
- What NSW allows would not be acceptable in WA or SA
- Stockton is in the frontline

Blast radius has been well understood (since 1915 or so: Hopkinson Rule). Example of WA guidelines / rules are below:

> Many States use rules based upon the explosives, their quantity, and the distance from the explosive to where people are at risk. These rules are known as Quantity-Distance (Q-D) criteria, and are based on the approach derived from the *Hopkinson-Cranz Scaling Law*[6] [7], which is further amended by a range of coefficients. It is the basis of much of the work on the estimation of appropriate quantity and separation distances.
>
> UN SaferGuard
> Securing ammunition, protecting lives

Kooragang: 10-12,000 tonnes AN.
(Explosive yield ~ 1/3 Hiroshima)



CODE OF PRACTICE

Safe storage of solid ammonium nitrate

Third edition

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Table 4.1 Recommended minimum separation distances for AN stores

Quantity of AN stored in the largest stack (kg)	Recommended minimum separation distances (D)			
	Vulnerable facilities and critical infrastructure (m)	Residential buildings (m)	Commercial buildings (m)	Industrial plant and factories (m)
10,001	300	240	140	110
15,000	350	280	160	120
20,000	410	330	180	130
30,000	440	350	200	150
40,000	480	380	220	170
50,000	520	410	240	180
75,000	590	470	280	210
100,000	650	520	300	230
125,000	700	560	330	240
150,000	740	600	350	260
175,000	780	630	370	270
200,000	820	660	380	290
250,000	880	710	410	310
300,000	940	750	440	330
350,000	990	790	460	350
400,000	1,030	825	480	360
450,000	1,070	860	500	380
500,000	1,110	890	520	390

Note above: kg not tonnes

Stockton has houses as close as 800m when (per WA regulations) distances of 3000m are needed for this amount (12,000 tonnes) of AN.

What a 3km radius looks like around a blast centre

As can be seen above there are a number of suburbs within a 3 km radius plus major port infrastucture and major transport route bridge. When this radius goes out to 5 kms we have 15 suburbs, Newcastle CBD and major port infrastucture and around 50,000 people.

It is noted the proposed changes in the discussion paper bring the requirements for ammonium nitrate storage separation distances between stockpiles and to communities closer to the WA regulations. This would result in the current stockpiles of AN storage at the Orica plant on KI of 6000 to 12000 tonnes to be contrary to the proposed new regulations requiring the stockpiles to be reduce to <200 tonnes to provide adequate distance between the AN storage and communities (Protected Works Class B). This would be welcome by the community.

We note AN stored at the Orica plant on KI is stored and managed to reduce the risk of accidental explosion. However, this doesn't mean the risk is reduced to a level acceptable to the community and we have seen accidents and Black Swan events around the world resulting in AN explosions causing loss of life, injury and damage to property and infrastructure.

Ammonium nitrate can explode under a range of conditions including fire, shock and contact with contaminants. There have been many accidental explosions worldwide despite precautions being taken to avoid explosions. Explosions involving even smaller quantities of ammonium nitrate, such as in the Toulouse explosion involving 300 tonnes in 2001, resulted in many injuries and damage to buildings up to 5 km from the plant. More recently we have seen the death, injury, damage and destruction of larger quantities of AN explosion can cause as happened in Beirut (amounts of AN still much less than that stored at the Orica plant on KI).

Ammonium nitrate is used as an explosive in the mining industry by the addition of a fuel and a detonator. However most accidental explosions of ammonium nitrate have not been via this route. Ammonium nitrate can become less resistant to detonation/initiation and explode due to the following conditions:

- The presence of contaminants including chlorides, some metals, oil, diesel, paper, rag or straw.
- Exposure to high temperatures (fire) especially when confined including confinement in larger stacks.
- Exposure to shock including shock waves from a nearby explosion. A small detonation can trigger an explosion in a larger quantities stored nearby causing a domino effect.

There have been many accidental explosions of ammonium nitrate since its production including over 10 explosions since 2000. This has been in storages, during the production process and during transport. ("List of ammonium nitrate disasters – Wikipedia"). Ammonium nitrate explosions also result in the release of large amounts of toxic gases including nitrogen dioxide and ammonia.

The explosion scenarios to be assessed should pay particular attention to identifying worst case scenarios. No significant events should be omitted and propagation and domino effects should be considered. Accident scenarios should not be dismissed because they are thought to be unlikely.

Accidental scenarios could include fire, explosion (detonation from shock), terrorism, aircraft crash (note the Newcastle airport and RAAF base is located at Williamtown just over 10 km from the Orica plant on KI plus helicopters regularly fly over the plant with pilots for incoming shipping), contamination, earthquake (as occurred in Newcastle in 1989) and lightning strikes.

The explosive potential of AN is outlined in the table below.

Explosive Potential of Ammonium Nitrate

Quantity (tonnes)	TNT equivalent (tonnes) (0.32/0.7)	Area Affect (km radius)	Effects
300	9.6/210	5	Toulouse explosion, killed 31, injured 14,000, damaged 30,000 houses, 5 km damage radius
2,300	736/1,610	50	Texas City explosion, killed 700, injured 15,000, windows shattered 60 km away
11,000	3,520/7,700	Unknown >>50 km	
20,000	6400/14,000	Unknown >> 50 km	Hiroshima atomic bomb equated to 18,000 t of TNT
Closest residents to the proposed Orica plant on KI are 0.8 km away, 3 km from Newcastle CBD, approximately 50,000 people within 5 km of the proposed plant			

Pictures from the Toulouse and Texas City explosion are shown below:

Toulouse AZF ammonium Nitrate plant before the Explosion

Toulouse AZF ammonium Nitrate plant after the Explosion

Toulouse Explosion Crater

Toulouse Site Damage

Toulouse Site Damage

Toulouse City Window Breakage

Building Damage Toulouse

Damage from Flying Steel Girders

Toulouse Explosion Injuries

Texas City Ammonium Nitrate Explosion

Accidents with Ammonium Nitrate

Location	Date	Details
Morgan, New jersey	1918	Explosion of AN stored due to explosion at nearby artillery depot
Kriewald, Germany	1921	Explosion of AN in railway wagons – 19 killed
Oppau, Germany	1921	Explosion of AN/ammonium sulphate mix – killed 450 people and destroyed 700 houses
Nixon, New Jersey	1924	Fire and explosion of stored AN
Muscle Shoals, Alabama	1925	Rail cars carrying AN caught fire and exploded
Rouen, France	1940	Explosion of AN due to bomb landing on storage during the war
Miramas, France	1940	240 tonnes of AN exploded after being hit by a shell from a fire in a munitions train
Tessenderlo, Belgium	1942	150 tonnes of stored AN exploded – several hundred people killed
Texas City, US	1947	Cargo ship being loaded had 2,600 tonnes of AN on board – fire broke out and AN exploded killing several hundred people and destroying nearby ship. Also created a powerful earth shock and knocked two small planes out of the shy flying at 1500 m
Brest, France	1947	Cargo ship loaded with 3300 tonnes of AN caught fire and exploded – caused 29 deaths and serious damage to Port of Brest
Red Sea	1954	Fire on cargo ship while carrying 4000 tonnes of AN – ship abandoned and exploded
Roseburg, Oregon	1959	Truck carrying AN caught fire and exploded killing 14 people and injuring 125 and destroying several blocks of the city.
Kansas City, Missouri	1988	Two trucks carrying 23 tonnes of AN exploded at a construction site killing 6 people
Papua New Guinea	1994	AN emulsion exploded at a mine site killing 11 workers- involved only few tonnes of AN however fire exploded stored 80 tonnes of AN

Port Neal, Iowa	1994	Two explosions at AN processing plant with 4 people killed and 18 injured. Released large amount of ammonia.
Sioux City, Iowa	1994	AN processing plant explosion during processing of AN - killed 4 people and there were many injuries
Toulouse, France	2001	Explosion at a Fertilizer factory of 200 to 300 tonnes of stored AN killed 31 people and injured 14,000 people 2,500 seriously. Blast shattered windows up to 5 km away with 10 m deep crater 50 m wide. Material damage estimated at 2.3 billion euros
Cartagena, Muricia, Spain	2003	Fertiliser factory had self-sustained decomposition fire - fire was controlled.
Barracas, Spain	2004	Truck carrying 25 tonnes of AN exploded after an accident killing 2 people and injuring 3. Explosion heard 10 km away and crater was 5 m deep
Mihailasti, Buzau, Romania	2004	Truck carrying 20 tonnes of AN tipped over and fire started and truck exploded killing 18 people and injuring 13. The crater was 6.5 m deep and 42 m diameter.
Ryongchon, North Korea	2004	Freight train carrying AN exploded killing 162 people and injuring over 3,000. Train station was destroyed and 8,000 buildings destroyed
Estaca de Bares, Spain	2007	AN fertilizer cargo underwent self-sustained combustion fire – fire was extinguished before an explosion
Monclova, Coahuila, Mexico	2007	Truck loaded with 22 tonnes of AN crash and fire started and then explosion resulting in the death of 37 people and 150 people injured
Bryan, TX, US	2009	AN Plant caught fire and emitted toxic fumes.
West, Texas, US	2013	240 tonnes of AN, 85 killed
Wyardra, Qld, Australia	2014	56 tonnes AN
Port of Tiajin, China	2015	800 tonnes AN, 173 killed
Beruit, Lebanon	2020	2,750 tonnes AN, 218 killed, AN stored at Port

The Figure below gives an overview of AN explosions since 2000 plus a list of the nine deadliest AN explosions in history (Risk Frontiers “Accidental Ammonium Nitrate Explosions”.

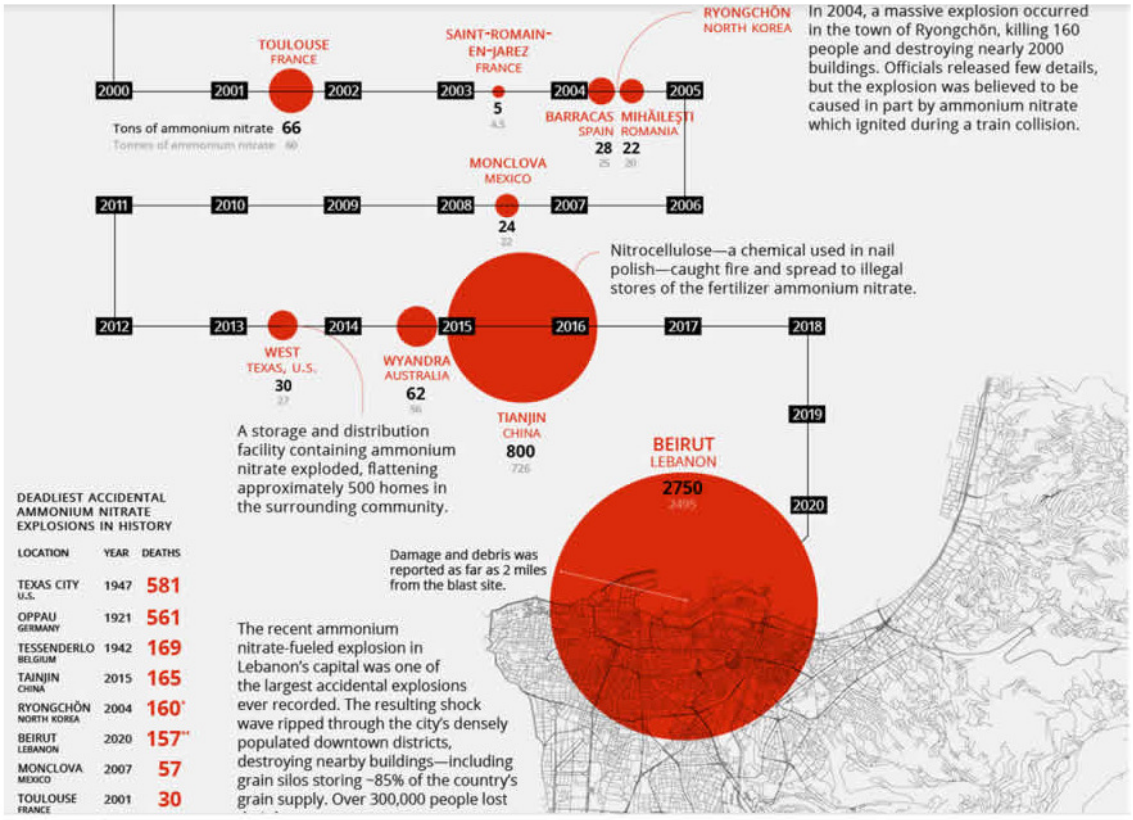

Figure 1. Timeline of the largest accidental ammonium nitrate explosions in the world since 2000. Source: VisualCapitalist.

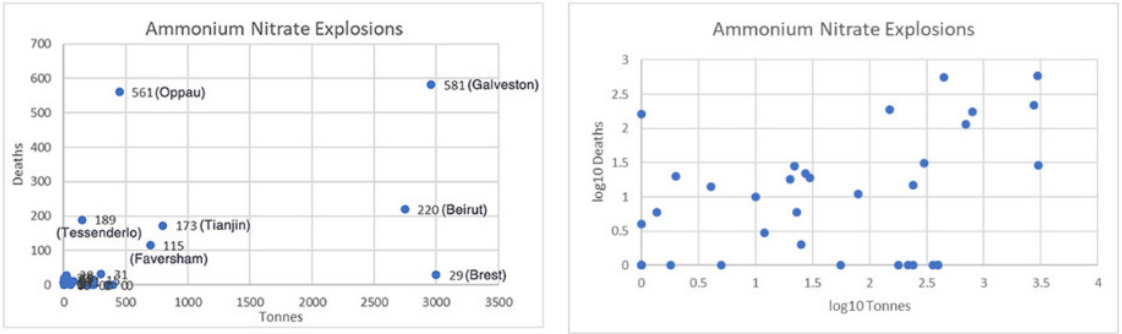

Figure 2. Relation between size (tonnes) and deaths from accidental ammonium nitrate explosions on linear (left) and log (right) scales. Several zero values on the axes of the log plot actually represent zero values: the 2004 North Korean event of 162 tonnes had no reported deaths.

Summary

In summary the Stockton Community Group welcomes the review and proposed changes the AN storage distances. The location of up to 12,000 tonnes of AN stored at the Orica AN factory has been a major concern for the community and we have noted the major difference in storage distances for different states. We consider the WA regulations to be based on more rigorous and accepted blast radius principles, and therefore be suitable and applicable to urban environments. The changes would bring the NSW regulations closer to the regulations in WA and as such the SCG welcomes these changes.

We note these changes would mean the storage volumes of AN at the Orica plant would result in storage volumes being <200 tonnes requiring storage of the AN produced at the plant to be off-site well away from communities. A purpose made storage facticity for the AN produced closer to the coal mines in the Hunter Valley with appropriate security would be a much safer result for the Stockton and Newcastle community and be well away from major Port infrastructure.

The SCG would prefer to see these changes be implemented as soon as possible to reduce the risk to the surrounding communities in Newcastle. However, this will require time for the construction of separate off-site secure storage areas away from communities.

It is noted when this plant was built in the 1960s the requirements and safety issues were not as rigorous as today where such a plant would not be built only 800 m from a major community and 3 km from a major cities CBD.