Chapter 3

Key issues with emissions from, and the location of, industrial activities

3.1 This chapter examines the evidence received in relation to the measurement and impact of existing industrial activities on the rock art of the Burrup Peninsula.

3.2 It also examines the evidence received in relation to the projected additional pollution load from Yara Pilbara's technical ammonium nitrate production facility (TANPF), and the expected impact on rock art, human health, and the environment.

Existing industrial activities and the impact on Aboriginal rock art

3.3 As noted previously, a range of industries are located on the Burrup Peninsula. Submitters raised concern that emissions from these industrial activities and the port zone may have had, and may continue to have, an impact on the Aboriginal rock art of the Burrup Peninsula.

3.4 Submitters were also concerned that the total emission load has either not been measured, or if it has been measured, the results are not publicly available.[1]

Shipping

3.5 The Port of Dampier is one of the busiest bulk ports in the world: 5,170 ships entered the port in 2014–15. Shipping lanes and anchorages are situated within a few kilometres of a number of Aboriginal rock art sites.

3.6 The committee received evidence concerning the possible impact of emissions from ships on rock art. It was noted that bulk cargo vessels utilise high-sulphur content fuel and it is estimated that a single bulk cargo ship will release an estimated 5,200 tonnes of sulphur dioxide into the atmosphere in a year. These sulphur dioxide emissions are highest during start-up and shut-down which occur at anchorage.[2]

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1 Bob Brown Foundation, *Submission 11*, p. 3.

2 Professor John Black, *Submission 13*, pp. 14–15.

3.7 The Friends of Australian Rock Art (FARA) noted the lack of monitoring or emissions from ships and stated that:

> …there has also been no specific measurement or monitoring of the toxic fumes emitted by ships burning cheap bunker oil in Dampier port; the low-quality oil results in a higher percentage of damaging sulphur emissions and particulates than refined oil.[3]

3.8 Sulphur dioxide, when combined with moisture in the air, forms sulphuric acid and precipitates as acid rain or fog which is globally known to have severe effects on stone buildings, rocks and rock art. Professor Black noted that areas in Australia such as Sydney Harbour require cruise ship operators to use fuel with a maximum sulphur content of 0.10 per cent. This is similar to the maximum sulphur content requirements in designated Emissions Control Areas established under Annex VI to IMO MARPOL 73/78 Convention. Professor Black submitted that this limit should also be applied to shipping occurring at the Port of Dampier.[4] However, the committee notes that the measures in Sydney Harbour only apply to passenger cruise ships. Caution should be exercised in comparing the operations of passenger cruise ships and commercial freight vessels.

Existing industries

3.9 As noted in Chapter 1, there are a range of existing industries on the Burrup Peninsula. Some submitters voiced concern that the impact of existing industries on the rock art of the Burrup Peninsula has never been quantified. Further, that the total emission load of these industries has never been measured.

3.10 The Bob Brown Foundation, for example, submitted that given the Commonwealth's responsibility to protect the environment and Aboriginal rock art from adverse impacts from emissions, then the current total emission load should be measured. The Foundation stated that such 'an accumulative load figure is critical to determine the environmental and public health impacts of existing industrial load pollution before additional loads are permitted'.[5]

3.11 Dr Ken Mulvaney noted that the Western Australian Government sponsored air quality monitoring undertaken by CSIRO in 2004–2005 and 2007–2008, however this monitoring ended before the Woodside Pluto LNG plant went into production. Further, the Burrup liquid ammonia plant was not in full production during these periods either. As such, 'it is unlikely that there is an accurate capture of the total pollution load from existing industrial activities'.[6]

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3 Friends of Australian Rock Art, *Submission 14*, p. 2.

4 Professor John Black, *Submission 13*, p. 15.

5 Bob Brown Foundation, *Submission 11*, p. 3.

6 Dr Ken Mulvaney, *Submission 10*, p. 1.

3.12 Submitters provided evidence which they argued indicated that emissions from Woodside's industrial site are already degrading the environment. For example, FARA stated that the impact of industrial emissions can be seen on the surface of concrete pavers at the Woodside Visitor Centre.[7]

3.13 Similarly, Professor Black provided his observations on the impact of emissions on buildings:

> Although, no scientific analysis of the bricks have been made to my knowledge…where there is a gap between the two roofs, the bricks on the paving have been eroded and the black marking to the side suggest an increase in microbial growth. If the current emissions are already having such a marked effect on bricks, what effect are they having on the acid-sensitive desert varnish, which is so crucial for preservation of the rock art?[8]

3.14 In addition to these observations, Professor Black submitted that a high level of air pollution is also demonstrated through the Bureau of Meteorology's radar vision for the area indicating that it is raining every day, despite an average of rainfall of only 20 days per year.[9]

3.15 FARA further expressed concern that 'Woodside's monitoring is kept internal and not posted on its website, and…the company has been experiencing difficulties in controlling the size of its main flare, which is visible up to 30 km away'.[10]

Impact on rock art

3.16 Professor Black stated that 'there is strong evidence that the acidity of rock surfaces on [the] Burrup Peninsula has already increased dramatically since pre-industrial times'. Professor Black described studies undertaken by Dr Ian MacLeod, former Director of the Western Australian Maritime Museum, which found that acidity on rock surfaces in 2004, was found to be as low as pH 4.2 compared to a near neutral pH7 on rock sample specimens collected before industrialisation. Professor Black stated that 'most importantly, Dr MacLeod observed logarithmic increases in the solubility of manganese and iron compounds with increasing acidity of the more recently measured rocks'.[11]

3.17 Dr MacLeod found that on the rocks of the Burrup Peninsula where:

> …acidity increased—that is, as the pH went down—there was a logarithmic increase in the number of microbes that inhabited the rock art or the rocks

7 Friends of Australian Rock Art, *Submission 13*, p. 2.

8 Professor John Black, *Submission 13*, p. 12.

9 Professor John Black, *Submission 13*, p. 12.

10 Friends of Australian Rock Art, *Submission 14*, p. 2.

11 Professor John Black, *Submission 13*, pp. 10–11.

> where the rock art is. He showed there that one of the reasons for the logarithmic increase in the way that the manganese and iron compounds were dissolved was because of this increase in acidity so that the acidity and the dissolving of the outer patina go together and they are both logarithmic so that, as acidity increases, this increases tenfold.[12]

3.18 Other evidence provided to the committee included the findings of studies conducted by Robert G. Bednarik over a number of decades. Professor Black explained that in 2007 Bednarik collected the 'through fall' rain under trees at sites on the Burrup Peninsula and found that it was highly acidic with a pH as low as 3.2. This was due to tree canopies retaining large amounts of dry airborne pollutants in their layers of foliage. As water falls through the foliage, the acid forming chemicals such as NO_x and SO_x are concentrated in the rainfall. Bednarik found the complete removal of rock patina below trees adjacent to the Woodside site on the Burrup Peninsula.[13]

3.19 Bednarik also photographed rock sites on the Burrup Peninsula from the 1960s and utilised the International Federation of Rock Art Organisation's standard colour assessment system to identify marked changes in colour from pre-industrial times to 2002. Based on these observations, Bednarik predicted in 2002 that the Burrup Peninsula's petroglyphs would disappear during the second half of the 21st century at the then current rates of acid emissions, and by 2030 if such emissions trebled. Professor Black noted that in 2014, Woodside released 22,400 tonnes of acid load into the environment and Yara Pilbara's liquid ammonia plant released 13, 600 tonnes into the environment—extremely large amounts of acid forming emissions. Professor Black concluded that:

> There is irrefutable empirical and theoretical evidence that any increasing acid accumulation on the surface of rocks on Burrup Peninsula is now destroying and will completely dissolve the desert varnish patina. These processes will result in the destruction of the petroglyphs within the next 20-30 years at the current rate of acid emissions.[14]

Response from industry

3.20 In response to concerns raised in relation to the impact of existing industrial activities on the rock art of the Burrup Peninsula, Yara Pilbara noted that:

> …the total industrial emission load on the Burrup Peninsula is a matter that has been addressed in detail in the various proposals and approval documents submitted by Yara Pilbara Fertilisers. Accordingly, it is a matter that has been presented for consideration during the course of the relevant approval processes.[15]

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12 Professor John Black, *Submission 13*, p. 12.

13 Professor John Black, Answers to Questions on Notice, p. 2.

14 Professor John Black, Answers to Questions on Notice, pp. 2–3.

15 Yara Pilbara, *Submission 9*, p. 10.

3.21 Yara Pilbara reiterated that it 'shares the broad community expectation that the unique Aboriginal heritage values of the Burrup Peninsula remain unaffected by industrial activities.' As such, it:

> …is committed to ongoing monitoring and investigations of rock art nearby to its operations to ensure that its environmental and heritage protection measures remain effective and to adapt these measures as may be required in response to scientific data.[16]

Projected emissions from Yara Pilbara's TANPF

3.22 The following sections explore evidence presented to the committee on the possible impact of the projected emissions from the TANPF on the rock art of the Burrup Peninsula. It also canvasses concerns raised in relation to the possible impact on human health and the environment.

3.23 The TANPF is expected to emit ammonium nitrate particles, nitrogen oxides, nitrous oxide, carbon monoxide, methane, ammonia, and carbon dioxide (see Table 3.1) into the atmosphere when it begins production.

Table 3.1 – TANPF expected emission load

Emission	Amount released
Nitrogen Oxides (NO_x)	Up to 135 t/yr
Nitrous Oxide (N_2O)	Up to 163.7 t/yr
Carbon Monoxide (CO)	Up to 41 t/yr
Methane (CH_4)	Up to 17.8 t/yr
Ammonia (NH_3)	Condition 5 from Report 1379, 11 July 2011: Best practice pollution control technology; 19.6 t/yr under initial application (calculated from EPA Report 1379, January 2011)
PM_{10} ammonium nitrate dust particles	Condition 5 from Report 1379, 11 July 2011: Best practice pollution control technology; 25.2 t/yr under initial application (EPA Report 1379, January 2011)
Sulphur Dioxide	Trace
Carbon Dioxide (CO_2)	Up to 532.6 t/yr
Total greenhouse gas emission	Approx. 84,451 t/yr

Source: Environment Protection Authority Western Australia, 'Technical Ammonium Nitrate Production Facility, Burrup Peninsula Report and Recommendations', January 2011, cited in Professor John Black, Submission 13, p. 8.

3.24 Submitters noted that these predicted emissions are 'minimum estimates, as they omit emissions from conveying, storage and transport of nitrate prills'.[17]

16 Yara Pilbara, *Submission 9*, p. 10.

17 Ms Lyndy Scott, *Submission 12*, p.1. See also Professor John Black, *Submission 13*, p. 8.

Likely impact of emissions on rock art

3.25 A number of submitters expressed concern that the expected increase in emissions on the Burrup Peninsula resulting from the TANPF would destroy the rock art on the Burrup Peninsula 'over a relatively short period of time'.[18] For example, Professor Black stated that the proposed acid load into the atmosphere of 200meq/m^2/year from the TANPF are 'at the highest category of the international scale for environments susceptible to acids'. Professor Black submitted:

> Acid emissions of the magnitude proposed are known to degrade whole ecosystems, destroy life in lakes and waterways and to deface stone statues and stone buildings around the world.[19]

3.26 Ms Lyndy Scott stated that 'an acid load of this magnitude damages granite and feldspar rocks (like Burrup types) around the world'.[20] The Bob Brown Foundation submitted:

> As rocks on Burrup Peninsula contain a substantial proportion of feldspar they are likely to be degraded by weak acids formed from the industrial emissions. The degradation is most likely to be greatest along the petroglyph engravings.[21]

3.27 Professor Black explained that the effects of pollutants on rocks are cumulative and increase over time. Weathering and exfoliation of the surface are the only ways that pollutants can be removed from rocks; however this process is also irreversible and would erase any rock art present. Professor Black noted that these processes only occur to a very limited extent to rocks on the Burrup Peninsula, and 'therefore the impact of increasing acid on Burrup rock surfaces over time is a critical factor when considering survival of the art'.[22]

3.28 Professor Black submitted that the Burrup Peninsula consists of a series of hills of stone blocks, with very little soil except on the lower regions. These rocks are 'extremely hard and do not exfoliate readily into soil, but split into large blocks with flat sides'. Professor Black further stated that though the petroglyphs found in the area largely occur on 'the flat surfaces of slow weather, hard gabbro and granophyre igneous rocks, they are extremely sensitive to increased surface acidity like calciferous limestone and marble'.[23]

3.29 The petroglyphs of the Burrup Peninsula are carved into the weathering rind of parent igneous rocks. This weathering rind can differ in thickness, depending on the

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18 Professor John Black, *Submission 13*, p. 9.

19 Professor John Black, *Submission 13*, p. 8.

20 Ms Lyndy Scott, *Submission 12*, p. 1.

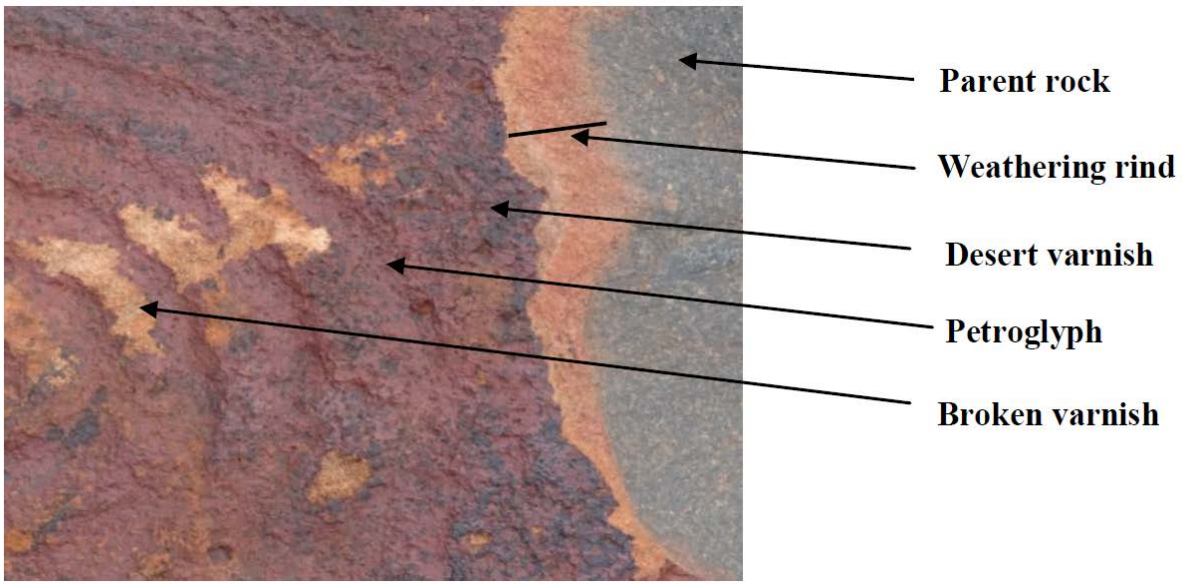
21 Bob Brown Foundation, *Submission 11*, p. 4.

22 Professor John Black, *Submission 13*, p. 9.

23 Professor John Black, *Submission 13*, p. 9.

time from fracture of the rock surface, from a few microns to around 10 millimetres after 30,000 years. The rind has a hard, dark-coloured outer patina called rock or desert varnish up to 200 microns thick, depending on its age. Petroglyphs are formed when the patina is broken, exposing the softer and lighter coloured, weathered rock beneath. This rock consists largely of partially formed clays. This process creates a colour and contour contrast between the petroglyph and background rock as demonstrated in Figure 3.1.[24]

Figure 3.1 – Burrup rock with petroglyph showing parent rock, weathering rind and desert varnish



Source: Professor John Black, Submission 13, p. 10.

3.30 Professor Black explained that desert varnish forms in low rainfall arid conditions where rock surfaces are alkaline. It has a growth rate of up to 10 microns per thousand years, and is formed by micro-organisms extracting minerals and clay from manganese and iron compounds.[25] These micro-organisms deposit extracted iron and manganese into an outer sheath which protects them from the harsh environment of the Burrup Peninsula, where temperatures can exceed 70 degrees centigrade.[26] These micro-organisms are thought to live for hundreds of years, lie dormant for much of the time, and only grow during favourable conditions. It is believed that the death of five of these micro-organisms per 1000 years is sufficient to form desert varnish

24 Professor John Black, *Submission 13*, pp. 9–10.

25 Professor John Black, *Committee Hansard*, 17 February 2017, p. 16.

26 Professor John Black, *Submission 13*, p. 10. See also Professor John Black, *Committee Hansard*, 17 February 2017, p. 16.

when incorporated with clay. Under normal alkaline desert environments, desert varnish continues to increase in thickness over time, albeit slowly.[27]

3.31 Desert varnish is susceptible to damage from an increase in the presence of acids in the environment, as acid dissolves manganese and iron compounds. This makes desert varnish thinner, weaker and lighter in colour. Professor Black submitted that:

> Removal of darker manganese and iron compounds from the outer, desert varnish layer, and the relative increase in ferrous oxide and clays in the desert varnish will result in the rock surface layers becoming thinner, lighter, redder and more white/yellow in colour over time. The impact on engraved surfaces will be greater because the desert varnish is thinner than on the non-engraved surface rock. Pollution from industry with an increase in acidity of the rock surfaces on Burrup Peninsula is likely to destroy the rock art over time.[28]

3.32 In addition to the impact of an increase in acidity on petroglyphs, concern was also expressed in relation to the effect of an increase in nitrogen on rock surfaces. As previously noted, the TANPF is expected to emit 25.2 tonnes per year of ammonium nitrate particles. Ammonium nitrate stimulates the growth of plants and other organisms through the provision of nitrogen and Professor Black stated that the 'increase in nitrogen on the surface of Burrup Peninsula rocks will stimulate greatly the growth of adventitious organisms that are traditionally at very low concentrations on rock surfaces'.[29] FARA described the effect of this emission as being:

> …equivalent to sprinkling fertiliser over the rock art landscape, which in turn, thanks to the perfect conditions of heat, dew/rain and humidity, will encourage unprecedented growth of the microbes on the rock surfaces. These burrowing microbes break down the rock surface and progressively degrade the petroglyphs. It has been suggested that the rock art could thus be destroyed within a generation.[30]

3.33 Professor Black highlighted research undertaken by Dr Ian MacLeod, former Director of the Western Australian Maritime Museum, which found that the growth of adventitious bacteria, algae, fungi and lichens increased as the nitrogen content of rock surfaces increases. Of particular note is the finding that these organisms will overrun and out-compete varnish forming micro-organisms, and produce organic acids which increase the acidity of rock surfaces. Further, Dr MacLeod found that the hyphae of growing fungi penetrate the soft weathering rind below the desert varnish

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27 Professor John Black, *Submission 13*, p. 10. See also Professor John Black, *Committee Hansard*, 17 February 2017, p. 16.

28 Professor John Black, *Submission 13*, pp. 10–11. See also Professor John Black, *Committee Hansard*, 17 February 2017, p. 16.

29 Professor John Black, *Submission 13*, p. 12.

30 Friends of Australian Rock Art, *Submission 14*, p. 2.

layer, and break away the edges of petroglyph engravings.[31] Lichen and fungi also produce organic acids such as oxalic and acetic acid which substantially weather desert varnish.[32]

3.34 Professor Black concluded that:

> The combination of an increased acid load dissolving the desert varnish and growth of adventitious organisms stimulated by increased ammonium nitrate and other nitrogen rich compounds in the air will destroy the petroglyphs over time.[33]

3.35 The committee also received evidence that rocks in California have been found to have lost desert varnish as a result of acid fog, and that based on this example, the petroglyphs of the Burrup Peninsula could disappear in 100 years. However, it should be noted that without undertaking proper measurements of the rocks of the Burrup Peninsula, the exact speed at which the rock art is being affected cannot be accurately predicted.[34]

Impact on the environment

3.36 As previously noted, increased nitrogen in the environment stimulates plant growth. Some submitters expressed concern that an increase in emissions from the TANPF would create significant changes to the unique vegetation growth on the Burrup Peninsula. Professor Black stated:

> The slow rate of degradation of the rocks on Burrup Peninsula results in a very low buffering capacity of the small amount of soil formed. Low buffering capacities in landscapes make ecosystems extremely susceptible to ecological changes from increasing acid loads. The vegetation on Burrup Peninsula is unique with many plant species common only to this area (Long *et al*. 2016). Thus, high acid emissions of 200 meq/m^2/yr are likely to make significant changes to this unique vegetation over time.[35]

3.37 Concern was expressed that an increase in vegetation would make the area susceptible to an increase in fire intensity resulting from lightning strikes. An increase in the intensity of bush fires would increase the degradation of the rock art, and would also contribute to the hastening of changes in flora populations in the area.[36]

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31 Professor John Black, *Submission 13*, p. 12.

32 Professor John Black, *Committee Hansard*, 17 February 2017, p. 16.

33 Professor John Black, *Submission 13*, p. 12.

34 Professor John Black, *Committee Hansard*, 17 February 2017, p. 17.

35 Professor John Black, *Submission 13*, p. 18. See also Professor John Black, *Committee Hansard*, 17 February 2017, p. 18.

36 Professor John Black, *Submission 13*, p. 18.

3.38 FARA submitted that the threat of fire:

> …will increase in magnitude and ferocity when the spread of fertiliser from Yara's TAN plant encourages unprecedented growth of the vegetation– thus potentially destroying much of the 45,000 year old rock art and seriously endangering plant infrastructure and the lives and health of the workers and residents of Dampier, Karratha and Roebourne.[37]

3.39 In addition, concern was raised that there has already been an increase in algal growth in the region's waterways as a result of an increase in nitrogen levels on the Burrup Peninsula.[38]

3.40 FARA provided evidence that at meetings with the Circle of Elders of the Murujuga Aboriginal Corporation, concerns were raised that water in the area has become undrinkable as a result of an increase in algal bloom in rock pools.[39]

Impact on human health from emissions

3.41 Evidence was received that emissions from the TANPF may have detrimental effects on the health of those who live, visit and work in the area. In particular, concern was expressed that 'evidence shows that airborne ammonium nitrate particles, inhaled or digested, are toxic to humans at levels *below* Yara's proposed output'.[40] Ammonium nitrate can cause orthostatic hypotension due to rapid dilation of blood vessels which results in faintness, dizziness, fatigue and reflex tachycardia (increased heart rate). If it is ingested, it can cause nephritis (kidney inflammation), and where converted to nitrite, cause nitrite poisoning.

3.42 Professor Black stated that:

> A 70 kg person undergoing light activity, with a lung-minute volume of 10 litres/min, breathing air with 50 mg/m3 ammonium nitrate particles (as may exist during upset conditions close to the Common stack) would reach the limit of exposure of 5 mg/kg/d (350 mg) in 11.6 hours. This analysis suggests airborne ammonium nitrate particles are a severe threat to the health of workers and the public and should not be released into the environment.[41]

3.43 The World Health Organization (WHO) recommends a maximum concentration in the air of 20 micrograms per cubic metre over a year, and 50 micrograms over 24 hours for all PM_{10} and smaller sized particles.[42] The TANPF

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37 Friends of Australian Rock Art, *Submission 14*, p. 2.

38 Professor John Black, *Submission 13*, p. 18.

39 Friends of Australian Rock Art, *Submission 14*, p. 2.

40 Ms Lyndy Scott, *Submission 12*, p. 1.

41 Professor John Black, *Submission 13*, p. 17. See also Professor John Black, *Committee Hansard*, 17 February 2017, p. 18.

42 PM_{10} refers to particulate matter that is 10 micrometres or less in diameter.

is expected to emit 15 milligram per cubic metre of PM_{10} or smaller sized ammonium nitrate particles—which Professor Black described as more than 1000 times more than the recommended maximum concentration for particle emissions.[43]

3.44 Professor Black also noted that modelling of PM_{10} concentrations within the boundary fences of the TANPF, and at publicly accessible areas such as Hearson Cove and Deep Gorge showed measurements that exceeded the WHO annual limit by 1.5 to 2 fold.[44]

3.45 Professor Black noted that Yara Pilbara's licence agreement with the Western Australian Government sets the PM_{10} limit at 15 milligrams per cubic metre, however:

> …for human health what is set in Australia is 25 micrograms, and in Victoria and in some other states it is set at 20 micrograms. That is about a 1,000-fold difference. So either they are saying that you can have 1,000 times more particles in the air for people on Burrup Peninsula or it is a misprint in the documentation that is there.[45]

3.46 A further issue raised in evidence was the lack of information provided to local communities about PM_{10} particles. The Bob Brown Foundation stated that 'there is no analysis of the likely impact of the release of ammonium nitrate on human health'.[46]

3.47 Professor Black also expressed concern that the TANPF would release 41 tonnes per year of carbon monoxide, and that the risk to human health, and the wellbeing of other living organisms in the surrounding environment should be considered.[47]

43 Professor John Black, *Submission 13*, p. 16.

44 Professor John Black, *Submission 13*, p. 16.

45 Professor John Black, *Committee Hansard*, 17 February 2017, p. 22.

46 Bob Brown Foundation, *Submission 11*, p. 4.

47 Professor John Black, *Submission 13*, p. 17.

Response from Yara Pilbara

3.48 Mr Chris Rijksen, General Manager, Yara Pilbara, told the committee that the 25 milligrams per cubic metre standard refers to ambient air concentration while the 15 milligrams per cubic metre referred to in the TANPF's work approval refers to the plant's stack emission. Mr Rijksen concluded:

> So it is incorrect to take the assumption that the emission at the stack is equivalent to the ground level concentration that a person will be exposed to.[48]

3.49 Yara Pilbara also responded to concerns raised in relation to the release of PM_{10} particles by noting that the effect of emission levels from its operations on human health were assessed under criteria which set objective parameters for measurement. It stated that its emissions modelling methodology and outcomes were assessed by the then Western Australian Department of Environmental Regulation (DER) during the TAN Plant Works Approval application. The Works Approval Environmental Assessment Report concluded that 'the PM_{10} emissions were determined to be insignificant'.[49]

3.50 Yara Pilbara noted that the impacts of carbon monoxide (CO) emissions from the TANPF were assessed in the public environmental review (PER) published in 2010. Dispersion modelling found CO emissions to be insignificant when compared with the relevant standard established under the National Environmental Protection Measure and Impact Statement for Ambient Air Quality (Air Quality NEPM). Specifically, the predicted worst-case CO ground level concentration was found to be 0.01 per cent of the 8-hour average NEPM standard. As such, 'the conclusion reached in the PER was that CO emissions from the TAN Plant do not pose a significant risk to humans, flora or fauna in the environment'.[50]

3.51 Yara Pilbara further noted that the impacts of CO emissions from the Ammonia Plant were reassessed in 2015 by the Environmental Protection Authority (EPA) WA and the Western Australian DER as part of an amendment to Ministerial Statement 586, which was approved in August 2015 by the Minister pursuant to section 45C of the *Environmental Protection Act 1986* (WA). The reassessment determined that the worst-case predicted ground level CO concentrations from the operation of the Ammonia Plant were less than 0.2 per cent of the NEPM. Yara Pilbara concluded that:

> The assessments conducted by the various regulatory agencies have imposed no conditions or requirements that require the Ammonia or the TAN Plant to reduce carbon monoxide emissions via capture before discharge.

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48 Mr Chris Rijksen, Yara Pilbara, *Committee Hansard*, 17 February 2017, p. 35.

49 Yara Pilbara, Answers to Questions on Notice, 17 February 2017, pp. 6–7.

50 Yara Pilbara, Answers to Questions on Notice, 17 February 2017, p. 7.

Ammonia and nitric acid leaks

3.52 Submitters commented on ammonia and nitric acid leaks from existing plants. It was noted that Yara Pilbara operations have already suffered ammonia leaks and as a consequence, 'the community can have no confidence in the company's estimates or proposed control of fugitive emissions from either the Yara Fertiliser Plant or the explosives plant'.[51]

Ammonia leaks

3.53 The Bob Brown Foundation and FARA both noted that a number of ammonia leakages had resulted in the hospitalisation of staff.[52] The Bob Brown Foundation commented:

> There were at least 24 reportable incidents from January to 17 November 2015. Ammonia leak was a common cause of the incidents. Between 16–20 January 2016, 4,601 tonnes of gas were released into the atmosphere.[53]

3.54 Ms Lyndy Scott submitted that 'local Aboriginal people have complained of ammonia smell and stinging eyes when they are downwind of the current fertiliser plant'.[54]

Response from Yara Pilbara

3.55 Yara Pilbara stated that in 2016 there were four releases of ammonia gas and one release of liquid ammonia from its liquid ammonia plant, and that there were no reportable incidents in 2015. It went on to comment that in 2016 'it was determined that none of the ammonia releases had any offsite impacts'.[55] Mr Brian Howarth, Health, Environment, Safety and Quality Manager, Yara Pilbara, explained to the committee that the four ammonia leaks in 2016:

> …all had a root cause, which is a defectively-calibrated process safety valve. These are valves that sit on top of our ammonia tanks. They are designed to release in the event of high-pressure levels or an exceedance in the tank capacity. The calibration on those devices was low and incorrect, which meant that they released at a lower set limit.[56]

3.56 Mr Howarth explained that these valves were installed using the services of a contractor. Following the first incident, an investigation was initiated, however due to

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51 Bob Brown Foundation, *Submission 11*, p. 6.

52 Bob Brown Foundation, *Submission 11*, p. 6; Friends of Australian Rock Art, *Submission 14*, p. 2.

53 Bob Brown Foundation, *Submission 11*, pp. 6–7.

54 Ms Lyndy Scott, *Submission 12*, p. 2.

55 Yara Pilbara, Answers to Questions on Notice, 17 February 2017, p. 14.

56 Mr Brian Howarth, Yara Pilbara, *Committee Hansard*, 17 February 2017, p. 34.

the specialised nature of the devices an expert was required to be flown in from the United States of America. It was determined that the valves were faulty and all 12 units present in the facility have since been replaced.[57]

3.57 In addition, Mr Howarth told the committee that though there has not been any person admitted to hospital as a result of ammonia exposure, operating procedures at the plant mandate a medical referral for any staff in the event of exposure to ammonia. Mr Howarth stated:

> In the first case, we had some painting crew working nearby; they were exposed to ammonia. If someone reports being exposed to ammonia on our site, it is an automatic medical referral. I can say that we have never had, in the time I have been there, any person admitted to hospital as a result of ammonia exposure. The automatic precaution if someone reports a whiff of ammonia is a medical referral.[58]

3.58 Yara Pilbara also noted that it is required to report any release of ammonia under a number regulatory provisions. These include:

- notification under section 72(1) of the *Environmental Protection Act 1986* (WA);
- licencing conditions which require a summary of any environmental incidents to be included in the Annual Environmental Report (AER), and licence conditions which require Yara Pilbara to report as soon as possible, any start up, shutdown or 'upset condition'; and
- the submission of National Pollution Inventory data to the federal Department of the Environment and Energy which is subsequently submitted to the Clean Energy Regulator.[59]

3.59 Table 3.2 provides an overview of the ammonia releases which occurred in 2016, and the reporting process that Yara Pilbara undertook after each event.

57 Mr Brian Howarth, Yara Pilbara, *Committee Hansard*, 17 February 2017, p. 34.

58 Mr Brian Howarth, Yara Pilbara, *Committee Hansard*, 17 February 2017, p. 39.

59 Yara Pilbara, Answers to Questions on Notice 3.4, 17 February 2017, p. 14.

Table 3.2 – Overview of ammonia releases in 2016

Year	#	Date	Volume of ammonia gas	Reporting Process
2016	1	03/12	3.50 tonnes (note: liquid ammonia, not ammonia gas)	AER
	2	03/06	0.70 tonnes	s72 notification
	3	30/05	1.10 tonnes	s72 notification
	4	25/03	1.40 tonnes	s72 notification
	5	03/02	1.72 tonnes	AER

Source: Yara Pilbara, Answers to Questions on Notice 3.4, 17 February 2017, p. 14.

3.60 Yara Pilbara also provided the committee with an overview of the eight circumstances of 'upset conditions' at the liquid ammonia plant that were reported to the Western Australian Department of Environmental Regulation. It stated that these eight circumstances accounted for 14 plant trips in total.[60]

Nitric acid leaks

3.61 Bob Brown Foundation also submitted that there had been a number of nitric acid leaks during the commissioning phase of the TANPF. It stated that:

> There have been at least two nitric acid leaks reported during commissioning of the ammonium nitrate plant. One leak on 27 April 2016 released NO_x that triggered the closest alarm at 100 ppm. The second leak on 30 April 2016 released an estimated 337 kg of oxides of nitrogen into the atmosphere with a concentration of 600 ppm (1,160 mg/m^3).[61]

60 Yara Pilbara, Answers to Questions on Notice 3.7, 17 February 2017, p. 16.

61 Bob Brown Foundation, *Submission 11*, p. 7.

Yarra Pilbara response

3.62 Yara Pilbara acknowledged that it had submitted two Dangerous Goods Incident Report Forms in relation to nitric acid incidents during commissioning in 2016. It also stated that a number of other incidents occurred during commissioning, and despite these incidents not exceeding reportable quantities, it nevertheless drew them to the attention of the authorities. Yara Pilbara stated that:

> These commissioning incidents were the result of localised spills which were effectively remediated with no identified impacts to human health, the environment or to offsite heritage values.[62]

Yara Pilbara technology and design mitigation measures

3.63 In response to concerns raised in relation to the likely impact of pollution from the TANPF, Yara Pilbara submitted that the design of the TANPF incorporates 'best practice pollution control technology' with:

> …the aim of achieving emission concentrations of ammonia and ammonium nitrate dust from the prilling tower and drum drier common stack below the levels stated in the Fertilizers Europe and European Commission best practice guidelines. It is considered that these guidelines (which have been incorporated into the DER issued Works Approval for the TAN Plant) represent the benchmark in describing best practice for industry on a global scale.[63]

3.64 Mr Rijksen, General Manager, Yara Pilbara, told the committee that Yara Pilbara has:

> …installed the best available technology in that plant, which consists of a double wet scrubber system on the main stack of the plant. So there is a double system filtering out particles and also ammonium emissions if they are still in the fumes by using a chemical process in the stack to clean the gases.[64]

3.65 Mr Rijksen noted that this 'is worldwide best practice that is described by the European fertiliser association' and endorsed by European regulators.[65]

3.66 Yara Pilbara noted that the predicted emissions from the TANPF were assessed through both State and Commonwealth environmental impact assessment processes and that approval conditions establishing air emission mitigation and

62 Yara Pilbara, *Submission 9*, p. 18.

63 Yara Pilbara, *Submission 9*, p. 13.

64 Mr Chris Rijksen, Yara Pilbara, *Committee Hansard*, 17 February 2017, p. 38.

65 Mr Chris Rijksen, Yara Pilbara, *Committee Hansard*, 17 February 2017, p. 38.

monitoring requirements were set by both regulators.[66] Mr Rijksen, Yara Pilbara told the committee that:

> Our commitment to environmental protection is reflected in many ways, including equipment enhancements, increased maintenance activities and process improvements at the ammonium plant, and accelerated competence development, and we use best practice emission control technology in the design of our new TAN plant…The TAN plant is subject to approvals granted under more than 10 state and Commonwealth acts and regulations. Predicted emissions from the plant were assessed through Commonwealth and state environmental impact assessment processes. Formal approval conditions prescribing air emissions mitigation and monitoring have been established by environmental regulators at both state and Commonwealth level to ensure protection of human health, the environment and the rock art.[67]

3.67 Mr Rijksen went on to state that 'full and proper risk analysis was undertaken in the planning and establishment of the TAN plant'. Mr Rijksen concluded that this 'reflects the fact at Yara Pilbara we operate within the regulatory framework set for us'.[68]

3.68 Yara Pilbara submitted that its most recent air quality modelling considers both normal operation and non-routine operation scenarios. It stated that outputs from dispersion modelling were combined with background concentrations measured in the local area. These combined results were then compared to adopted assessment criteria as set through state and Commonwealth assessment processes. The adopted air quality criteria include those for the protection of the environment, rock art, and human health. These criteria are based on the Air Quality NEPM, the New South Wales Department of Environment and Climate Change standards, and criteria established by CSIRO through the BRATWG.[69]

66 Yara Pilbara, *Submission 9*, p. 13.

67 Mr Chris Rijksen, Yara Pilbara, *Committee Hansard*, 17 February 2017, pp. 32–33.

68 Mr Chris Rijksen, Yara Pilbara, *Committee Hansard*, 17 February 2017, p. 32.

69 Yara Pilbara, *Submission 9*, pp. 13–14. See also, Yara Pilbara, Answers to Questions on Notice, 17 February 2017, pp. 6–7.

3.69 Yara Pilbara stated that the results from modelling indicated that:

> …for normal operations, predicted concentrations for all modelled gasses and for acid deposition at rock art sites were below the adopted assessment criteria. This indicates that during normal operation there would be no harm to the beneficial use of the atmosphere, specifically human health and the environment, and that impact to rock art in the local area is unlikely.[70]

3.70 Yara Pilbara particularly highlighted that EPA WA has:

> …concluded that the predicted emission of waste gasses from the TAN Plant is unlikely to have a significant impact on cumulative annual average concentrations of these gasses and is therefore unlikely to have a significant impact on rock art.[71]

3.71 Yara Pilbara submitted that the TANPF and the liquid ammonia plant contribute 2.1 per cent of nitrogen oxide (NOx) emissions, 14.1 per cent of sulphur dioxide (SO2) emissions, and 21.7 per cent of particulate (PM_{10}) emissions compared to the total environmental emissions of these substances on the Burrup Peninsula. It concluded that 'this data demonstrates that the most significant risks to rock art from nitrogen and sulphur dioxide emissions is not presented by the two Yara Pilbara plants'.[72]

Risks associated with the location of the TANPF

3.72 A number of submitters expressed concern that the TANPF is located in a cyclone surge zone and too close to the existing liquid ammonium nitrate plant, and that the risk analysis was inadequate.

3.73 It was argued that the land used for the TANPF is unsuitable for industrial development due to flood impact associated with cyclonic tidal surge and climate change sea level impacts.[73] Submitters commented that a cyclonic tidal surge could result in an explosion. FARA stated that:

> In spite of Yara Pilbara's ridiculously close proximity to the rock art, gas hub and major port, it is also in a cyclone surge zone and only 5.5m above sea level: uncontrollable winds and rising water could damage infrastructure, soak chemicals and result in spontaneous explosion…[74]

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70 Yara Pilbara, *Submission 9*, p. 14.

71 Yara Pilbara, *Submission 9*, p. 13. See also Environment Protection Authority of Western Australia, *Technical Ammonium Nitrate Production Facility, Burrup Peninsula: Report and Recommendations of the Environmental Protection Authority*, Bulletin 1379, January 2011, http://www.epa.wa.gov.au/sites/default/files/EPA_Report/Final%20EPA%20Report%20050111-web_0.pdf.

72 Yara Pilbara, Answers to Questions on Notice, 17 February 2017, p. 4.

73 The Hon Robin Chapple MLC, *Submission 15*, p. 2.

74 Friends of Australian Rock Art, *Submission 14*, p. 4. See also Bob Brown Foundation, *Submission 11*, p. 8; Dr John Black, *Submission 13*, p. 18.

3.74 Dr Black added that 'with projected sea level rise of at least 6 metres by 2040 and a cyclone storm surge of 7 metres, the security of the ammonium nitrate plant and storage facility looks extremely risky'.[75]

3.75 Submitters argued that location of the TANPF in close proximity of other plants posed a danger of fire and explosion. The Bob Brown Foundation commented that 'explosions from ammonium nitrate plants are not uncommon' and that 'the likely impact on surrounding industry, on the petroglyphs and the towns of Dampier, Karratha and Roebourne from an explosion at the Technical Ammonium Nitrate plant would be catastrophic'.[76]

3.76 The Bob Brown Foundation went on to note that 'usually there is a separation zone' but that the Western Australian Government had permitted the 'siting the explosives plant adjacent to the Yara Fertiliser Plant'. The Foundation questioned what level of risk analysis had been conducted prior to this decision.[77] Similarly, Mr Brynn Matthews submitted:

> To put an ammonium nitrate plant next to one processing hydrocarbons has got to be unwise if not foolhardy. The failure to do a risk analysis of this adjacent placement of industries, as referred to in the committee terms of reference, is negligent to the extreme.[78]

3.77 Ms Judith Hugo, Convenor, FARA, also expressed concern that a liquid spill, such as diesel, could pose danger to the TANPF as it could 'detonate an explosion'. Ms Hugo stated that a 'liquid spillage is far more dangerous than fire to the ammonium nitrate substance'.[79]

3.78 Submitters expressed further concern that any analyses of these risks may have been inadequate. For example, the Bob Brown Foundation stated that 'it is extraordinary that risk analysis of establishing an explosives plant in close proximity to both the NW Shelf joint venture and the Pluto natural gas hubs has been so cursory'. It further submitted:

> What analysis was done of the likelihood of cyclone storm surge and its impacts on the proposed explosives plant, since it is sited in the surge zone. With global warming driving sea level rise and more extreme weather events, was this taken into account?[80]

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75 Professor John Black, *Submission 13*, p. 18.

76 Bob Brown Foundation, *Submission 11*, p. 8.

77 Bob Brown Foundation, *Submission 11*, p. 8.

78 Mr Brynn Matthews, *Submission 7*, p. 1.

79 Ms Judith Hugo, Friends of Australian Rock Art, *Committee Hansard*, 17 February 2017, p. 43.

80 Bob Brown Foundation, *Submission 11*, p. 7. See also Friends of Australian Rock Art, *Submission 14*, p. 4.

3.79 Similarly, FARA stated that 'the WA government has pursued a long-term vision of inappropriately transforming the Burrup peninsula into the largest industrial precinct in the Southern Hemisphere as a magnet for foreign investment and huge royalties, without carrying out proper risk analysis'.[81]

3.80 Ms Lyndy Scott submitted that documentation from Yara has a number of 'omissions and inconsistencies' including that 'it does not cover the very real risk of explosion, a negligent oversight'. Further, 'there are no adverse-impact mitigation strategies' and 'it does not cover risks of carbon monoxide poisoning to humans, animals and plants'.[82]

3.81 Both FARA and the Bob Brown Foundation also expressed doubt that Yara Pilbara would be able to adequately respond in the event of a fire or an explosion at its facilities.[83]

3.82 The Bob Brown Foundation further submitted that though the EPA WA has stated that 'ammonium nitrate is difficult to detonate and that the risk of detonation would be controlled by "best practice" operations to be put in place by the company', it questioned the basis upon which EPA WA had reached this conclusion.[84]

Response from Yara Pilbara

3.83 In response to these concerns, Yara Pilbara stated that it 'rejects the claim that there has been a failure to include adequate risk analysis in the planning and establishment of the TANPF.' It submitted that a range of risk assessments were conducted during the planning and design stages, as noted in the TAN Production Facility Public Environmental Review for Burrup Nitrates Pty Ltd (the PER), and other approval submissions. As a result of these planning assessments, a range of action plans have been developed and implemented.[85]

3.84 Further, it noted that during initial site selection for the TANPF, three industrial estates in the Pilbara region were examined and ranked according to suitability. The assessment process considered issues including Aboriginal heritage, land tenure, environmental sensitivity, the proximity to local communities, and the suitability for TAN storage. Yara Pilbara submitted that:

> Importantly, the selected site for the TAN Plant was already zoned for strategic industrial use under the then Shire of Roebourne Town Planning Scheme No.8. The industrial precinct that contains the TAN Plant, the

81 Friends of Australian Rock Art, *Submission 14*, pp. 3–4.

82 Ms Lyndy Scott, *Submission 12*, p. 4.

83 Bob Brown Foundation, *Submission 11*, p. 8. See also Friends of Australian Rock Art, *Submission 14*, p. 4.

84 Bob Brown Foundation, *Submission 11*, p. 8

85 Yara Pilbara, *Submission 9*, p. 19.

> Ammonia Plant and Woodside's Pluto LNG Plant had been previously assessed for strategic industrial purposes through the Burrup Peninsula Land Use Plan and Management Strategy.[86]

3.85 Yara Pilbara explained that the Western Australian planning approvals regime includes a risk-based approach to the location of industrial facilities. As such, there is no standard recommended separation distance required between ammonium nitrate and other industrial or residential facilities. Yara Pilbara noted that such a risk-based approach is utilised in the European Union, and other Australian states and territories. It also noted that its insurance providers conduct annual inspections and reviews of the facilities and are aware of the distance between the two plants.[87]

3.86 Yara Pilbara submitted that the PER for the TANPF 'clearly acknowledged the risks associated with sympathetic explosion and over pressure effects, ammonia gas releases and extreme weather events such as cyclones'. Further, the PER makes 'specific reference to the management measures' to be implemented to address the risks raised by concerned submitters. These include:

- a safe distance between the bulk storage area at the TANPF and the ammonia storage tanks located at the Ammonia Plant;
- the elevation of the site to a minimum of 5.5 metres above the Australian Height Datum (AHD), which is about the 1-in-100 year flood line of 4.8 metres AHD;
- buildings constructed to withstand a wind velocity of 300 km/hr in any direction at 10 metres above ground;
- stormwater drains constructed for 105 mm/hr rainfall;
- design features to accommodate the potential for future sea level rise over the 20 year plus operational phase;
- segregation valves in the ammonia pipeline to limit loss of product in the event of a leak; and
- the development of an Emergency Response Management Plan covering emergency scenarios for all phases of the TANPF project.[88]

3.87 Mr Brian Howarth, Yara Pilbara, rejected descriptions of the TANPF as an 'explosive plant' and explained that technical ammonium nitrate is simply an ingredient in explosives. Mr Howarth stated that 'technical ammonium nitrate itself, in

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86 Yara Pilbara, *Submission 9*, p. 19. See also Yara Pilbara, Answers to Questions on Notice, 17 February 2017, p. 8. See also, *TAN Production Facility Public Environmental Review for Burrup Nitrates Pty Ltd*, p. 14, section 4.4.

87 Yara Pilbara, Answers to Questions on Notice, 17 February 2017, pp. 8–9.

88 Yara Pilbara, *Submission 9*, pp. 19–20.

its raw form, is safe to handle. It was used as a fertiliser for many, many years'.[89] Yara Pilbara similarly submitted that:

> For ammonium nitrate to be an explosive, it needs to be sensitised. Sensitisation for Yara Pilbara's TAN product only occurs at the customer's mine site, in preparation for use of the product in blasting. All ammonium nitrate at the Yara Pilbara site is equivalent to a fertiliser grade ammonium nitrate held at a hardware store.[90]

3.88 Yara Pilbara also noted that the Western Australian Department of Mines and Petroleum Code of Practice for Safe Storage of Ammonium Nitrate states that pure ammonium nitrate (AN) is 'difficult to detonate, and flame, spark, rough handling, impact or friction are not known to cause a propagated detonation'.[91]

3.89 Mr Howarth explained that in the event of a fire, ammonium nitrate 'will not ignite' as it 'does not have that property'. Further, should a fire occur at the TANPF, neither the ammonium nitrate nor the facility would explode and that there would not be 'a sympathetic detonation of every piece of ammonium nitrate on that site'. Mr Howarth stated:

> There are multilayered safety systems that are defined in our safety case and safety report, which is approved by the Department of the Mines and Petroleum, that detail the 21 safety critical elements in place. There a multiple layers of protection, automatic shutdowns, fire systems protection and all sorts of things…[92]

3.90 Yara Pilbara indicated that the TANPF was designed and constructed in accordance with the requirements of the *Dangerous Goods Safety Act 2004* (WA). In addition, it complies with the requirements of the Dangerous Goods Safety (Storage and Handling of Non-explosives) Regulations 2007, the Dangerous Goods Safety (Security Risk Substances) Regulations 2007, and the Dangerous Goods Safety (Major Hazards Facilities) Regulations 2007.[93]

3.91 Further, the TANPF was determined to be a Major Hazard Facility by the then Western Australian Department of Minerals and Petroleum (DMP) and as such, must operate in accordance with an approved Safety Report which 'demonstrates that the site's safety management system includes appropriate controls, mitigation and incident response'. The Safety Report for the TANPF was approved by the DMP on 26 May 2015.[94]

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89 Mr Brian Howarth, Yara Pilbara, *Committee Hansard*, 17 February 2017, p. 38.

90 Yara Pilbara, Answers to Questions on Notice, 17 February 2017, p. 11.

91 Yara Pilbara, Answers to Questions on Notice, 17 February 2017, p. 11.

92 Mr Brian Howarth, Yara Pilbara, *Committee Hansard*, 17 February 2017, p. 38.

93 Yara Pilbara, *Submission 9*, p. 21.

94 Yara Pilbara, *Submission 9*, p. 21.

3.92 Yara Pilbara stated that it is 'committed to the storage of ammonium nitrate products in a manner that avoids sympathetic detonation risk and in accordance with Yara and industry accepted standards'. Further that:

> …explosion risk was an issue that was specifically considered as part of the planning and development of the TAN Project, and which is the subject of specific management measures to further minimise the risk posed.[95]

3.93 Yara Pilbara stated that risk assessments conducted during the design and planning phase of the TANPF were required to demonstrate, to the DMP's satisfaction, that the TANPF's proposed location and operation would not pose unacceptable levels of risk to neighbouring land users. This included local communities. Yara Pilbara noted that 'importantly, those risk assessments were conducted separately to the preparation of the PER and considered these other risks in great detail'.[96]

3.94 As a designated Major Hazard Facility, the TANPF has 'multiple layers of safety systems, engineering controls and procedures for the safe production, storage and handling of Technical Ammonium Nitrate. Each of these systems applies one or more Safety Critical Elements (SCEs). SCEs are devices, systems or action that would likely disrupt the change of events following an initial incident, or that would mitigate the impacts of an event so that serious harm or the likelihood of serious harm is reduced.[97]

3.95 The TANPF's design and safety management systems include provisions for mitigation and emergency response. Critical to the prevention of over-pressure scenarios at the TANPF are measures to ensure fire prevention and control. This includes fire detection and suppression systems which have been considered in the design reviews conducted for the facility, including as part of the Fire Risk Assessment. Yara Pilbara submitted that in the event of an emergency which has the potential for offsite impacts, it has emergency response plans which were formulated in consultation with the Department of Fire and Emergency Services.[98]

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95 Yara Pilbara, *Submission 9*, p. 21.

96 Yara Pilbara, *Submission 9*, p. 21.

97 Yara Pilbara, Answers to Questions on Notice, 17 February 2017, p. 11.

98 Yara Pilbara, *Submission 9*, p. 22.