Solid Sodium Cyanide Plant Kwinana

Du Pont (Australia) Pty Ltd

Report and Recommendations
of the
Environmental Protection Authority

Environmental Protection Authority
Perth, Western Australia
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ERRATA

Page 6 Section 3.2.2 Emissions from scrubber

"...about 4.6 kg/h of cyanide..."

should read

"...about 0.46 kg/h of cyanide..."

Page 6 Section 3.2.4 Hydrogen cyanide vented from the cooling tower

"...less than 10 ppm sodium cyanide..."

should read

"...less than 50 ppm sodium cyanide..."

(Page 7 Section 3.3 is correct.)

Appendix 2

Questions 35, 36, 37 and answers missing - printed on reverse of this sheet

Contents

Contents (Cont'd)

Figures

Appendices

Summary and recommendations

The Environmental Protection Authority has assessed the proposal by Du Pont (Australia) Limited to construct and operate a sodium cyanide plant at Kwinana. The plant would have the capacity to produce 45,000 tonnes of solid sodium cyanide briquettes annually.

Sodium cyanide is predominantly used as a leaching agent in the gold extraction process. All solid sodium cyanide currently used in Australia is imported.

The Environmental Protection Authority has assessed the environmental aspects of the project based on:

- information provided in the PER;
- submissions made to the Environmental Protection Authority;
- the proponent's answers to issues raised;
- further information from a number of organisations; and
- the Environmental Protection Authority's own investigations, including specialist advice.

The Environmental Protection Authority identified seven main issues regarding the proposed plant:

- risks and hazards;
- gaseous emissions;
- liquid effluent disposal;
- solid waste disposal;
- occupational health issues;
- transport of the product; and
- noise, dust and construction phase impacts.

In addition, the Environmental Protection Authority is concerned about the level of emergency response planning and preparedness in the Kwinana industrial area.

It is important to note that the environmental impact assessment process, including public review, resulted in several changes to the original proposal, which have resulted in environmental benefits. Firstly, the expressed concern at the production and handling of hydrogen cyanide under pressure resulted in the proponent making a commitment to "secondary containment" of all relevant sections of the plant. This containment will allow capture and detection of any leaks, followed by immediate shutdown for repairs. Secondary containment has not been quantified in the analysis of risks or gaseous emissions, giving a conservative margin in the assessment of impacts.

Secondly, by treating waste water to a greater degree than originally proposed and increasing the quantity recycled, demand for fresh water will be reduced. The area of evaporation ponds will be reduced from the original five hectares to the currently proposed 1.5 hectares.

Thirdly, the proponent has advised of a willingness to make available its expertise in the field of emergency planning and public safety. While not pre-empting any decision on the proposal, the Environmental Protection Authority believes that the proponent's experience in this field would be of considerable advantage to the statutory authorities charged with this task in the Kwinana area.

The Environmental Protection Authority has concluded that the environmental issues can be adequately managed, as detailed in this report, and therefore that the proposal is environmentally acceptable. Accordingly the Environmental Protection Authority makes the following recommendation:

Recommendation 1

The Environmental Protection Authority concludes that the proposal as described in the Public Environmental Report with modifications as described in this report, to manufacture and distribute solid sodium cyanide briquettes, is environmentally acceptable and recommends that the proposal could proceed subject to the Environmental Protection Authority's recommendations in this report and the environmental management commitments made by the proponent. (Appendix 4 of this report.)

The Environmental Protection Authority has examined the preliminary risk analysis for the proposal (Public Environmental Review Volume 2) and has sought an expert critique of this analysis. Following this, it has concluded that individual risk levels fall within the Environmental Protection Authority's existing published guidelines. That is, the risk associated with the sodium cyanide plant is sufficiently low as to be acceptable to the Environmental Protection Authority. The cumulative risk for the Kwinana region was updated to take this proposed facility into account. The risk levels determined in this study meet the guidelines adopted by the Environmental Protection Authority and so are acceptable to the Environmental Protection Authority.

Recommendation 2

The Environmental Protection Authority recommends that the proponent should prepare, in stages and at times to be determined by the Environmental Protection Authority on advice from the Department of Mines, a comprehensive hazard identification and risk management programme (ie a Total Hazard Control Plan), to the satisfaction of the Environmental Protection Authority on advice from the Department of Mines.

The programme should include, but not be limited to, the following:

1 **safety engineering design;**

2 **quantified risk assessments;**

3 **Process Hazard Review of the facilities;**

4 **implementation systems; and**

5 **safety reviews during the life of the plant.**

The ongoing results should be forwarded to the Environmental Protection Authority and the Department of Mines.

Recommendation 3

The Environmental Protection Authority recommends that, prior to commissioning, the proponent should develop and implement, to the satisfaction of the Environmental Protection Authority and relevant agencies, an emergency plan which takes into account all relevant events including "plant upset" conditions. This plan should be fully integrated with the requirements of the Kwinana Integrated Emergency Management System.

The possibility of emergencies extending beyond a plant needs to be managed in an integrated way for the whole Kwinana industrial area under the Kwinana Integrated Emergency Management System (KIEMS). Development of the System is a Government responsibility, and implementation has been somewhat slow up to this time. Given the recent start-up of several plants with significant off-site risks, this matter needs to be expedited. In particular it is important that some of the obvious major aspects of the System be put in place as soon as possible, including provision of fundamental emergency response support.

Recommendation 4

The Environmental Protection Authority recommends that no approval or licence to commission the proposed plant be issued by any statutory authority until the key emergency response provisions of the Kwinana Integrated Emergency Management System are in place to the satisfaction of the Minister for Environment on the advice of the Environmental Protection Authority.

The Environmental Protection Authority has received a letter from State Emergency Service (Appendix 7), indicating the projected timetable for implementation of KIEMS. The Environmental Protection Authority's advice to the Minister for Environment under the above recommendation will be based largely on meeting this timetable, and addressing the immediate issues indicated above.

The Environmental Protection Authority has reviewed information provided on gaseous emissions and the pollution control equipment being proposed by Du Pont. The Environmental Protection Authority has assessed available data for worst case emissions and considers that applicable emission standards can easily be attained. The results reviewed to date are expected to be improved upon when design details are further advanced. Furthermore, details of how the proponent intends to achieve the improvement will be supplied to the Environmental Protection Authority during assessment for Works Approval and Licensing under Part V of the Environmental Protection Act, 1986. The Environmental Protection Authority has checked the results of dispersion modelling and finds that ground level concentrations of the possible emissions will be within acceptable criteria.

The Environmental Protection Authority has assessed available data for worst case gaseous emissions and has concluded that its emissions standards should be easily attained. However the Environmental Protection Authority anticipates that more accurate data will be available at the end of the detailed design stage of the plant. Accordingly the Environmental Protection Authority recommends as follows.

Recommendation 5

The Environmental Protection Authority recommends that prior to commissioning of the plant the proponent should supply the detailed design information on all atmospheric emissions and the techniques proposed to control these emissions within relevant standards acceptable to the Environmental Protection Authority. Control technology employed shall be to the satisfaction of the Environmental Protection Authority.

Recommendation 6

The Environmental Protection Authority recommends that the proponent should prepare an inventory of greenhouse gas emissions and report to the Environmental Protection Authority if there is a significant change in these emissions. Reporting should be to the satisfaction of the Environmental Protection Authority.

The Environmental Protection Authority believes that liquid effluent from the proposed plant can be managed, using the basic system proposed, without adversely affecting the environment. However, further information will be required during the detailed design stage on specific aspects of liquid effluent management.

Recommendation 7

The Environmental Protection Authority recommends that prior to commissioning the plant the proponent should submit details of the waste water monitoring and

management programme outlining methods of monitoring the quality of effluents entering evaporation ponds, ground water quality, leak detection and the effects on wildlife. The programme should detail remedial action to be taken if problems are encountered in any of the areas listed above and should be to the satisfaction of the Environmental Protection Authority.

Solid wastes from the manufacturing process would consist of sodium cyanide not meeting market specifications, accumulated solids from evaporation ponds, packaging materials contaminated with cyanide, and domestic refuse. Product not meeting specifications would not be disposed of but re-worked into the process or sold as lower grade product. On infrequent occasions accumulated solids from the evaporation ponds would be removed to a gazetted landfill site. Damaged packaging material would be decontaminated with hypochlorite and disposed of at a gazetted landfill site. Domestic sewage from amenity facilities would be treated in septic tanks in accordance with requirements of the Town of Kwinana and the Water Authority of Western Australia. Other domestic waste would be disposed of to a gazetted landfill site. The Environmental Protection Authority concludes that no adverse environmental impact will result from solid waste disposal as proposed.

On the issue of occupational health the Department of Occupational Health, Safety and Welfare (DOHSWA) has identified the product packaging operation as the main generator of sodium cyanide dust. DOHSWA has indicated to the Environmental Protection Authority that workers' exposure to cyanide dust, gas or solution would be minimal and could be adequately controlled under normal operating conditions of the plant through engineering controls and existing administrative procedures. No recommendation is considered necessary.

The sodium cyanide briquettes would be packaged into "bag/box" containers. The bag comprises an outer bag of woven polypropylene material with attached lifting hoops, and a waterproof polyethylene inner liner. Bags are placed in a plywood box (16 mm thick) with reinforced internal corner bracing. Each box is bound and strengthened with seven bands of steel strapping. The gross weight of the bag/box package is 850 kg. The bag/box arrangement would be transported in standard freight containers. Each freight container would contain twenty boxes stored two abreast and two high. Each container would have three emergency information panels. This method is the currently accepted way of transporting solid sodium cyanide by road, rail and sea within this State. This method of transporting solid sodium cyanide briquettes offers little opportunity for uncontrolled spills and loss of material. The Environmental Protection Authority considers that it presents no adverse environmental impact. The Environmental Protection Authority considers also that no additional controls are warranted for transport of this material, of either routes or methods, other than those in place for all hazardous materials.

The Environmental Protection Authority considers that, given both the considerable distance between the plant site and the nearest residential areas and existing background noise levels emanating from the Kwinana industrial area, noise emanating from the site during normal plant operation would have no adverse environmental impact on neighbouring residential areas.

During the construction of the project dust, noise and contaminated water would potentially have off-site environmental impact. The Environmental Protection Authority considers that the proponent needs to liaise closely with the relevant government agencies, including the Kwinana Town Council, during the construction phase to ensure that no negative environmental impacts occur during that period.

Recommendation 8

The Environmental Protection Authority recommends that prior to commencement of construction the proponent should prepare a construction-stage management programme to the satisfaction of the Environmental Protection Authority. The programme should address, but not be limited to, management of stormwater runoff from the site, and management of dust and noise.

1. Introduction

Du Pont (Australia) Limited proposes to establish a sodium cyanide plant at Kwinana. The plant would manufacture 45,000 tonnes of solid sodium cyanide briquettes annually.

The proposed plant would be located at Patterson Road, Kwinana. The proposed site is shown in Figure 1.

Sodium cyanide is predominantly used as a leaching agent in the gold extraction process. All solid sodium cyanide currently used in Australia is imported. The proponent states in the PER that if the proposal proceeds then:

- Western Australia's natural gas would be used as a chemical feedstock rather than as fuel;
- supplies of sodium cyanide would be more reliable and there would be less reliance on imported product; and
- increased product availability would allow gold producers to store smaller quantities of sodium cyanide at mine sites, thereby reducing the risk of loss of containment.

The proponent submitted information about its proposal to the Environmental Protection Authority in the form of a Public Environmental Report (PER). The PER had an eight week public review period commencing on 26 July and finishing on 22 September 1989.

The Environmental Protection Authority received 29 submissions on this project, five from Government agencies and 24 from private individuals or conservation organizations. A list of persons and organizations making submissions is included in Appendix 1.

Relevant issues raised in submissions were summarised and forwarded to the proponent for comment. The proponent's responses to questions were circulated for further comment to persons and organisations who made submissions. Questions arising from submissions and the proponent's answers are included in Appendix 2.

The Environmental Protection Authority also sought independent advice on the sodium cyanide production process and the Preliminary Risk Analysis from independent consultant Quantarisk Pty Ltd. The consultant's report is contained in Appendix 3.

The Environmental Protection Authority has assessed the environmental aspects of the project based on:

- information provided in the PER;
- submissions made to the Environmental Protection Authority;
- the proponent's answers to questions raised;
- further information from a number of organisations; and
- the Environmental Protection Authority's own investigations, including the Quantarisk report.

During the Environmental Protection Authority's assessment of the proposal, it became apparent that there were six principal issues involved. These were:

- the risks and hazards associated with the manufacture of sodium cyanide and the implications for the Kwinana area;
- the gases emitted from the flare, scrubber, and natural gas-fired air heater, gases vaporised from water in the cooling tower, and greenhouse gases emitted by the process;
- disposal of liquid effluents containing sodium cyanide to evaporation ponds;
- disposal of solid wastes from the process;
- occupational safety issues related to generation of sodium cyanide dust in the work place and safe disposal of contaminated water in the event of a major fire;
- transport of solid sodium cyanide; and
- potential impacts during the construction phase, including noise, dust and stormwater runoff.

In addition, the Environmental Protection Authority is concerned about the level of emergency response planning and preparedness in the Kwinana industrial area.

2. Description of the proposal and the existing environment

2.1 Outline of the operation

Du Pont proposes to manufacture solid sodium cyanide by the Andrussow process, a process the company has used in other parts of the world since the early 1950s. The basic process is shown on Figure 2.

Sodium cyanide manufacture begins by reacting natural gas, ammonia and air over a catalyst to form a gas stream containing hydrogen cyanide. Liquid ammonia is vaporised by heating to 120°C, and the ammonia vapour is combined with natural gas. The carbon dioxide in natural gas is removed prior to reacting the raw materials, thereby preventing formation of sodium carbonate in the gas stream. The gas/ammonia stream is mixed with filtered compressed air. The mixture enters a converter where it is passed through a platinum/rhodium catalyst to produce hydrogen cyanide gas. The temperature of the hydrogen cyanide gas mixture is reduced from about 1100°C to about 230°C in a heat exchange system producing steam for several on-site uses.

The dilute hydrogen cyanide gas stream is piped to an absorber column where it reacts with a sodium hydroxide solution. The reaction produces sodium cyanide in solution. The close connection of the reactor and the absorber limits the amount of

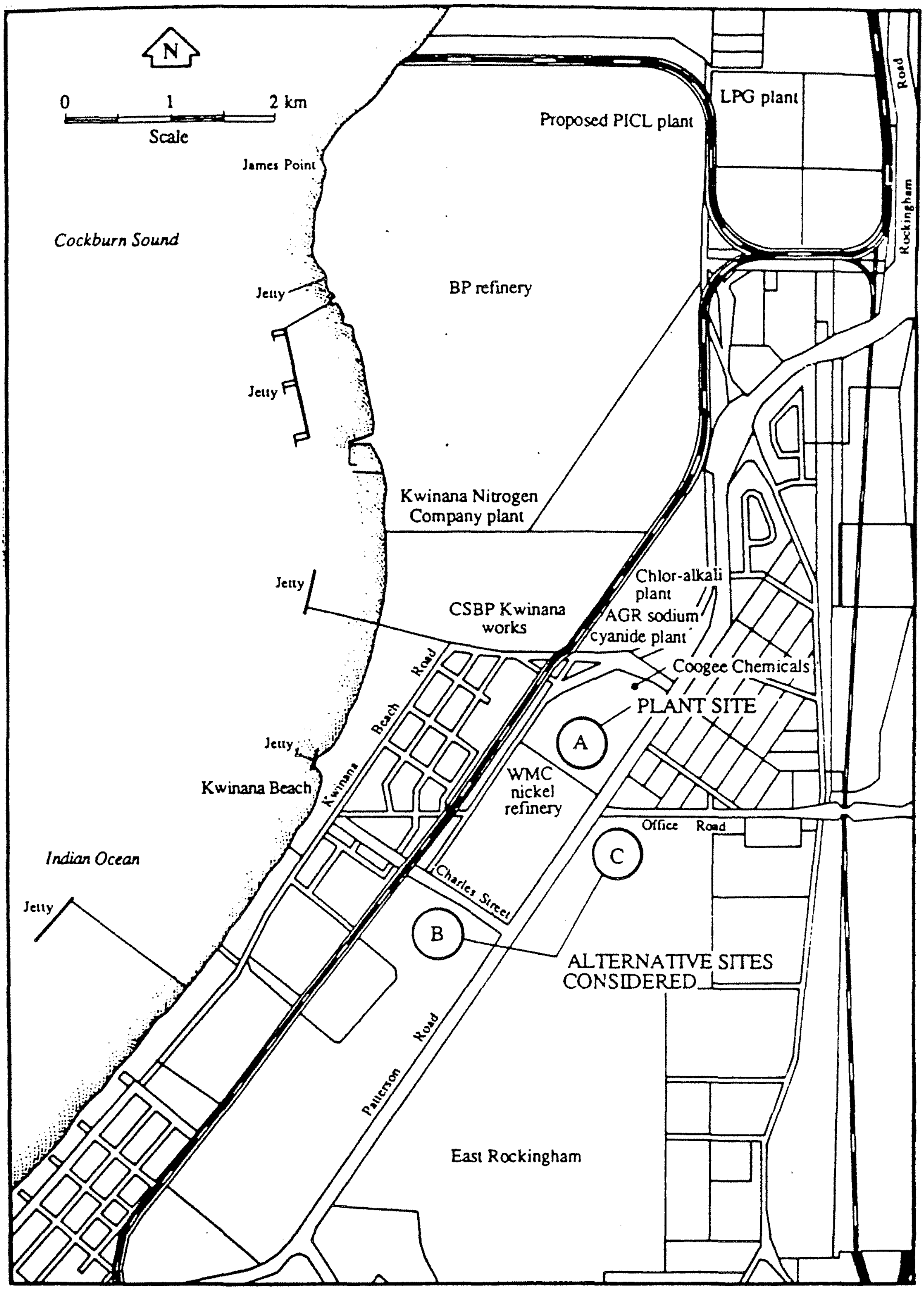

Figure 1: Prospective plant sites in Kwinana

Source : PER

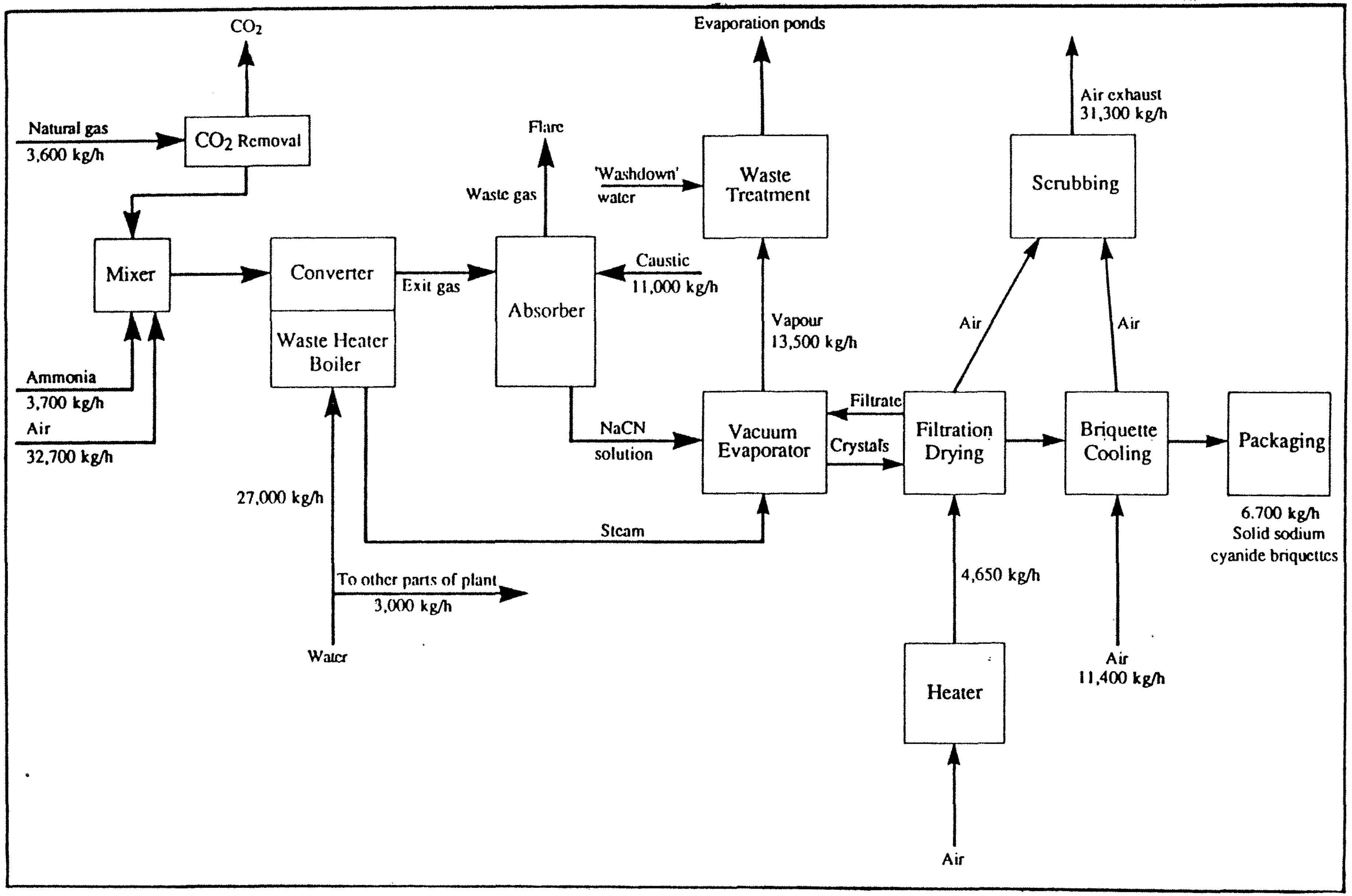

Figure 2: Simplified process flow diagram.
Source : PER

hydrogen cyanide in the system to 1.87 kg at any time.

Gas leaving the absorber column is burnt at the flare. The flare stack is connected directly to the top of the absorber .

Sodium cyanide solution is continually pumped from the absorber column to a vacuum evaporator (crystalliser) where it is concentrated to a slurry containing about 8% precipitated sodium cyanide. Sodium hydroxide is continually fed over two sieve trays in the top of the crystalliser to scrub any hydrogen cyanide in the vapour. This sodium hydroxide is then collected and fed to the absorber.

The slurry is de-watered and dried with hot air in a rotary filter/mixing conveyor system. The resultant crystals are pneumatically conveyed to a briquetter system where they are compacted into solid briquettes (32mm x 32mm x 16mm). The briquettes are cooled to about 80°C in the screener with chilled air.

The product is then packaged.

On the issue of overall process selection, Quantarisk Pty Ltd in their report to the Environmental Protection Authority stated:

"Application of history and experience is a benefit that is hard to measure; it contributes to optimal process operation, improved process safety and increased awareness of the environmental implications of the process."

The Environmental Protection Authority believes that the proponent has demonstrated this, particularly in the modifications made to the proposal during the assessment process, the responses to issues raised, and commitments to environmental management. This is discussed further in the relevant sections of this report.

2.2 Site selection

Du Pont considered several sites, both internationally and nationally, before proposing the present location at Kwinana for its plant. Within Western Australia, sites at Port Hedland, Karratha, Geraldton/Greenough, Kalgoorlie, Northam and Wundowie also were considered.

At Kwinana, the three sites shown in Figure 1 were considered.

The preferred site (Site 'A') was chosen for the following reasons:

- gold production has steadily increased within Australasia;
- Western Australia is a major gold-producing area;
- Kwinana is reasonably central to other gold producers in the region;
- the preferred site is appropriately zoned and there are minimal conflicts with existing land uses;
- residential areas are at least two kilometres from the preferred site and there is a substantial buffer zone;
- piped natural gas, ammonia and caustic soda are available immediately adjacent to the site;
- rail transport for the product is available immediately adjacent to the site;
- the site is immediately adjacent to an industrial facility that supplies and utilizes steam;
- the risks associated with transporting and storing natural gas, ammonia and caustic soda are least at the preferred site;
- support infrastructure and human resources are readily available at the site; and
- other industries familiar with risk control and emergency response are located close to the preferred site.

2.3 The site

The site is a rectangular block located towards the northern end of the Becher-Rockingham beach ridge in the Kwinana industrial area. It is west of Patterson Road near the Office Road intersection (Figure 1).

2.4 The existing environment

The climate in the area is characterised by mild, wet winters and hot dry summers. The average annual rainfall in the Kwinana area is 790 mm, approximately 70% of which occurs between May and August. Rainfall patterns are typically characterised by heavy downpours. Annual evaporation is 2000 mm.

The area containing the site is located on the Becher-Rockingham beach plain, which is a section of the Quindalup Dune System. This coastal dune formation of unconsolidated aerolian deposits has a low undulating relic foredune topography that slopes towards the north-west. Sand in the area is characterized by white, medium-grained calcareous sand which overlies limestone at shallow depth.

There is little surface water runoff in the area because of the porosity of the sandy soil and underlying calcareous material which allows rapid infiltration of rainwater to the underlying shallow aquifer. The groundwater level in the Kwinana area is between 2.5 metres and three metres below the surface, and the direction of groundwater flow is towards the north-west.

Groundwater salinity in the area is approximately 1000 mg/L which is brackish. A shallow saline wedge extends approximately one kilometre inland from the coast. The site is located just east of the saline wedge.

3. Environmental issues and proposed controls

3.1 Risks and hazards

The Environmental Protection Authority required that the risks and hazards associated with sodium cyanide production be analysed as part of the environmental assessment process.

Quantitative risk analysis uses mathematical techniques to estimate the risk a system poses to people and property. Its primary function is to improve plant safety by identifying and quantifying risks associated with components of the operation. This is achieved by identifying potential hazards (ie listing possible mishaps), evaluating the frequency at which these are likely to occur and estimating the possible damage or injury likely to be caused as a result.

Risk analysis can be used to compare project alternatives such as sites and treatment processes. Options for minimizing hazards are considered during the project's design stage.

Du Pont appointed a risk consultant to undertake a preliminary risk analysis to assess the potential impact of hazardous chemicals used and stored in the proposed complex. Conventional risk analysis techniques were used to identify hazards associated with the plant.

Results of the Preliminary Risk Analysis are discussed in Section 5.2 of this report.

The risk analysis focussed on chemicals that would be present in quantities sufficient to present a risk to surrounding areas in case of accidental releases. Those considered were as follows.

3.1.1 Ammonia

Ammonia is one of the principal feedstocks in the manufacture of sodium cyanide. Du Pont proposes to use 29,000 tonnes of ammonia annually. It is a pungent, toxic gas which is highly irritating to humans if inhaled and can cause permanent respiratory tract damage or fatality.

At ambient temperature and pressure it is a colourless gas which is lighter than air. It would be supplied by CSBP and piped to the plant as a gas under pressure via a pipeline of approximately 2.5 km. There would be a small amount (less than 10 tonnes) of ammonia stored on site as a liquid under pressure.

Any liquid ammonia spill would evaporate rapidly and could form a dense cloud of ammonia/air vapour. Liquid ammonia also causes severe burns on contact with skin.

3.1.2 Hydrogen cyanide and sodium cyanide

Hydrogen cyanide is a colourless gas with a mild odour. Hydrogen cyanide exists as a gas in this process. It would be present only as a transient component in the reactor outlet mixture flowing into the absorber where most of it reacts to form sodium cyanide. Only 1.87 kg of hydrogen cyanide would be present in the plant at any time.

Hydrogen cyanide and sodium cyanide are highly toxic by ingestion, inhalation and skin absorption. The cyanides are non-cumulative poisons (ie they can be detoxified readily). Unless the cyanide is removed, death results through asphyxia. Severe exposure (by inhalation) can cause immediate unconsciousness.

The Immediately Dangerous to Life and Health (IDLH) concentration for hydrogen cyanide gas is 50 parts per million (ppm), and the Threshold Limit Value (TLV) in Australia is 5 ppm for an eight hour period. Concentrations of 100 to 200 ppm for exposures of 30 to 60 minutes can be fatal and exposure levels of 300 ppm or more are rapidly fatal unless immediate and effective first aid is administered.

Sodium cyanide would exist in the plant in solution, as dust or as solid briquettes. The caustic nature of sodium cyanide can cause skin burns if not washed off. This property is a more immediate hazard than sodium cyanide poisoning.

3.1.3 Natural gas

Natural gas is the other principal feedstock for the proposed plant. Du Pont estimates 42.45 million cubic metres of natural gas would be used annually.

Approximately 87% (by volume) of the natural gas used is methane; other components include other hydrocarbons and carbon dioxide. An odouriser is added to the gas for leak detection.

Methane is colourless and odourless, and is flammable in the range of 5 to 15% by volume in air. It is toxic as an asphyxiant. It is not explosive when unconfined but may explode at high concentrations when confined.

Releases of methane may result in the formation of a dense cloud because sudden reductions in pressure would result in cooling of the gas and surrounding air. Low pressure, or relatively slow release, would not involve this cooling and as the gas is lighter than air it would dilute below flammable concentrations more rapidly.

3.1.4 Carbon monoxide

Carbon monoxide is a colourless, odourless gas with a density similar to air. When inhaled, it combines with haemoglobin in the blood and renders the haemoglobin incapable of carrying oxygen to tissue, thereby producing asphyxia. Concentrations of 1000 to 1200 parts per million over one hour can be dangerous, but carbon monoxide is eliminated from the lungs when clean air is inhaled.

Carbon monoxide is present only in the hydrogen cyanide reactor products and absorber overhead gas streams at low concentrations and is therefore unlikely to cause a hazard, either on or off site, in the event of a leak. Its presence would however increase the toxicity of hydrogen cyanide if a mixture were released.

3.1.5 Process safety

In the report by Quantarisk Pty Ltd to the Environmental Protection Authority, the consultant has noted that "there are a number of general features (of the process) that enhance safety:

- low operating pressures throughout;
- low operating temperatures, except in the conversion stage;
- the chemical reactions are well known;
- there is a very low hydrogen cyanide inventory in the process;
- the heat of reaction is removed quickly by a boiler forming part of the converter;
- there is a trade off between decreasing mobility and increasing inventory of materials as they pass through the process;
- there is continuing conversion of any residual hydrogen cyanide that may be dissolved in the sodium cyanide solution; and
- the final product form, briquettes, reduces the consequences of product spillages."

3.2 Gaseous emissions

Gaseous wastes would be emitted from the flare, the scrubber, the natural gas fired air heater and the cooling tower air stream. These would all be vented to the atmosphere.

Among the gases vented, carbon dioxide and oxides of nitrogen are greenhouse gases.

3.2.1 Emissions from the flare

Gases discharged to the flare would consist of:

Component	Wt %
Nitrogen	79.8
Water vapour	9.5
Carbon monoxide	5.4
Ammonia	2.2
Hydrogen	1.2
Ethane	0.7
Methane	0.6
Carbon dioxide	0.3
Hydrogen cyanide	0.3

Most gases of concern going to the flare are from the vents of the sodium cyanide decomposition tanks. The flare stack system also would burn the full waste gas stream from the absorber. At times, the full flow from the converter/waste heat boiler may also be diverted to the flare stack. The flare would be approximately 98% efficient in destroying ammonia and hydrogen cyanide.

The gases discharged from the flare would be water vapour, carbon dioxide and nitrogen which form by combustion of gases in the flare from the absorption tower. Small quantities of nitrogen oxides and ammonia would also be released with the flare gas.

Approximate concentrations and flow rates for gases emitted from the flare are as follows:

Component	Approx wt (%)	Approx flow (kg/h)
Water vapour	13	9090
Nitrogen	80	61,360
Carbon dioxide	6	4180
Oxygen	1	910

Nitrogen oxides would be present in the range 5 and 20 ppm.

3.2.2 Emissions from the scrubber

Du Pont proposes to install a scrubber using water to remove sodium cyanide particulates and hydrogen cyanide gas from gases and liquids flowing through the process.

In the first two stages of scrubbing, the sodium cyanide concentration in the scrubbing solution can reach 6%. In the final stage of scrubbing the solution would be made up with fresh water and is released to the lower stage of the scrubber. Caustic would be added to the liquid to maintain a high pH, thereby keeping cyanide in the ionized form preventing evolution of hydrogen cyanide. The off-gas is wet air containing about 4.6 kg/h of cyanide as sodium cyanide. The scrubber is designed to be 99% efficient in removing sodium cyanide and hydrogen cyanide.

3.2.3 Emissions from the air heater

Gaseous emissions from the air heater would consist of nitrogen oxides and carbon dioxide. The exact quantities of gaseous wastes from the heater are not yet known but, based on estimates from similar heaters used in Du Pont's Texas City plant, emissions are expected to be within Western Australian air emission standards.

3.2.4 Hydrogen cyanide vented from the cooling tower

After testing for cyanide concentration, treated effluent containing less than 10 ppm sodium cyanide would be pumped from the decomposition tanks to the cooling tower where most of the remaining cyanide would be vaporised to the atmosphere.

The expected concentration of hydrogen cyanide in the cooling tower airstream is less than 1.0 ppm.

3.2.5 Greenhouse gases

Two greenhouse gases, carbon dioxide and nitrous oxide, would be emitted from the flare and the natural gas fired air heater. The proponent estimates that approximately 4200 kg/h of carbon dioxide would be emitted with smaller, as yet unquantified, amounts of nitrous oxides.

3.3 Liquid effluent

The proposed wastewater treatment and disposal facilities are schematically shown in Figure 3. Washdown, spillage and runoff wastewater would be collected from the sealed and bunded processing and storage areas and directed to a concrete sump. The wastewater in the sump would be pumped to one of three (150 megalitres) decomposition tanks to thermally decompose the cyanide. Steam under pressure would be added to the solution in the decomposition tanks to promote mixing and to heat the solution to 95 - 100°C. By thermal decomposition, the procedure would reduce the sodium cyanide concentration in the wastewater to 50 parts per million. Treated effluent would be pumped from the decomposition tanks to the cooling tower at a rate of 1350 litres per hour. The expected concentration of hydrogen cyanide in the cooling tower airstream would be less than 1.0 part per million.

About 14,000 litres per hour of water vapour containing 10 parts per million cyanide would be condensed from the evaporator and reused as cooling water. Purges of between 1350 and 2250 litres per hour would be taken from the cooling tower system and pumped to a series of evaporation ponds. The concentrations of sodium cyanide in the solution entering the evaporation ponds would be less than 1.0 parts per million free cyanide.

One and a half hectares of evaporation ponds would be required to store discharged wastewater and runoff. The ponds would be double-membrane lined with leak detection systems installed between membranes. Ponding capacity surplus to normal operating needs would be available at all times to allow ponds to be drained if leaks are detected. The ponds would have sufficient capacity to accommodate runoff from an extreme rainfall event (a one in a 100 year, 72 hour duration storm) at the end of winter when pond water levels would be highest.

Plant maintenance washing and "first flush" stormwater from the process plant and product storage area would also be contained and treated as liquid effluent. Following the first flush, stormwater from heavy rains would be pumped directly from the sump tank to the evaporation ponds. Monitors would be installed between the sump tank and the evaporation ponds to measure the amount and quality of water being pumped, including cyanide concentration.

3.4 Solid wastes

Solid wastes from the plant would be limited to:

- sodium cyanide not meeting specifications;
- precipitated salts from the evaporation ponds;
- packaging material; and
- domestic refuse.

3.4.1 Sodium cyanide not meeting specifications

Sodium cyanide not complying with performance specifications would be produced during plant start-up and while balancing flows of reactants. Product not meeting specifications would not be disposed of but re-worked into the process or sold as lower grade product.

3.4.2 Accumulated solids

On infrequent occasions accumulated solids from the evaporation ponds would be removed to a gazetted landfill site. The solids would consist of dissolved solids removed from incoming purchased water, water treatment chemicals, salts of ammonia and formates from decomposed cyanide. These solids would be analysed, removed from the ponds by vacuum truck, loaded into containers and placed in an approved solid waste disposal facility.

3.4.3 Packaging material

Damaged packaging material would be decontaminated with hypochlorite and disposed of at a gazetted landfill site.

3.4.4 Domestic wastes

Domestic sewage from amenity facilities would be treated in septic tanks in accordance with requirements of the Town of Kwinana and the Water Authority of Western Australia. Normal domestic solid waste would be disposed of to a gazetted landfill site.

3.5 Sodium cyanide transport

Sodium cyanide briquettes would be stored on-site in a 2800 tonne capacity warehouse. The sodium cyanide briquettes would be packaged by the "bag/box method". The outer layer of the bag is a woven polypropylene material with attached lifting hoops, while the inner layer is a waterproof polyethylene liner. These bags are placed in a plywood box (16 mm thick) with reinforced internal corner bracing. Each box is bound and strengthened with seven bands of steel strapping. The gross weight of the bag/box package is 850 kg.

Approximately one month's inventory of required bag/box packaging would be kept in the undercover warehouse at any one time.

The bag/box arrangement would be transported in standard freight containers. Each freight container would contain 20 boxes stored two abreast and two high.

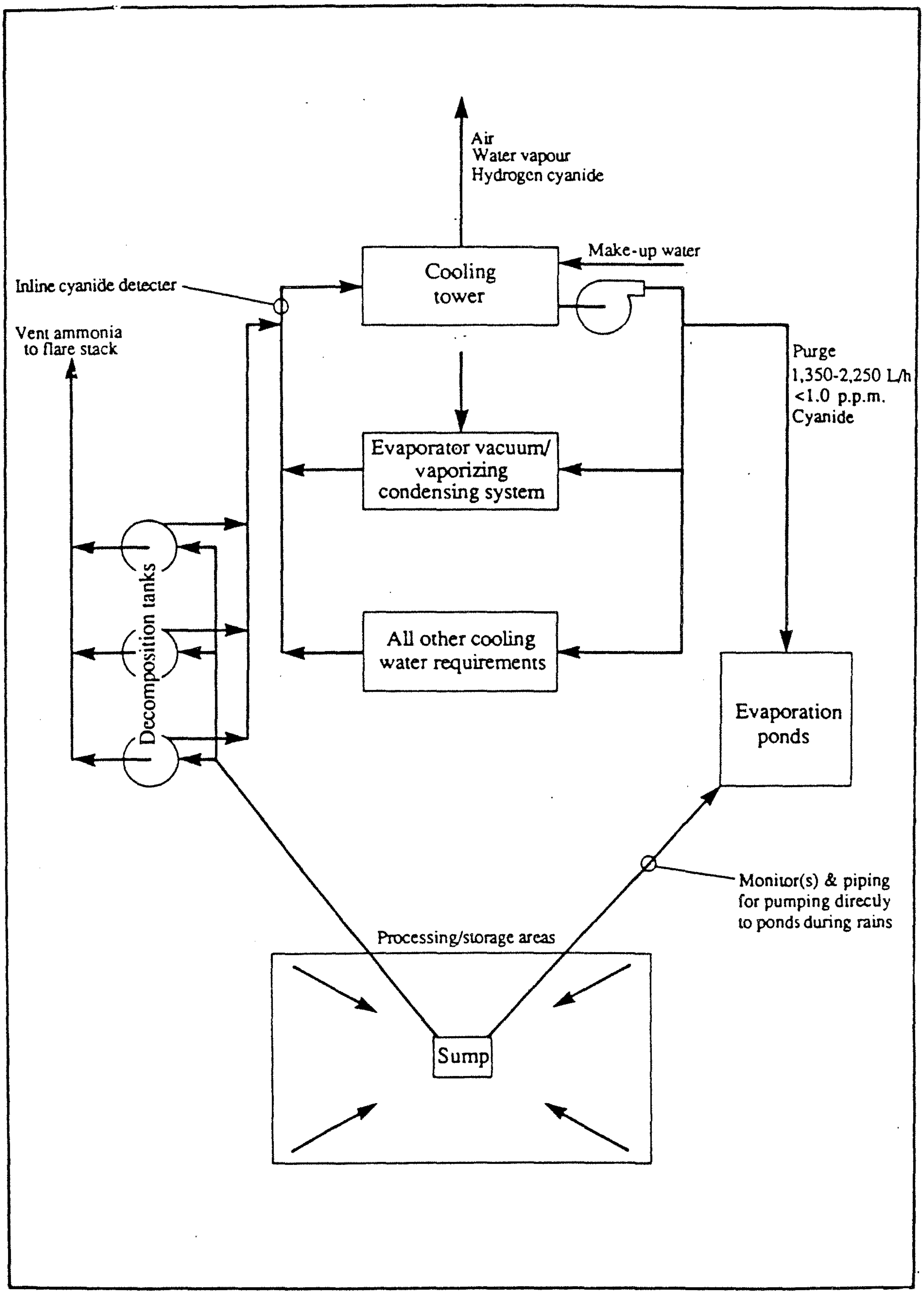

Figure 3: Proposed wastewater treatment/disposal facilities

Source : PER

The method described above is the currently accepted way of transporting solid sodium cyanide by road, rail and sea within Western Australia.

3.6 Noise, dust and construction phase impacts

Noise would be generated from the proposed plant mainly during the construction phase.

Once the plant is operational, the main source of noise would be the vacuum pump which would be isolated from the surrounding area to reduce noise. Noise from other plant components are expected to be below 85 dB(A) at source.

Increase in traffic in the area caused during construction, and by the workforce, plant operations and product transport would be negligible. Patterson Road, Rockingham Road and other major roads in the area cope well with existing traffic and have ample capacity to accommodate further increases in regional traffic movement.

During construction, dust generation by earth-moving equipment and contamination of storm water runoff are other potential environmental impacts needing to be managed.

3.7 Occupational health issues

The submission by the Department of Occupational Health, Safety and Welfare of (DOHSWA) raised the issue of cyanide dust generation in the plant. Insufficient cyanide dust would be generated by the process to have off-site environmental impact but dust would have to be managed to ensure a safe working environment.

4. Summary of submissions

4.1 Introduction

Twenty six submissions were received by the Environmental Protection Authority. Below is a list of specific issues raised.

ISSUE	FREQUENCY
Gaseous emissions	16
Liquid waste management	11
Public safety	9
Risks and hazards	9
Groundwater contamination and monitoring	8
Risks associated with transporting solid NaCN	8
Frequency of beach closures during ammonia unloading	6
Kwinana Integrated Emergency Management System	6
Need for the proposal	6
Plant should be located in the Pilbara	5
Worker safety and welfare	5
Ammonium pipeline and storage	5
Risks associated with handling solid NaCN	4
Greenhouse effect	4
Du Pont overseas safety records	4
Solid waste management	4
Effects of evaporation ponds on wildlife	4
Product packaging and storage	4
Sodium cyanide dust management	4
Gas scrubbing system	3
Storage and handling of other raw materials	3
Public amenity	2
Noise	2
Sources of water for the plant	2
"Domino effects"	2
On-site emergency response capabilities	2
Efficiency of the flare	1
Pollution of Cockburn Sound	1
Strategic risks associated with HMAS Stirling	1
Plant maintenance procedures	1
Hazards and operability study	1
Energy consumption by the plant	1
Risks associated with operating a reactor under positive pressure	1
The secondary gas containment system	1
Inventory of HCN	1

4.2 Grouping of issues

For the purposes of assessment, these issues were grouped as follows:

Risks and hazards:

- Public safety
- Risks associated with handling and transporting solid sodium cyanide
- Kwinana Integrated Emergency Management Scheme
- Ammonia pipeline and storage
- Du Pont's overseas safety record
- "Domino effect"
- Plant maintenance procedures
- Hazards and operability study
- Risks of operating a reactor under pressure
- Secondary containment system around the reactor
- Inventory of hydrogen cyanide

Gaseous emissions:

- Gas scrubbing system
- Greenhouse effect
- Efficiency of flare

Liquid effluents:

- Sources of water for the plant
- Groundwater contamination and monitoring
- Effects of evaporation ponds on wildlife
- Pollution of Cockburn Sound

Solid wastes

Worker safety and welfare:

- Product packaging and storage
- Sodium cyanide dust management
- Public amenity of the Kwinana Beach area

These issues, and others considered by the Environmental Protection Authority, are discussed below.

4.3 Issues raised peripheral to this assessment

The Environmental Protection Authority also received submissions on the following issues:

- Risks associated with proximity to HMAS Stirling;
- Plant should be located in the Pilbara; and
- Energy consumption of the plant.

HMAS Stirling is a Federal Government facility. The major concern appears to be the possible interaction between HMAS Stirling as a terrorist target and surrounding hazardous industries. The Environmental Protection Authority believes that, while this seems unlikely, nevertheless the separation distances are adequate to prevent any such interaction.

The proponent examined a wide range of alternative sites, as discussed in the PER, prior to selecting Kwinana as their preferred location. The Environmental Protection Authority regards the site selection process as adequate and believes that a proponent has the right to put forward a preferred site. In this case the Environmental Protection Authority would require the proponent to consider alternative sites only if the Kwinana site was not environmentally acceptable.

The plant is a low consumer of energy, in the context of existing total demand in the State. Consideration of energy demand of this plant in isolation is not warranted.

These issues therefore are not discussed further in this report.

4.4 Changes to the proposal

It is important to note that the environmental impact assessment process, including public review, resulted in several changes to the original proposal, which have lead to environmental benefits. These changes were suggested by the proponent in the light of issues raised in public submissions, or areas of concern expressed by the Environmental Protection Authority.

Firstly, the expressed concern at the production and handling of hydrogen cyanide under pressure resulted in the proponent making a commitment to "secondary containment" of all relevant sections of the plant. These include the reactor and the absorber, and the pipeline connecting them, where the major part of the hydrogen cyanide inventory would be located. This containment will allow capture and detection of any leaks, followed by immediate shutdown for repairs. Secondary containment has not been quantified in the analysis of risks or gaseous emissions, giving a conservative margin in the assessment of impacts.

Secondly, by treating waste water to a greater degree than originally proposed and increasing recycling, demand for fresh water will be reduced. The area of evaporation ponds will be reduced from the original five hectares to the current 1.5 hectares. A change from chemical treatment to heat treatment will avoid creating chemical residues requiring disposal.

Thirdly, the proponent has advised of a willingness to make available its expertise in the field of emergency planning and public safety. While not pre-empting any decision on the proposal, the Environmental Protection Authority believes that the proponent's experience in this field would be of considerable advantage to the statutory authorities charged with this task in the Kwinana area. In particular, their experience with the "right-to-know" aspects of American and some European legislation should assist controlling authorities in achieving public education and understanding of these matters.

5. Assessment of environmental impacts

5.1 Introduction

Construction and operation of the proposed solid sodium cyanide plant has the potential to generate the following environmental impacts:

- Risks and hazards;
- Gaseous emissions;
- Liquid effluent discharges;
- Solid wastes;
- Occupational health issues;
- Product transport; and
- Noise, dust and construction phase impacts.

As detailed in the following sections, the Environmental Protection Authority believes that the proponent has shown that all these potential impacts can be controlled to an acceptable level.

Recommendation 1

The Environmental Protection Authority concludes that the proposal as described in the Public Environmental Report with modifications as described in this report, to manufacture and distribute solid sodium cyanide briquettes, is environmentally acceptable and recommends that the proposal could proceed subject to the Environmental Protection Authority's recommendations in this report and the environmental management commitments made by the proponent (Appendix 4 of this report).

5.2 Risks and hazards

5.2.1 Introduction

In Bulletin 278, "EPA Guidelines - Risks and Hazards of Industrial Developments on Residential Areas in Western Australia", May 1987, the Environmental Protection Authority made the following statement:

"Historical records show that industrial accidents occur, and that technical safeguards have their limitations. However, with proper planning, review and control during the plant design, commissioning and operational stages these risks and hazards can, in most cases, be minimised, managed and made acceptable in the sense that they can be reduced to a level that the community is prepared to tolerate."

The following are used by the Environmental Protection Authority as a criterion for the assessment of the fatality risk acceptability of new industrial installations:

- An individual risk level in residential areas of less than one in a million a year is so small as to be acceptable to the Environmental Protection Authority.
- An individual risk level in residential areas exceeding ten in a million a year is so high as to be unacceptable to the Environmental Protection Authority.

Where the preliminary risk level in residential areas has been calculated to be in the range one in a million to ten in a million per year, the Environmental Protection Authority will call for further evaluation of the risks associated with the project. The Environmental Protection Authority may then be prepared to recommend that the project is acceptable subject to certain planning and technical requirements.

In cases where the Environmental Protection Authority believes that a proposal involves a significant element of risk, a risk analysis is required as part of the environmental impact assessment process. The results of the risk analysis are assessed against criteria set by the Environmental Protection Authority during the development of policy as detailed in Bulletin 278. It is also integral to the policy that final design and operation of a proposed plant would be controlled to make a plant as safe as reasonably practicable, through techniques such as hazard and operability (HAZOP) reviews.

A Preliminary Risk Analysis (PRA), required by the Environmental Protection Authority, has been carried out by Det norske Veritas for the proposal. The PRA was published as Volume 2 of the PER. Guidelines for preparation of the PRA appear as Appendix J of the PRA. Guidelines for preparation of the required documentation are provided to give some assistance to the proponent. However it is made clear in the Guidelines that it is the responsibility of the proponent to identify and analyse the environmental issues pertinent to the proposal.

To further assist in refining target areas, areas of particular concern were indicated during preparation of the PRA. Firstly, the Du Pont process operates under pressure, unlike the plant which has been commissioned recently in Kwinana which operates at slightly below atmospheric pressure. This is perceived as an advantage of the present plant since it eliminates the possibility of leakage from the process equipment. The proponent's detailed comments on this were sought. The second issue relates to the inventory of hydrogen cyanide on the site, which must be kept to an absolute minimum.

Public submissions, and questions from the Environmental Protection Authority to Du Pont on the content of the PRA, suggests a level of dissatisfaction with the quality of that document. Given the Environmental Protection Authority's experience in assessment of similar proposals, an unacceptable level of risk was not expected. However failure to comply with the provided guidelines in a number of important areas resulted in difficulties in following the path by which the conclusion was reached in this case.

The aim of the questions to the proponent was to improve the level of "transparency" of the methods used in the PRA. The Environmental Protection Authority believes that this has been achieved adequately, and that an assessment now can be made. The assessment of potential impact on risk levels in this section of the report is based on the Environmental Protection Authority's experience and the following documents:

- Public Environmental Report;
- Preliminary Risk Analysis;
- Proponent's response to issues raised;
- Report by Quantarisk Pty Ltd to the Environmental Protection Authority;
- Submissions by government departments, particularly that of the Department of Mines; and
- Cumulative Risk Update by Technica Limited.

The PRA followed well-established hazard analysis techniques:

- To identify hazards present in the facility;
- To identify incidents that could lead to accidental release of hazardous materials to the environment;
- To estimate the magnitude of the associated consequences of these incidents;
- To estimate the frequency at which these incidents occur; and
- To estimate the resultant levels of risk to residential areas.

These levels of risk were added to those already calculated for the Kwinana area. The cumulative risk levels were then evaluated against the criteria adopted by the Environmental Protection Authority.

Details of the PRA, and the Environmental Protection Authority's assessment of the results, are presented in the following sections.

5.2.2 Failure cases

The hazardous materials to be handled on the site were identified as ammonia, natural gas, hydrogen cyanide, sodium cyanide, carbon monoxide and sodium hydroxide (caustic). Their hazardous properties were listed in Appendix A of the PRA and are summarized in Section 3.1 of this report.

Any other hazardous materials on the site, for example laboratory chemicals, would not be present in sufficient quantities or in a form which could result in off-site effects. Therefore they were not considered further in the PRA. This approach is acceptable to the Environmental Protection Authority.

Processes which could lead to releases of hazardous materials include vaporization and heating of ammonia, heating and mixing natural gas with air, production and movement of gaseous hydrogen cyanide under pressure, and heating and handling liquid and powdered sodium cyanide. There are significant storages of ammonia, and liquid and solid sodium cyanide on site which must be considered in the analysis. Natural gas and ammonia would be supplied by pipeline.

The PRA analysed the whole plant to identify all possible failures which could result in loss of hazardous materials. The list was culled to those incidents with possible consequences off-site. These were grouped into a smaller number of similar release events to make analysis easier. In this culling and grouping, a conservative approach was used to make sure all incidents were covered.

The failure cases considered were presented in Table 5.4 of the PRA. A number of submissions indicated that the basis for generating these cases was not explained adequately. Several of the questions to the proponent were related to this concern (eg 1(a), 1(e), 2, 8, 10 in Appendix 2 of this Report) and the allied matter of release durations and/or quantities released (eg 1(d), 1(g) in Appendix 2).

In identifying possible failure incidents, and later in assigning failure frequencies, the consultant took into account a number of safety features which are integral to the design of the plant. This has a tendency to reduce the number of incidents which can have an off-site effect.

The Environmental Protection Authority notes the major issues raised in the PRA (page 14). These are the need for particular attention to pipelines, operator training, preventative measures to avoid failures, and good housekeeping. These would be covered by specific items in a Total Hazard Control Plan for the facility, under the heading "Implementation Systems", as recommended below.

The comprehensive answer to Question 1(a), plus details provided in answer to other questions, satisfy the Environmental Protection Authority that the process of generating the failure cases was of sufficient rigour to identify all events with potential for off-site consequences. It is accepted also that sufficient justification has been provided for the level of confidence in the shutdown systems, which would limit release durations to less than the times stated in the analysis.

Part of the PRA process is to prevent an incident in one part of the plant, or on another nearby plant, leading to further incidents (the "domino" effect). The proponent's consultant has judged that separation distances and other safeguards are adequate to prevent this. The consultant also has shown that there is no potential for effects of explosion overpressures or of heat radiation beyond the site.

The Environmental Protection Authority accepts this initial assessment, but believes that in the final design detailed consideration should be given to the presence of the hydrocarbon storages at the nearby Coogee Chemicals. This would be included as part of the work under Recommendation 2 below.

On the matter of possible interaction between the rail line and the pipeline corridor, Det norske Veritas indicates a need to review present standards. The Environmental Protection Authority accepts this as desirable and will pursue the matter with the relevant Government agencies.

Severity Ranking	Risk event	% of risk	Frequency
1	Vaporizer major release	22.8	300
2	Reactor major release	6.04	
3	Waste heat boiler major release	6.04	
4	Absorber major release	6.04	
5	Cook tanks major release	6.04	
6	CO_2 stripper major release	6.04	
7	Scrubber major release	6.04	
8	Process/pipe drain points etc	6.04	
9	Vaporizer relief valve	6.04	
10	Gas heater rupture	6.04	
11	Packing and handling spills	6.04	
12	Buffer storage major release	4.87	60
13	NH_3 pipeline rupture	2.40	2.5
14	Warehouse incident	2.17	10,000
15	Vaporizer feed major release	1.95	1125
16	NH_3 pipeline major release	1.73	7.5
17	Flare malfunction	1.57	100
18	Flare line rupture or release	1.45	10,000
19	Vaporizer feed guillotine failure	0.66	125
20	Buffer storage rupture	0.03	6.0
21	Vaporizer rupture	0.03	6.0
22	Natural gas supply major leak	0.02	0.9
23	Natural gas supply rupture	0.01	0.3

Table 5.1: Failure events used in calculation of risk levels

Note: Events 2 - 11 inclusive conservatively assessed as localized in-plant risks only

The above process resulted in a final list of failure cases given in Table 5.1, which was taken from the proponent's responses. The Environmental Protection Authority is satisfied that the list is comprehensive, and adequate for the PRA.

5.2.3 Consequence calculations

For each possible incident, the consequences were analysed. The release rate of toxic gases was combined with meteorological factors to give plume dispersion for all weather conditions. The dispersion models used are acceptable to the Environmental Protection Authority.

Toxicity relationships (known as probit equations) were used to give the probability of death at each point in the plume. The Environmental Protection Authority was concerned that, in the estimation of consequences of ammonia releases, the proponent had used probit equations which differed from, and were less conservative than, those used in other studies. The proponent subsequently provided references for derivation of the equations used.

At this stage the Environmental Protection Authority accepts the probit equations used in this study and is investigating inclusion of this recent work in the cumulative risk model for the Kwinana area.

Consequences of fire were estimated from heat flux using models acceptable to the Environmental Protection Authority.

5.2.4 Failure frequencies

By reviewing the safety records of similar facilities, and combining with other data on pipe, process and storage failures, an analysis was made of predicted failure frequencies. There was concern expressed in submissions that the frequency data in Table 5.4 of the PRA were less than those used in other studies carried out in the Kwinana area. In answer to Question 1(b), the proponent indicated that the frequency data used refer to event frequencies, and are lower than component failure frequency data due to inclusion of probabilities of events developing into a major release.

The failure frequencies used are listed in Table 5.1

The Environmental Protection Authority accepts these numbers and is confident that process controls can be applied to achieve frequencies below those used in the analysis. Application of these controls would be assured through development of a Total Hazard Control Plan as recommended below.

5.2.5 Risk levels from the plant

Given that the Environmental Protection Authority agrees with the above steps, the estimation of off-site risk levels is relatively simple. Consequences of possible incidents and their respective frequencies were multiplied by the probability of wind in each direction.

The proponent used the same weather information, supplied by the Environmental Protection Authority, as used for all other studies in the Kwinana area. To speed up calculations the information can be grouped into major classes of wind speed/stability category, with probability of each class being determined for each wind direction. The groupings used by the proponent are acceptable to the Environmental Protection Authority.

The results of the analysis of all possible incidents were added together to give the total off-site risk from the plant, in terms of the likely number of deaths per million years. Figure 1.1 of the PRA presents the overall result. This is included in this report as Figure 4.

The results show that risk levels reduce to less than one-death-in-ten-million-years within the immediate vicinity of the plant boundary.

In the responses to questions, the proponent also provided a ranking of events which contribute to off-site risk. This is reproduced above as Table 5.1. The major contributors are emissions of ammonia. Possible releases of hydrogen cyanide have no potential for off-site effects because of the small inventory and process controls. This estimate does not take account of the secondary containment system which would provide an additional level of safeguard.

It is noted that in carrying out the PRA the consultant made a number of assumptions, included in the PRA as Appendix B. The Environmental Protection Authority expects that the proponent will confirm the intent of these assumptions as part of their commitments, to be attached to any Ministerial Statement for the project.

5.2.6 Confidence in the proposal

In the conclusion to the PRA, Det norske Veritas made the following overall assessment of the proponent's risk management record:

"6.9 Safety Record

"From examination of Du Pont Health and Safety Records and their systems for maintaining process safety, DnV concludes that Du Pont has a total commitment to safety which is evident throughout the organization and its facilities, and that they are industry leaders in this respect.

"6.10 Management of Safety, Occupational Health, Reliability and Environmental Protection

"Du Pont Australia will be employing safety systems developed by the Du Pont Organization in its extensive manufacturing activities and applied to meet the requirements of the West Australian Authorities. From the commitment given to safety by Du Pont in all of its activities, and its outstanding safety record, it is expected that this plant will be operated with a very high level of both in-plant and public safety."

The Environmental Protection Authority commissioned Quantarisk Pty Ltd to carry out a qualitative review of the proposed process in the context of the Guidelines for Public Environmental Reports and Preliminary Risk Analyses. The review also assessed the technology proposed for the plant to identify those features that enhance the basic safety of the process. This review is included as Appendix 3.

To quote from the conclusion of the report to the Environmental Protection Authority:

"Some of the important features identified are:

- a very small inventory of toxic material that is gaseous and highly mobile in nature;
- process operating conditions are not arduous;
- significant reduction in the mobility of toxic materials as the inventories of the materials increases; and
- a product form (briquettes) that offers little opportunity for uncontrolled spills and loss of material.

"The process appears not to be complicated when compared to other chemical processes. Its concept is kept simple and shows evidence of careful design with attention being paid to safety. Additional features, such as the commitment to secondary containment of hydrogen cyanide, are evidence of the proponent's view of the benefits of engineering for safety."

The Environmental Protection Authority agrees with this assessment.

5.2.7 Cumulative risk

The Environmental Protection Authority's assessment of acceptability of risk is based on the cumulative risk at the nearest residential areas from all industrial developments. Such an analysis has been carried out for each proposal for a hazardous industry in the Kwinana area.

Cumulative risk analysis was carried out by Technica Limited under contract to the Department of Resources Development, and is attached to this report as Appendix 5. This report shows compliance, or otherwise, with the Environmental Protection Authority's risk criterion of one-in-a-million deaths per year in residential areas.

The cumulative risk contours, reproduced in this report as Figure 5, show that the one-in-a-million level extends to the CBH Jetty in the south, the Thomas Road-Rockingham Road intersection in the east, and the SECWA Power Station in the north. By overlaying the base case (Figure 1 from the Technica report) with the cumulative risk contours including the proposed plant, it can be seen that the proposed plant has no influence on the one-in-a-million contour. The criterion is satisfied, well within the non-residential areas.

The Environmental Protection Authority concludes that, subject to the Recommendation below, the proposal does not impose an unacceptable level of risk on residential areas.

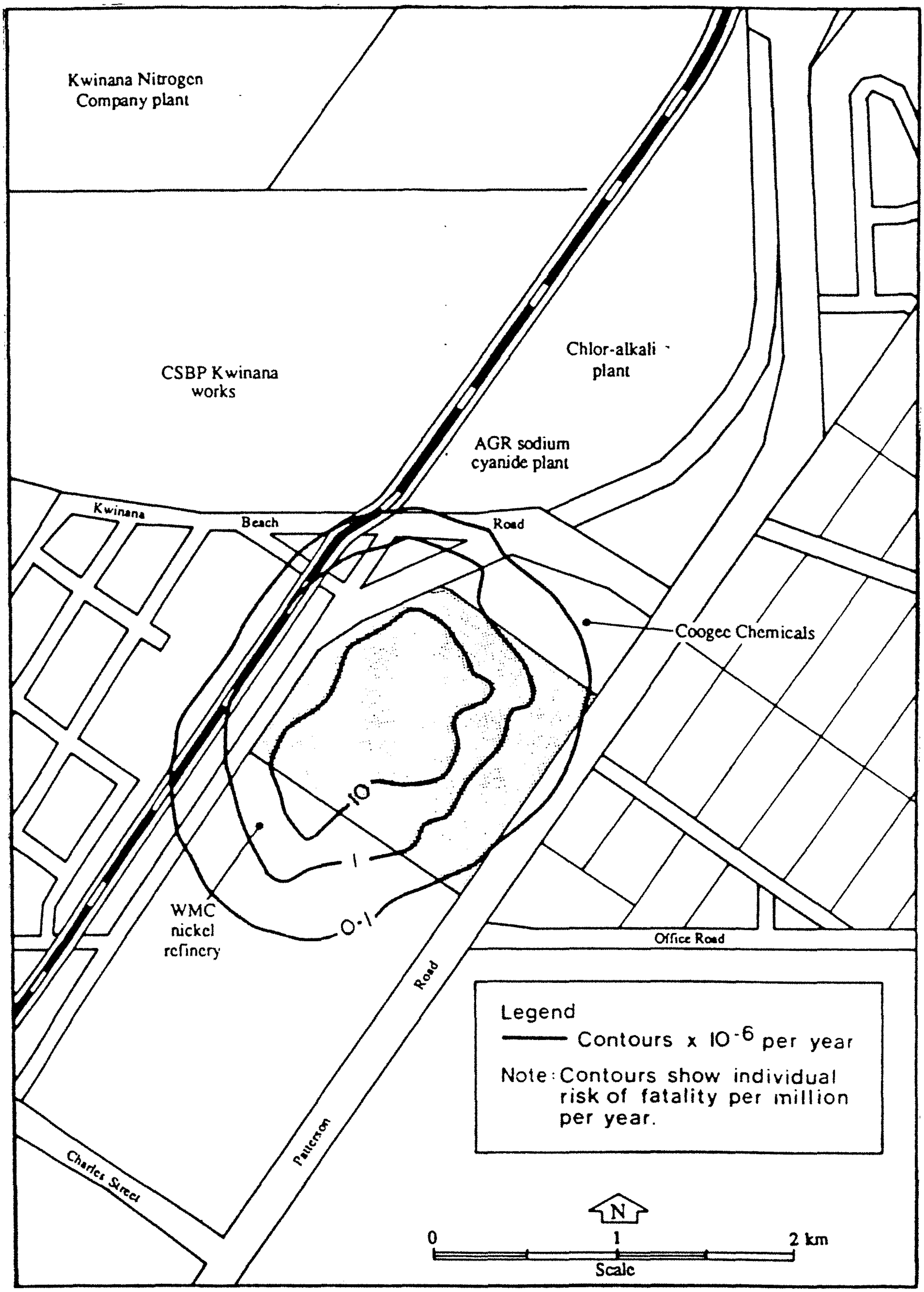

Figure 4: Individual risk contours

Sources: PRA, PER

5.2.8 Risk management strategy

A key part of the risk analysis process is that, as well as incorporating sound technical design, good management systems and practices are in place to keep the risk below the estimated design levels for the life of the plant.

In the conclusion of the PRA, the consultant made the following general technical and management recommendations for effective risk management:

"6.8 Emergency Procedures

"Du Pont will prepare emergency procedures for the proposed plant, basing them on established practices at their other sodium cyanide manufacturing facilities. The company will also co-ordinate their emergency procedures with the Kwinana Integrated Emergency Management System (KIEMS) which is currently being drawn up.

"Hazop & Other Future Safety Studies

"Du Pont is committed to carrying out a Hazard and Operability Study during the detailed design phase and will ensure that action items arising from this study are implemented.

"The assumptions and results of this Preliminary Risk Analysis will be reviewed when the plant design is finalised to check that the results and conclusions remain valid.

"Other studies will be carried out to examine critically fire safety, emergency preparedness and commissioning procedures, and in-service safety will include regular audits.

"These studies will be carried out to meet Du Pont's internal safety requirements as well as those of the W.A Department of Mines.

"6.12 Training, Commissioning & Start-Up Procedures

"Preparation for the safe start-up of the plant will include the involvement of experienced personnel throughout the building, testing, commissioning and start-up phases of the project.

"Experienced personnel will be used in operating the plant until thorough training of new personnel is completed. Training will include plant and process familiarisation, safety induction and training, operating procedures and emergency response.

"Start-up and operating procedures generally will be considered in the HAZOP and detailed procedures will be reviewed prior to start-up."

The Environmental Protection Authority expects that the proponent will confirm the intent of these statements as part of their commitments, to be attached to any Ministerial Statement for the project. They form the basis of a suitable Total Hazard Control Plan for the project.

The Environmental Protection Authority notes that Du Pont uses slightly different terminology for some aspects of its safety management system to those used in the past by the Environmental Protection Authority. An example is Du Pont's use of the term "Process Hazard Review" instead of "Hazard and Operability Review". The Environmental Protection Authority is prepared to use Du Pont terminology, on the proviso that the methodologies used are to the satisfaction of the Environmental Protection Authority and relevant statutory authorities.

5.2.9 Conclusion

The Environmental Protection Authority concludes that the risk levels imposed on residential areas by the proposed solid sodium cyanide plant, when added to those levels which exist at present, are acceptable and meet the criterion adopted by the Environmental Protection Authority in Bulletin 278. This conclusion is subject to adherence to commitments made by the proponent and subject to the following recommendations.

Recommendation 2

The Environmental Protection Authority recommends that the proponent should prepare, in stages and at times to be determined by the Environmental Protection Authority on advice from the Department of Mines, a comprehensive hazard identification and risk management programme (ie a Total Hazard Control Plan), to the satisfaction of the Environmental Protection Authority on advice from the Department of Mines.

The programme should include, but not be limited to, the following:

1 safety engineering design;

2 quantified risk assessments;

3 Process Hazard Review of the facilities;

4 implementation systems; and

5 safety reviews during the life of the plant.

The ongoing results shall be forwarded to the Environmental Protection Authority and the Department of Mines.

Recommendation 3

The Environmental Protection Authority recommends that, prior to commissioning, the proponent should develop and implement, to the satisfaction of the Environmental Protection Authority and relevant agencies, an emergency plan which takes into account all relevant events including "plant upset" conditions. This plan should be fully integrated with the requirements of the Kwinana Integrated Emergency Management System.

5.2.10 Contingency planning

On-plant contingency planning is generally covered in matters raised in Section 5.2.8. The proposed systems are judged to be adequate.

The possibility of consequences external to the plant needs to be managed in an integrated way for the whole Kwinana industrial area. This has been recognised and commented upon by the Environmental Protection Authority in several previous assessments of proposed industrial developments. The proponent and their consultant also have recognized this explicitly in a commitment to be fully involved in the Kwinana Integrated Emergency Management System (KIEMS).

Development of the System is a Government responsibility, and implementation has been somewhat slow up to this time. Given the recent start-up of several plants with significant off-site risks, this matter needs to be expedited. In particular it is important that some of the obvious major aspects of the System be put in place as soon as possible, including provision of fundamental emergency response support.

Recommendation 4

The Environmental Protection Authority recommends that no approval or licence to commission the proposed plant be issued by any statutory authority until the key emergency response provisions of the Kwinana Integrated Emergency Management System are in place to the satisfaction of the Minister for Environment on the advice of the Environmental Protection Authority.

The Environmental Protection Authority has received a letter from State Emergency Service (Appendix 7), indicating the projected timetable for implementation of KIEMS. The Environmental Protection Authority's advice to the Minister for Environment under the above recommendation will be based largely on meeting this timetable, and addressing the immediate issues indicated above.

5.3 Gaseous emissions

5.3.1 Introduction

As previously identified, gaseous wastes would be emitted to the atmosphere from:

- the flare;
- the scrubber;
- the natural gas fired air heater; and
- the cooling tower airstream.

5.3.2 The flare

Under normal operating conditions, gases discharged to the flare would comprise:

Component	Wt %
Nitrogen	79.8
Water vapour	9.5
Carbon monoxide	5.4
Ammonia	2.2
Hydrogen	1.2
Ethane	0.7
Methane	0.6
Carbon dioxide	0.3
Hydrogen cyanide	0.3

Most of these gases come from the vents of the sodium cyanide decomposition and from the absorber. At times, the full flow from the converter/waste heat boiler may also be diverted to the flare stack. The flare would be approximately 98% efficient in destroying ammonia and hydrogen cyanide.

Flare emissions would normally consist of:

Component	Approx wt%	Approx flow kg/h
Water vapour	13	9090
Nitrogen	80	61,360
Carbon dioxide	6	4180
Oxygen	1	910

Nitrogen oxides would be present in the range 5 to 20 parts per million.

Abnormal emissions can occur when the plant starts up, shuts down or malfunctions. During plant start-up and shut-down gaseous emissions are predictable. During plant upset conditions all gaseous emissions will be vented to the flare. The Environmental Protection Authority agrees with the proponent that this should result in avoiding increases in nitrous oxides and the associated brown haze. It is anticipated that this will result in lower restrictions on start-up conditions than are imposed on the existing sodium cyanide plant. However, easing of restrictions will be dependent on results of monitoring early startups.

Details of how less-predictable fugitive emissions would be managed must be submitted by the proponent to the Environmental Protection Authority during the Works Approval and Licensing of the plant under Part V of the Environmental Protection Act 1986.

During plant upset conditions requiring emergency shut down, valves feeding ammonia, natural gas and air would close, the process air-blower would shut down and the reactor would be flooded with nitrogen gas which would be routed to the flare. Any hydrogen cyanide present would pass through the sodium cyanide absorber to the flare.

Several precautions have been incorporated in the flare design to ensure that the flare is not extinguished without detection.

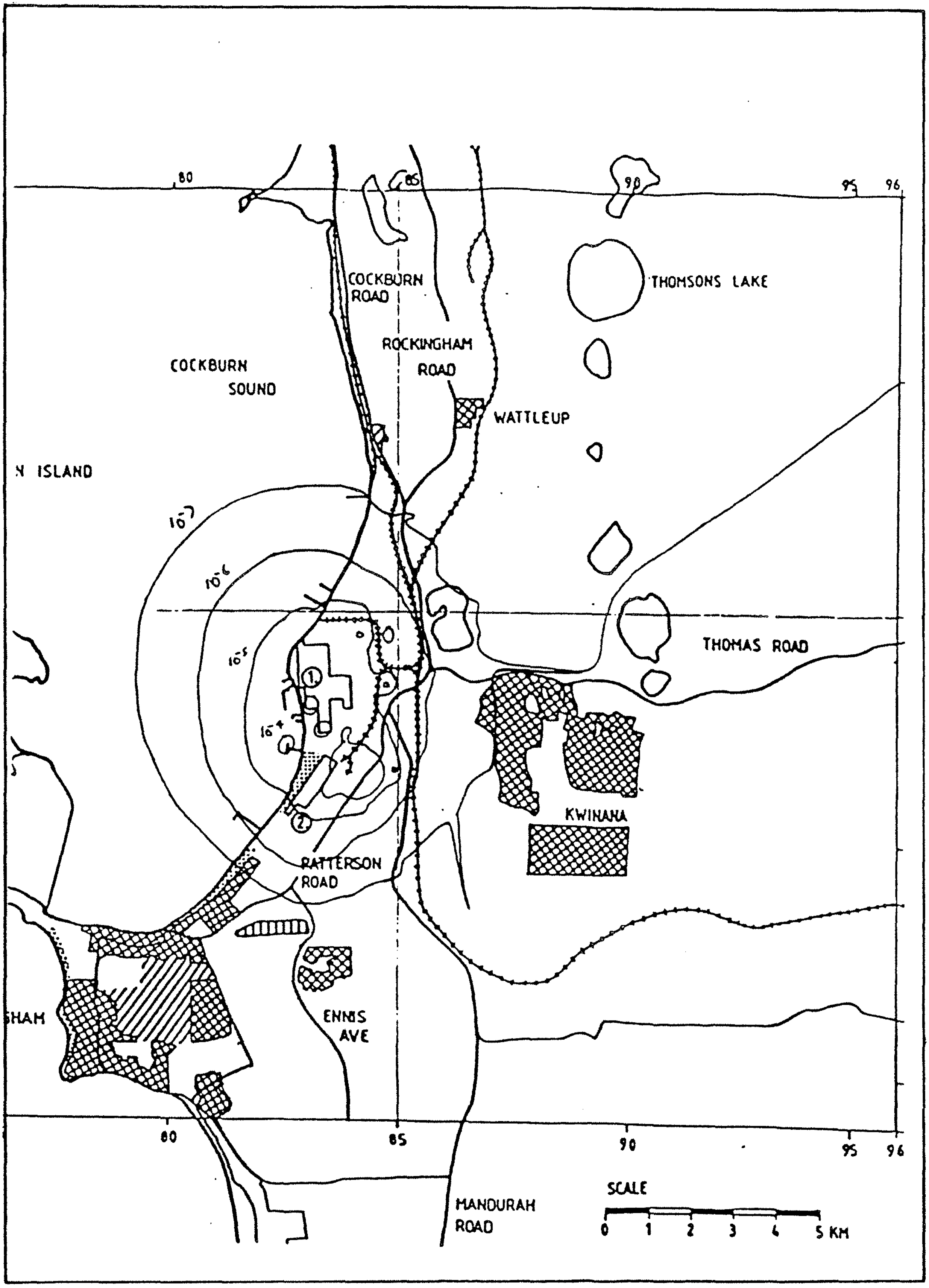

Figure 5: Kwinana cumulative individual risk levels - including proposed plant

Source: Technica

Flame-outs can only occur if both the main flame and the continuous pilot light fail simultaneously and the automatic igniter also fails to re-ignite the gas. In such situations the plant would automatically shut down

5.3.3 The scrubber

Du Pont proposes to install a scrubber to remove hydrogen cyanide and particulates from gases flowing through the process. Water circulating through the scrubber would remove sodium cyanide. In the first two stages of scrubbing, the sodium cyanide concentration in the scrubbing solution can reach 6%. In the final stage of scrubbing the solution would be made up with fresh water and is released to the lower stage of the scrubber. Cyanide is kept in solution by adding caustic soda, maintaining a high pH which prevents formation of hydrogen cyanide. The three-stage scrubber is 99% efficient in removing sodium cyanide. Accumulated sodium cyanide would be routed back to the process and converted to solid sodium cyanide.

Since the concentration of sodium cyanide in the stack is would be in the order of 10 ppm, the downwind concentrations would be below detectable levels. This low level emission of sodium cyanide would not result in accumulation around the stack. Sodium cyanide, once emitted, would decay rapidly to sodium formate which is non-toxic.

5.3.4 The natural gas-fired air heater

Gaseous emissions from the air heater would consist of nitrogen oxides and carbon dioxide. The exact quantities for gaseous emissions from the heater are not yet known. Data for a similar heater used at Du Pont's Texas City plant are, however, available, and preliminary calculations by the Environmental Protection Authority indicate that ground level concentrations of emissions from the proposed heater would be well within levels stated in the guidelines. The acceptable ground level concentration for nitrogen oxides (stipulated in Victorian Environment Protection Authority guidelines) is 1.5 ppm (one hour average).

5.3.5 Cooling tower air stream

After testing for cyanide concentration, treated effluent containing less than 10 ppm sodium cyanide would be pumped from the decomposition tanks to the cooling tower where most of the remaining cyanide would be vaporised to the atmosphere. The expected concentration of hydrogen cyanide in the cooling tower airstream is less than 1.0 ppm.

The level of hydrogen cyanide Immediately Dangerous to Life and Health (IDLH) is 50 ppm and the Threshold Level Value (TLV), a regulatory limit which sets maximum exposure to a gas over an eight hour period, is 5 ppm in Australia.

Given that rapid dilution and dispersion in the atmosphere would further reduce hydrogen cyanide concentrations, the Environmental Protection Authority considers that no adverse environmental impact would result from this source of emission.

The Environmental Protection Authority has reviewed information provided on these discharges and the pollution control equipment being proposed by Du Pont. Although accurate figures for gaseous emissions are not available at this stage, the Environmental Protection Authority has assessed available data for worst case emissions and considers that applicable emission standards can easily be attained. The results reviewed to date are expected to be improved upon when design details are further advanced. Furthermore, details of how the proponent intends to achieve the improvement must be supplied to the Environmental Protection Authority during assessment for Works Approval and Licensing under Part V of the Environmental Protection Act, 1986.

Recommendation 5

The Environmental Protection Authority recommends that prior to commissioning of the plant the proponent should supply the detailed design information on all atmospheric emissions and the techniques proposed to control these emissions within relevant standards acceptable to the Environmental Protection Authority. Control technology employed shall be to the satisfaction of the Environmental Protection Authority.

5.3.6 Greenhouse gases

Two greenhouse gases, carbon dioxide and nitrous oxide, would be emitted from the flare and the natural gas fired air heater. The proponent estimates that approximately 4200 kg/h of carbon dioxide would be emitted with smaller, as yet unquantified, amounts of nitrous oxides.

The State Government has a policy of reducing overall greenhouse gas emissions by 20%. A necessary first step is to determine what greenhouse gases are currently produced and what emission trends are on the global, national and state scale. The Western Australian Greenhouse Co-ordination Council has recently published the "Greenhouse Gas Audit for Western Australia" (November 1989). The Environmental Protection Authority recognises that this plant would be a minor producer of the gases of concern. However it is important for completeness that the proposed plant be included in the estimates. Therefore the Environmental Protection Authority recommends as follows:

Recommendation 6

The Environmental Protection Authority recommends that the proponent should prepare an inventory of greenhouse gas emissions and report to the Environmental Protection Authority if there is a significant change in these

emissions. Reporting should be to the satisfaction of the Environmental Protection Authority.

5.4 Liquid effluent

Liquid effluent from the plant would consist of:

- process water;
- wash water;
- spillages; and
- runoff.

Water from these sources would be pumped to a decomposition tank where the water would be heated to 95 - 100°C to reduce cyanide concentrations to 50 ppm.

After testing for cyanide concentration, the treated effluent would be pumped from the decomposition tanks to the cooling tower where some of the remaining cyanide would be vaporised to the atmosphere. Cooling tower water containing less than 10 ppm would be purged to evaporation ponds at the rate of 1350 to 2250 litres per hour. The expected concentration of hydrogen cyanide in the cooling tower airstream is less than 1.0 ppm. This was discussed in Section 5.3.5.

Hypochlorite was originally to have been used as a chemical back-up for destroying cyanide in the cooling water stream. This has been changed in favour of increasing the duration of thermal decomposition of cyanide. Thermal destruction converts cyanide into gases whereas chemical destruction would have created chemical by-products which are more difficult to dispose of in an environmentally acceptable manner.

Cyanide concentrations of the purge stream would be monitored using automatic detectors and by manual testing .

In the PER, five hectares of land was proposed for evaporation ponds. The proponent has reduced the area required for evaporation ponds to 1.5 hectares by recycling process water back to the plant. The proposed pond site is at the eastern edge of the salt water intrusion wedge from the ocean and therefore overlies brackish groundwater. No groundwater resources would be at risk by locating the ponds at the proposed site.

Nevertheless, evaporation ponds would be constructed using two layers of impermeable membranes with cyanide detectors placed between the membranes and in the ground below to ensure that leaks are detected. Test wells would be maintained at appropriate points around the plant and background monitoring data would be collected prior to commissioning of the plant as a control for future monitoring.

Pond capacity would be sufficient to handle a 100 year rainfall event occurring in the wettest month. Excess ponding capacity would be available to allow drainage of any pond should any leaks in membranes be detected.

There would be no off-site disposal of liquid effluent and the plant would have no impact on the water quality of Cockburn Sound. Accumulated solids (sodium chloride, sodium carbonate and sodium formate) would be removed with a vacuum truck and taken to an approved landfill site for disposal.

The Environmental Protection Authority received a number of submissions concerned with the venting of ammonia and hydrogen cyanide from the ponds. Levels of both compounds would be extremely low in the ponds and evidence from Du Pont's operations in the United States shows that no detectable hydrogen cyanide or ammonia is expected to be vented from the ponds.

Submissions also raised the issue of the pond's likely effects on birdlife. Cyanide levels in ponds are not expected to be high enough to be toxic to birds. Waterbirds have been known to reside and breed for considerable periods on mine tailings dams containing higher cyanide levels than expected in the planned evaporation ponds. Given the high pH of the effluent, the caustic nature of ponds would be a greater threat to wildlife than would the cyanide. This will require that the ponds be managed in a way which addresses this issue.

The Environmental Protection Authority believes that liquid effluent from the proposed plant can managed without adversely affecting the environment. Further information will, however, be required regarding details of how liquid effluent will be managed.

Recommendation 7

The Environmental Protection Authority recommends that prior to commissioning the plant the proponent should submit details of the waste water monitoring and management programme outlining methods of monitoring the quality of effluents entering evaporation ponds, ground water quality, leak detection and the effects on wildlife. The programme should detail remedial action to be taken if problems are encountered in any of the areas listed above and should be to the satisfaction of the Environmental Protection Authority.

5.5 Solid wastes

5.5.1 Introduction

Solid wastes from the manufacturing process would consist of:

- sodium cyanide not meeting market specifications;
- accumulated solids from evaporation ponds;
- packaging materials contaminated with cyanide; and
- domestic refuse.

5.5.2 Sodium Cyanide not meeting specifications

Sodium cyanide not complying with performance specifications may be produced during plant start-up and while balancing flows of reactants. Product not meeting specifications would not be disposed of but re-worked into the process or sold as lower grade product.

5.5.3 Accumulated solids

On infrequent occasions, accumulated solids from the evaporation ponds would be removed to a gazetted landfill site. The solids would consist of dissolved solids removed from incoming water supply, water treatment chemicals, salts of ammonia and formates from decomposed cyanide. These solids would be analysed, removed from the ponds by vacuum truck, loaded into containers and placed in an approved solid waste disposal facility.

5.5.4 Packaging material

Damaged packaging material would be decontaminated with hypochlorite and disposed of at a gazetted landfill site. Decontamination would be carried out using sodium hypochlorite or ferrous sulphate solutions. Spent decontaminants would be collected in sumps and pumped to the waste water treatment facility. If contamination is heavy, a preliminary wash with steam condensate would precede the chemical wash.

5.5.5 Domestic wastes

Domestic sewage from amenity facilities would be treated in septic tanks in accordance with requirements of the Town of Kwinana and the Water Authority of Western Australia. Other domestic waste would be disposed of to a gazetted landfill site.

The Environmental Protection Authority concludes that no adverse environmental impacts should result from solid waste disposal as proposed.

5.6 Occupational safety and welfare

5.6.1 Product packaging and storage

On-site storage of sodium cyanide briquettes would be in a warehouse with the capacity to house 2800 tonnes of briquettes.

The storage area would be bunded and would be equipped with dry fire extinguishers and reticulated fire-water. Fire protection is discussed further in Section 5.6.3 of this report.

The sodium cyanide briquettes would be packaged in a waterproof polyethylene liner inside a woven polypropylene bag. The bags would be encased in a 16 mm thick plywood box with internal corner bracing. Each box is bound and strengthened with seven bands of steel strapping.

The Environmental Protection Authority considers this type of packaging to be appropriate for storage and transport of solid sodium cyanide. No negative environmental impacts from storing and packaging sodium cyanide in this manner are envisaged.

5.6.2 Sodium cyanide dust management

Several submissions were received regarding managing sodium cyanide dust from the process. Analysis by the proponent indicates that insufficient cyanide dust would be generated from the process to have an off-site impact, but dust would have to be managed on-site to ensure worker safety.

The Department of Occupational Health, Safety and Welfare (DOHSWA) has identified the product packaging operation as the main generator of dust. Most of the solids handling equipment would be operated under vacuum, and seals would be kept dust tight. The process would include a dust extraction system which prevents any dust escaping during packaging. Dust removed by this extraction system would be recovered in the scrubber.

Sodium cyanide dust readily absorbs moisture from the air even in low humidity conditions. When that happens, the dust ceases to remain airborne and is easily removed by water.

On-site accumulations from spills would be washed with water. Where possible the resulting sodium cyanide solution would be recycled to the process or, where that is not possible, sent to the waste treatment facility for thermal decomposition.

DOHSWA has indicated to the Environmental Protection Authority that workers' exposure to cyanide dust, gas or solution would be minimal and could be adequately controlled under normal operating conditions of the plant through engineering controls and administrative procedures. The advice from DOHSWA is attached as Appendix 6.

5.6.3 Contaminated water from fire-fighting

Sodium cyanide is non-combustible and does not pose a fire risk in itself. However, it can decompose to hydrogen cyanide under heat in certain conditions. It is essential that an effective fire control system is installed to minimise this potential.

Small fires would be extinguished with dry fire extinguishers located on every level and throughout the plant. The plant also would have a system for distributing fire-water, with on-site storage, a back-up diesel pump and a pilot pump.

In the event of a fire in the product storage warehouse, a considerable volume of contaminated water could result. Fire-water used on large fires would be drained directed to the decomposition tanks and then to the evaporation ponds. The ponds would hold the contents of the fire water supply tank which would be large enough to fight a major fire.

The Environmental Protection Authority considers that issues related to the occupational environment will be adequately addressed by the Department of Occupational Health Safety and Welfare.

5.6.4 Public amenity

Two submissions were received commenting on the decreased public amenity resulting from the plant. The proposed plant would marginally increase the pressure against public use of the Kwinana Beach area. This would result from the potential for more imports of ammonia over the Fremantle Port Authority bulk cargo jetty. Two shipments were imported by another company in 1989, for which the Environmental Protection Authority required an exclusion zone for the public. The specific management of public safety issues when ammonia ships berth is currently under review by the Environmental Protection Authority. In the long term, it must be recognised that the amenity value of a public beach in an industrial area is going to be difficult to maintain given the direct incompatibility of the beneficial uses (recreation versus industrial).

5.7 Transport of product

The bag/box arrangement would be transported in standard freight containers. Each freight container would contain 20 boxes stored two abreast and two high. Each container would have three emergency information panels.

The method described above is the currently accepted way of transporting solid sodium cyanide by road, rail and sea within this State. This method of transporting solid sodium cyanide briquettes offers little opportunity for uncontrolled spills and loss of material. The Environmental Protection Authority considers that it presents no adverse environmental impact. The Environmental Protection Authority also considers that for this material it is unnecessary for any controls to be placed on transport routes or methods, other than those already in place for dangerous goods.

5.9 Noise, dust and construction phase impacts

The main source of noise from the plant, once operational, would be the vacuum pump which would be isolated from the surrounding area. Noise from other plant components are expected to be below 85 dB(A) at source.

The Environmental Protection Authority considers that, given both the considerable distance between the plant site and the nearest residential areas and existing background noise levels from the Kwinana industrial area, noise emanating from the site during normal plant operation would have no adverse environmental impact on neighbouring residential areas.

During the construction of the project dust, noise and contaminated water would potentially have off-site environmental impact.

The Environmental Protection Authority considers that the proponent needs to liaise closely with the relevant government agencies, including the Kwinana Town Council, during the construction phase to ensure that no negative environmental impacts occur during that period. In particular, the proponent needs to ensure that:

- noise levels generated during construction do not exceed those levels deemed acceptable by relevant legislation, and that activity is restricted to standard construction working hours;
- grease and oil contaminating stormwater is filtered out before runoff is discharged off-site;
- dust is suppressed by sprinkler water; and
- traffic generation is kept to a minimum.

Increase in traffic in the area caused during construction and by the workforce, plant operations and product transport would be negligible. Patterson Road, Rockingham Road and other major roads in the area cope well with existing traffic and have ample capacity to accommodate further increases in regional traffic movement.

Recommendation 8

The Environmental Protection Authority recommends that prior to commencement of construction the proponent should prepare a construction-stage management programme to the satisfaction of the Environmental Protection Authority. The programme should address, but not be limited to, management of stormwater runoff from the site, and management of dust and noise.

6. Conclusions

The Environmental Protection Authority identified seven main issues regarding the proposed plant for manufacturing solid sodium cyanide at Kwinana:

- risks and hazards;
- gaseous emissions;
- liquid effluent disposal;
- solid waste disposal;
- occupational health issues;
- transport of the product; and
- noise, dust and construction phase impacts.

In addition, the Environmental Protection Authority is concerned about the level of emergency response planning and preparedness in the Kwinana industrial area.

The Environmental Protection Authority has examined the preliminary risk analysis for the proposal (Public Environmental Review Volume 2) and the cumulative risk for the Kwinana region was updated to take this proposed facility into account. The cumulative risk levels meet the guidelines adopted by the Environmental Protection Authority and so are acceptable to the Environmental Protection Authority.

The possibility of emergencies extending beyond a plant needs to be managed in an integrated way for the whole Kwinana industrial area under the Kwinana Integrated Emergency Management System (KIEMS). Development of the System is a Government responsibility, and implementation has been somewhat slow up to this time. Given the recent start-up of several plants with significant off-site risks, this matter needs to be expedited. In particular it is important that some of the obvious major aspects of the System be put in place as soon as possible, including provision of fundamental emergency response support. The Environmental Protection Authority has received a letter from State Emergency Service (Appendix 7), indicating the projected timetable for implementation of KIEMS. The Environmental Protection Authority's assessment of any future proposals will be based largely on meeting this timetable, and addressing the immediate issues indicated above.

The Environmental Protection Authority has reviewed information provided on gaseous emissions and the pollution control equipment being proposed. The Environmental Protection Authority has assessed available data for worst case emissions and considers that applicable emission standards can easily be attained. The Environmental Protection Authority has checked the results of dispersion modelling and finds that ground level concentrations of the possible emissions will be within acceptable criteria. The results reviewed to date are expected to be improved upon when design details are further advanced, and these will be supplied to the Environmental Protection Authority for Works Approval and Licensing under Part V of the Environmental Protection Act, 1986.

The Environmental Protection Authority believes that liquid effluent from the proposed plant can be managed, using the basic system proposed, without adversely affecting the environment. However, further information will be required during the detailed design stage on specific aspects of liquid effluent management.

Solid wastes from the manufacturing process would consist of sodium cyanide not meeting market specifications, accumulated solids from evaporation ponds, packaging materials contaminated with cyanide, and domestic refuse. Product not meeting specifications would not be disposed of but re-worked into the process or sold as lower grade product. On infrequent occasions accumulated solids from the evaporation ponds would be removed to a gazetted landfill site. Damaged packaging material would be decontaminated with hypochlorite and disposed of at a gazetted landfill site. Domestic sewage from amenity facilities would be treated in septic tanks in accordance with requirements of the Town of Kwinana and the Water Authority of Western Australia. Other domestic waste would be disposed of to a gazetted landfill site. The Environmental Protection Authority concludes that no adverse environmental impact will result from solid waste disposal as proposed.

On the issue of occupational health the Department of Occupational Health, Safety and Welfare (DOHSWA) has indicate to the Environmental Protection Authority that workers' exposure to cyanide dust, gas or solution would be minimal and could be adequately controlled under normal operating conditions of the plant through engineering controls and existing administrative procedures.

The sodium cyanide briquettes would be packaged into "bag/box" containers. This method is the currently accepted way of transporting solid sodium cyanide within this State. This method of transporting solid sodium cyanide briquettes offers little opportunity for uncontrolled spills and loss of material. The Environmental Protection Authority considers that it presents no adverse environmental impact. The Environmental Protection Authority considers also that no additional controls are warranted for transport of this material, of either routes or methods, other than those in place for all hazardous materials.

The Environmental Protection Authority considers that, given both the considerable distance from the plant site to the nearest residential areas and existing background noise levels from the Kwinana industrial area, noise emanating from the site during normal plant operation would have no adverse environmental impact on neighbouring residential areas. Any unforeseen problems which arise can be adequately controlled under existing legislation.

During the construction of the project dust, noise and contaminated water would potentially have off-site environmental impact. The Environmental Protection Authority considers that the proponent needs to liaise closely with the relevant government agencies, including the Kwinana Town Council, during the construction phase to ensure that no negative environmental impacts occur during that period.

Since all environmental issues can be adequately managed, the Environmental Protection Authority finds the proposal by Du Pont (Australia) Limited to construct and operate a 45,000 tonnes per year sodium cyanide plant at Kwinana to be environmentally acceptable, subject to commitments made by Du Pont and recommendations made in this report.

Appendix 1

List of those who made submissions

List of those who made submissions

Individuals

Barbara Churchward

G Carpenter

Mrs C E Leopez

Mrs P Thwaiter

Paula Hooper

D E Wilkinson

G Wright and J Garbutt

P M and E Johnston

Mr S Soo

Mr Paul Desmond

Mrs C M L Taylor

Groups

Australian Conservation Foundation

Conservation Council of Australia (Inc)

Pollution Action Network

Conservation of Kwinana's Environment

Companies

Coogee Chemicals Pty Ltd

Minproc Resources Pty Ltd

ICI Industrial Chemicals

CSBP and Farmers Limited

WT Resources Pty Ltd

Local Government

Town of Kwinana

City of Rockingham

City of Cockburn

State Government

Department of Occupational Health, Safety and Welfare of Western Australia

Department of Mines, Explosives and Dangerous Goods Division

Department of Health

Water Authority of Western Australia

State Emergency Service

Appendix 2

Summary of issues raised in the public and Government submissions and responses given by the proponent

LIST OF CONTENTS

THE FOLLOWING TECHNICAL APPENDICES REFERENCED IN THIS DOCUMENT ARE AVAILABLE FROM THE E.P.A. ON REQUEST

GLOSSARY OF TERMS

THE FOLLOWING IS AN EXPLANATION OF SOME OF THE TECHNICAL TERMS AND ABBREVIATIONS USED IN THE ANSWERS :

DCS : Distributive Control System
A computer system for process monitoring and control.

DNV : Det Norske Veritas
An independent consultant commissioned by Du Pont to carry out a quantified risk analysis on the proposal according to EPA guidelines.

EPA : Environmental Protection Authority

ESD : Emergency shut down

HAZOP : Hazard and Operability Study
This is a detailed study of the process design and it's operability with respect to the potential for failure due to defects in process design, logic, equipment failure or operator error. The study is generally carried out by a team with experience in process design and technology, engineering, manufacturing, construction and safety.

HCN : Hydrogen cyanide

INTERLOCK : A system which restricts a device from operating unless preconditions are met. E.g. If a blender will not operate unless the lid is in place, then the blender operation is interlocked with the lid position.

KIEMS : Kwinana Integrated Emergency Management System

NACN : Sodium cyanide

NOx : Nitrous oxides

PPM : Parts per million

PRA : Preliminary Quantified Risk Analysis
A method of expressing risk in quantifiable terms.

REDUNDANT SYSTEMS : Duplication of systems so that if the primary system fails to operate, the redundant system then comes into play.

SCRUBBER : A device to remove dust and foreign gas from air before that air is vented.

SODIUM CYANIDE PLANT
PUBLIC ENVIRONMENTAL REPORT

7/11/89

QUESTIONS FOR DU PONT (AUSTRALIA) LTD ARISING OUT OF PUBLIC SUBMISSIONS

RISKS AND HAZARDS

QUESTION 1 Table 5.4 is a "Summary of Hazardous Incidents Generated for PRA". It is not clear from the PRA whether a rigorous analysis was used to derive this list. Details which need to be answered are as follows:

Q1 a) It is normal for a full list of incidents to be generated by fault tree analysis, prior to eliminating or aggregating events to facilitate analysis. The proponent should provide a full list of events, including those high frequency events which were eliminated because there would be no off-site consequences and those which are of very low frequency and therefore do not affect the final risk contours.

ANSWER Hazardous incidents associated with the proposed plant could involve the release of ammonia, natural gas or hydrogen cyanide gas to the atmosphere from pipe work, storage vessels and process equipment to produce toxic or flammable vapours, capable of propagating the event or causing off-site human harm or damage.

The following events were analysed for frequency and consequence in the QRA:

Ammonia Pipeline and Fittings :

- guillotine fracture
- major leak
- minor leak

Bulk Ammonia Storage and Fittings :

- catastrophic failure
- disruptive failure (major leak)
- minor leak

Liquid Ammonia Line to Vaporizer and Fittings:

- guillotine fracture
- major leak
- minor leak

Ammonia Vaporizer and fittings :

- catastrophic failure
- disruptive failure (major leak)

Relief valve on Vaporizer outlet line.

low (less than one in a hundred million events per year) it was not included in the risk file. Minor leaks normally came into this category.

iii) For events which have the same hazard distances, such as major leaks from different fittings on the same vessel/system, the leak frequencies were added to produce an aggregate frequency for an event with a particular hazard distance.

Q1 b) The failure data used are generally lower than those used for other developments in the Kwinana area. Also the durations of the release events are about half those commonly used. If the frequencies/durations used in the analysis are based on auditing of other Du Pont operations or on other sources what are they and why are they relevant?

ANSWER The frequency data in Table 5.4 of the Preliminary Risk Analysis (PRA) refer to event frequencies and are therefore generally lower than the component failure frequency data due to the inclusion of probabilities of event development.

Table 5.3 shows the component failure data, which is found to be in agreement with other studies.

Q1 c) What is the ranking of hazard of the incidents as required under 5 (v) and 5 (vi) of the Guidelines?

ANSWER Major release incidents have been ranked (two dimensionally) according to risk in Appendix G of the PRA.

For ranking of risks, 'consequence', as used in Appendix G, is a measure of potential for human harm (injury or death). 'Frequency' is measured in events/year for each event.

DNV has also ranked the risk events quantitatively, combining frequency with a measure of the hazardous area covered by each event.

The list of events and their importance expressed as % contribution to total risk is as shown below:

SEVERITY RANKING	RISK EVENT	% CONTRIBUTION TO RISK
1	Vaporizer major release	22.76
2	Reactor major release	6.04)*
3	Waste heat boiler major release	6.04)*
4	Absorber major release	6.04)*
5	Cook tanks major release	6.04)*
6	CO_2 stripper major release	6.04)*
7	Scrubber major release	6.04)*
8	Process/Pipe drain points etc.	6.04)*

cover such contingencies. To allow for manual shutdown, the Kwinana Plant will have a plant wide public address system with radio backup and operators on patrol with portable radios. 30 minute self-contained breathing apparatus will be stationed at strategic points to aid in response to emergencies involving a local fume condition. Critical valves have separate push button trips in the control room in case the interlock mechanism itself fails to operate.

In the event of failure of automatic detection and shutdown, the response periods assumed would be adequate to cover manual response. Where the risk due to release is of concern, (e.g. ammonia releases from the pipeline, buffer storage, or vaporizer), the Risk Analyst allowed for worst cases as follows:

- Rupture cases were modelled as both instantaneous and continuous releases,

- Major releases were modelled as continuous releases.

Valve failure was considered in all cases.

Further, Du Pont employs an internal Risk Assessment Procedure in relation to interlocks which would mean that redundant (or duplicate) systems would be installed where a high risk potential for personnel exists.

Q1 e) It would appear that the following events have not been included in the analysis :

- Natural gas losses from the carbon dioxide stripper and gas pre-heater circuits;
- Ammonia plus natural gas from the heater and filter;
- Gas mixture prior to the catalyst;
- Loss of containment at the waste heat boiler;
- Emissions during periods of flare or scrubber failure.

The proponent should explain as required by the guidelines, the process by which these events were excluded from the analysis. Event trees and mass balances are required, particularly for start up.

Answer Leakages of natural gas from all sections of the supply line where included in the QRA.

Natural gas and ammonia releases were considered throughout the plant generally by DNV, and were represented by the frequencies adopted. Minor releases omitted from the analysis were not considered to have any significant impact.

Emissions during periods of flare or scrubber failure would be detected and the plant shut down immediately. Releases from the flare during flame-out were considered, using seems to be in conflict with the text (pp42-43) which says that the ESD would "limit any discharge to a few minutes". This should be clarified.

ANSWER

One minute was considered by DNV as an appropriate time for the discharge calculations. A longer period was mentioned in that text to allow for the tail end characteristic of most release scenarios. The difference between modelling, as tabulated, and reality, as discussed, is not considered to be significant.

The rupture discs are monitored and interlocked for both rupture and hydrogen cyanide leakage. In the event of a burst or leaking disc, the operation will be automatically shut down. The proponent expects this to occur in the order of seconds, however, it is not possible at this stage to predict exactly how long this will take. The release time used in the PRA is very conservative.

QUESTION 2

It is not clear from the PRA whether the full length of the ammonia pipeline from KNC has been included in the risk analysis. Assessments for the Ammonia-Urea Plant and the CSBP Sodium Cyanide Plant indicated that the ammonia pipeline was a significant contributor to risk. Please clarify.
Has the risk due to the gas supply pipeline been considered?

ANSWER

The full length of the ammonia pipeline from KNC was included in the PRA by DNV. As the pipeline route, including the section of the pipeline within CSBP/KNC property, is not yet defined, the analysis considered a typical route. Since the risk contours along the pipeline route were below 10-7 at a distance of 14 m from the pipeline, the contour does not impact on residential areas.

DNV's pipeline risk calculations are based on recent toxicity information on ammonia (Ref: Ammonia Toxicity Monograph, I. Chem. E. 1988). Differences between DNV's results and previous studies by others (using now outdated information) arise from the different toxicity data and the possibility that previous studies have included excessively conservative (pessimistic) bias.

In line with modern practice to present realistic assessment and avoid cumulating bias (whether positive or negative) DNV has attempted to provide best estimate data unless specified otherwise.

The risk due to the gas supply pipeline from the high pressure main tee into and within the site was been considered in the PRA.

QUESTION 3

The plant layout in Figure 3.1 shows a future services corridor. What impact on the plant has been assessed as arising from incidents in the corridor?

The effects of fire or explosion on the Du Pont and WMC rail cargo was considered to be within the level risks normally encountered in transport, eg collision with flammable goods transport. The design of packaging and Du Pont's emergency response arrangements are set to allow for appropriate response to this eventuality.

QUESTION 5 What design philosophy and standards are to be used for the secondary containment system? To what extent have the frequency/duration data for releases for the risk assessment been modified to allow for this containment?

ANSWER Although the stated objective of the proposed secondary containment system is to add to the safety of the plant, DNV did not make any allowance for reduced frequency and duration of release due to the containment system. Therefore, DNV based their assessment on the original plant components, without the secondary containment system. It may be expected that future design reviews and hazard and operability studies would determine that positive safety improvement would result from the containment system.

The secondary containment system will consist of fabricated removable heavy sheet metal assemblies around flanges and other potential leak points in parts of the system containing hydrogen cyanide. These will be under vacuum during operation, and will be piped to the suction side of the hydrogen cyanide process air blower. This piping will be tied in between the primary and secondary air filters and will get its motive force from the blower suction. If the blower goes down, the source of pressure to any leak will disappear. Du Pont does not intend to use this system to continue operation with a leak. If one is detected, Du Pont will shut down and repair it. The covers at potential leak points will be removable to permit periodic inspection of the primary containment. (Without this capability, the secondary containment would interfere with maintaining integrity of the primary containment.) There will be hydrogen cyanide detection in the line to the blower. Actions taken in the event that hydrogen cyanide is detected are explained in the answer to question 7.

The design philosophy of this system is based on a similar system in operation at Du Pont's Laporte methyl isocyanate manufacturing plant since 1985. That philosophy is to protect every flange, instrument fitting or other credible leak point in the hydrogen cyanide system.

QUESTION 6 How would plant maintenance procedures be affected by the proposed gas containment shrouding?

ANSWER During operation, leak detection would be simplified, by directing air to the hydrogen cyanide detectors. Maintenance would then be performed by shutting down the process and removing the shrouds. The shroud system at the Laporte methyl isocyanate manufacturing plant was specifically designed for easy removal and has been maintained well since

QUESTION 10 There appears to be a conflict between release quantities for the ammonia vaporizer rupture from p41 (1.5t) and Table 5.4 (1.0t). Also in the disruptive failure case, a total of 2160 kg would be released (9 kg/s for 4 min). Why is this different from the rupture release?

ANSWER The liquid hold-up from the vaporizer were calculated by DNV as:

Total Volume	approx 4.3m3
Feed 780 kPa	25° C
Operating 400 kPa	8° C
1/2 full ammonia	appox 2.15m3 or 1.5t

Release Case 1 :

Rupture

assumed mass of ammonia in cloud 1.0t (67%)

Release Case 2 :

Major leak (liquid)

400 kPa @ 18°C

25mm hole

Flow rate 7kg/s (max)

Worst Case (780kPa) = 9kg/s (max)

Release Case 3 :

Disruptive rupture or failure for 4 minutes (conservative time estimate) before flow drops to near 1kg/s or isolation.

Average flow from rupture = $\frac{1500\text{kg}}{4 \times 60 \text{ secs}}$ = 6.25 kg/sec

+ continuous flow rate 1 kg/sec

= 7.25 kg/sec

Release Case 4 :

Major leak (vapour)

Insufficient pressure and volume to sustain a high flow - no significant off-site effects.

0.2kg/s	na	na	na
0.125kg/s	na	na	na

* interpolated conservatively

QUESTION 11 On page 47 of the PRA, it is indicated that probit curves for ammonia are "shown", whereas they are not in the text. How do the curves in this PRA compare with others used internationally e.g. USDG, DSM, COVO, ICHENME?

ANSWER The probit equations for ammonia used by DNV were

a Average Population Probit = 1.85 ln (C^2t) - 35.9 (2nd Report of the working party I.Chem.E 1988).

b Vulnerable Population Probit = 3.04 ln (C^2t) - 59.1 (Withers & Lees.)

Curves relating percent fatality to time of exposure for 3 levels, 1700 ppm, 5000 ppm and 10000 ppm are shown in Appendix 3.

The results of using 5 different probit equations have been examined by DNV in recent studies. The referenced data used is considered by DNV to be appropriate because it incorporates up to date information from the Institution of Chemical Engineers second report of the toxicity working party. The membership of the working party which prepared the referenced ammonia toxicity monograph comprised specialists from Loughborough University, Dutch State Mines (DSM), ICI, Technica and Health and Safety Executive, U.K. (HSE).

QUESTION 12 What quantities of hydrogen cyanide and other gases will be released to the atmosphere in the event of an Emergency Shut Down and what are the specified closing times for critical ESD valves?

ANSWER In an emergency shutdown, the feed valves (ammonia, gas, air) will close, the process air blower will shut down, and the reactor will be purged with nitrogen to the flare. No hydrogen cyanide will be "blown down". It will go to the flare through the sodium cyanide absorber as in normal operation. Because there will be less hydrogen cyanide passing through the absorber than normal, absorption efficiency will actually increase. Valve closing times are not relevant to this situation.

QUESTION 13 In the event of a bursting disc failure ("about once a year") what maximum quantity of hydrogen cyanide and other gases could be released to the atmosphere?

cyanide does not accumulate.

The HCN would continue to disperse as it would during a dry weather release. For risk analysis purposes, the dry weather release scenario would have more down wind effect.

QUESTION 17 What level of "back up" is provided to ensure continuity of operation of the flare pilot flame and incinerator?

ANSWER The flare will have a flame failure system with an infra-red flame failure detector and automatic pilot interlocked to automatically shutdown the process if no flame is detected.

QUESTION 18 Have separation distance on non-compatible materials (both on-site and with neighbouring industries) been taken into account in the plant layout?

ANSWER Yes. In the plant layout, the process and warehouse facilities are located near the centre of the property. Within the site, sodium cyanide is separated from any acidic materials. Spill containment for acidic materials, (e.g. water treatment chemicals) will be kept separate from that for sodium cyanide.

QUESTION 19 What bunding is provided for dangerous goods storage?

ANSWER Bunds designed to conform with the relevant existing and emerging Australian standard will be provided. There will be no penetrations for drains or pump lines. Rainwater will be pumped over the bund wall.

QUESTION 20 Outline the plant management's capacity to respond to on-site emergencies. Given that KIEMS is not yet operational, what approach will be followed to advise the public off-site who may be affected?

ANSWER Du Pont recognizes that it has a corporate responsibility to employee safety and occupational health. Du Pont is a world leader in providing safe working conditions for its workforce and safety for the general public in neighbouring areas. Du Pont plants have consistently held world industrial safety records for many decades. The international company's safety performance is many times superior than the chemical industry average in every country where it maintains manufacturing facilities.

Du Pont's on-site emergency response plan is to be developed and will be based on those in place at Memphis and Texas City where Du Pont currently manufactures sodium cyanide. The plant and operation will have automatic hydrogen cyanide detection, portable hydrogen cyanide detectors, automatic shutdown interlock systems designed to

ANSWER **Yes. Du Pont already has procedures in place at its Memphis and Texas City plants to cope with this occurrence. The relevant procedure for the proposed Kwinana plant will be developed from these existing procedures. More importantly, we have a Safety & Health Standard which identifies the training and procedures needed to <u>prevent</u> hydrogen cyanide exposure. This is detailed in Standard L-16 (24/1/85) in Appendix 5.**

PLANT PROCESSES

QUESTION 23 The description implies that there is only a single reactor in the design. How will the secondary containmment system for the reactor work in practice?
Is it necessary to change the reactor catalyst and if so, how often? Will this lead to disruption of production with consequent shut-down and start-up proceedings being required?

ANSWER **The catalyst will be renewed approximately twice per year following a complete shutdown and decontamination of the entire process. Catalyst can be changed without disturbing the secondary containment, so secondary containmment will only be disturbed once per year, if that.**

QUESTION 24 While it may be correct to state that normal emissions from various sources, after pollution control, will comply with EPA requirements, there is insufficient information in the PER outlining how performance standards will be achieved. A detailed set of commitments should be provided by Du Pont,

ANSWER **Performance standards will be identified in conjunction with the EPA, for each pollution control device. These will be fitted with instruments, displays, recorders and alarms and where necessary, interlocked to shut down the process. For example, the flare will have an infra-red detector, which will indicate continuously on the operator's DCS console. If it fails to detect a flame, the igniter will automatically attempt to restart the burner. If this fails, the hydrogen cyanide process will interlock down. The interlock and alarm actions will record on a printer. Other operating parameters associated with the event will be sorted in the electronic historian, able to be printed on hard copy as needed. Similarly, license conditions for emission sources will be determined by the EPA as part of the works approval process. Also part of the approval will be Du Pont's commitments extracted from the PER, QRA, these answers and the hazard and operability study.**

QUESTION 25 What precautions have been taken to prevent the production of gaseous nitric acid in the reactors in the event of incorrect input ratios of ammonia?

on equilibrium data. Most of the small quantity of hydrogen cyanide remaining after waste treatment will be stripped and considerably diluted in the cooling tower air.

QUESTION 30 What are the expected levels of operability or maximum plant output given the two stated production rates in the PER ie 45,000t/a or 6,700 kg/h?

ANSWER The plant is designed for 80% utility. The full rate is 6500 kg/hr or 156 T/D. The annual capacity is 45454 T/yr or 124.5 T/D.

QUESTION 31 Will the proposed plant produce a "purge stream" of liquid cyanide that will require sale or disposal?

ANSWER The cooling water system produces a purge stream with about 0.1 ppm cyanide content. This will be contained and directed to the evaporation ponds on site. No liquid effluent will leave the plant either as a waste stream or as sodium cyanide solution available for sale.

QUESTION 32 Section 4.2 of the PER discusses the formation of calcium carbonate. What is the source of calcium?

ANSWER This was an error. The PER should have read sodium carbonate rather than calcium carbonate.

QUESTION 33 Will the direct condensation of water vapour ex the evaporator result in ammonia in the cooling circuit?
If so, what will be the concentration and consequent concentration of ammonia in the air stream. Will this result in odours on-site or off-site?

ANSWER There will be about 0.1% ammonia in the cooling tower water, mostly as ammonium ion, as controlled by the pH of the cooling tower water which is maintained at pH 12. There will be no ammonia odour on or off the plant from the cooling tower.

QUESTION 34 On what basis is 1.0 ppm hydrogen cyanide in the cooling tower air stream considered an acceptable level?

ANSWER The Australian Threshold Limit Value for hydrogen cyanide is 5 ppm. The 1 ppm level in the cooling tower air is 20% of the Threshold Limit Value prior to dispersion and dilution by the atmosphere.

QUESTION 35 Sodium hypochlorite in the cooling tower water leads to formation of cyanogen chloride, a strong irritant which could be emitted in the cooling tower plume. What happens to the cyanogen chloride?

ANSWER Du Pont no longer plans to use hypochlorite for backup treatment of cyanide in the cooling tower water. We propose instead to certify the cyanide content of cook tank batches and sump water before it is pumped to the cooling tower. Hypochlorite treatment of cyanide does not work at high pH. The chlorine would be stripped from the water before reacting, and a small amount of cyanogen chlorite would also form.

We will use hypochlorite on occasion to treat algae that might form in the water and on the tower packing surface. This will only be done when we are not pumping cyanide bearing water to the tower, and we will certify the cyanide content before doing so.

QUESTION 36 What would be the source of caustic soda given that Petrochemicals Industries Company Ltd is likely not able to supply it?

ANSWER The proposed project is not dependent on PICL or PIL. Negotiations are under way with other caustic suppliers in the Kwinana area, both existing and planned, to obtain a source of caustic for the project. Du Pont no longer plans to have a 30000 tonne capacity storage tank on site, instead caustic will be supplied via pipeline by other suppliers in the Kwinana area.

QUESTION 37 There are no process details provided on the scrubber for particulates.
Is it a wet scrubber, if so what is the scrubbing solution and how will it be disposed of? What is the nature and concentration of effluents in the scrubber off-gas?

ANSWER The scrubber will be a "Dynawave" triple reverse jet scrubber using Du Pont technology licensed to Monsanto. Water containing up to 6% sodium cyanide scrubbed from the gas will circulate through the first two stages. The final stage will circulate with a fresh water make up and a purge to the lower stages. The liquid will be pH controlled by caustic addition to keep cyanide in the ionized form, thus preventing evolution of hydrogen cyanide out the stack. Accumulated sodium cyanide will be purged back to the process, to be converted to solid sodium cyanide product. The off gas is wet air, containing about 0.46 kg/hr of cyanide as sodium cyanide. The sodium cyanide is dispersed in the atmosphere. Since the concentration in the stack will be in the order of 10 ppm as cyanide, the downwind concentration will be well below any detectable level. The sodium cyanide will decay to sodium formate, so it will not accumulate over time. This is verified by Du Pont's Memphis sodium cyanide plant where no accumulated product is detectable after 35 years of operation.

The scrubber design philosophy is detailed in Appendix 7.

QUESTION 38 What are the flow properties of sodium cyanide powders. Are they likely to cause flow problems and if so have the environmental hazards associated with clearing such blockages in non-contained buildings been considered?

ANSWER Sodium cyanide powders flow well in the planned dilute phase pneumatic conveying system, screw conveyors, and by gravity in lines pitched 70 degrees from horizontal. Blockages which occur are removed by dissolving with hot water. Operators performing this work are protected by air line hoods, rubber gloves, boots, and suits. The wash water is all contained with internal washings returning to the process and dilute external washings going to the waste treatment plant.

QUESTION 39 Is there a cause of concern for the health risk from accidental discharges of ammonia and carbon monoxide? There is no mention in the report of field detectors with alarms for these gases. Please comment.

ANSWER Carbon monoxide and ammonia will be discharged only if the flare fails and the process shutdown interlock also fails to actuate. The flare will be equipped with continuous pilot, automatic reigniter, and a flame monitor interlocked to shut down the process in the event of a flame failure. Ammonia releases from large leaks are dealt with in the PRA.

QUESTION 40 What is the composition of the gas to flare and the likely products of combustion in the flare during both normal and upset conditions.

ANSWER The gas to the flare will be composed of approximately :

Component	Wt %
Nitrogen	79.8
Water Vapour	9.5
Carbon monoxide	5.4
Ammonia	2.2
Hydrogen	1.2
Ethane	0.7
Methane	0.6
Carbon dioxide	0.3
Hydrogen cyanide	0.3

The products of the flare combustion will be water vapour, nitrogen, carbon dioxide, and oxygen, plus trace quantities of nitrogen oxides in both normal and upset conditions.

QUESTION 45 How will the company ensure that fugitive emissions of ammonia, methane and hydrogen cyanide will be controlled and meet EPA requirements?

ANSWER All equipment will be hydrostatically tested initially and leak tested before startup upon completion of any maintenance involving equipment opening. Patrols with portable analysers will ensure equipment integrity during operation. Equipment containing hydrogen cyanide from the reactor to the absorber will have a secondary containment system, operating under vacuum and discharging back into the process. Area fixed hydrogen cyanide monitors will be installed and will alarm in the control room if hydrogen cyanide is detected. Methane will be odorized with mercaptan and will be detectable at harmless levels, as will ammonia. These measures will ensure that fugitive emissions are controlled to meet EPA requirements.

QUESTION 46 Fig 4.1 shows 31,300 kg/h of air being discharged from the scrubber, yet section 4.6 refers to 22,675 kg/h. Which figure is correct and given the stated efficiencies of sodium cyanide and hydrogen cyanide removal (99% and 98% respectively) how much sodium cyanide and hydrogen cyanide will be emitted?

ANSWER As the flow sheet has subsequently developed, the gas flow rate will be 29727 kg/hr. The hydrogen cyanide/sodium cyanide emission will be 0.445 kg/hr expressed as sodium cyanide. The actual hydrogen cyanide in the stack will be very small and will be suppressed by controlling the pH above 13 to keep the cyanide in ionized form.

QUESTION 47 What is Du Pont's policy on Greenhouse gases and how is this policy being applied to the proposed plant?

ANSWER Du Pont has practised vigorous energy conservation efforts, especially since the early 1970's to conserve hydrocarbon fuels, resulting in lower emissions of carbon dioxide. Du Pont also underwrites major research on superconductivity, solar energy, and other leading edge efforts to conserve hydrocarbon fuels. A major initiative is under say to encourage recycling of plastics, eliminating carbon dioxide emissions from both incinerating and replacing the unrecycled materials.

All of the steam at the sodium cyanide plant will be produced from waste heat generated in the hydrogen cyanide converter, except for minor periods and during startup of the plant. A startup package boiler will burn natural gas, the hydrocarbon fuel that produces the smallest quantity of carbon dioxide for the energy yielded. Solar evaporation of waste water will also be maximised to replace burning hydrocarbons for that purpose.

Hot water washdown stations on every floor of dry end of the process.

Solid concrete floors to prevent drippage to lower floors during washdown.

Intermediate change house to keep potentially contaminated clothing out of control room, etc.

Decontamination station for equipment at the operating area before moving to shop area.

Decontamination station for equipment after disassembly at the shop before proceeding with repair or shipment to an outside shop.

Coverall laundry facilities in intermediate change house. Laundry water piped to waste treatment system.

Eyewash stations, safety showers, and first aid equipment on every level of the dry end building.

Secondary egress from every elevated platform.

30 minute self contained breathing apparatus and breathing air stations at every level.

Adequate building ventilating fans that can be quickly shut off if necessary.

Administrative:

Require employees to wear coveralls, gloves, goggles, hard hats, rubber overshoes when working in dry end.

Require employees to leave protective clothing in intermediate change house before entering control room, etc.

Extensive training on a 'check off' basis on safety aspects of sodium cyanide. Repeat training on a regular periodic basis.

Periodic training on use of safety equipment.

Sodium cyanide 'dust' is very hygroscopic, such that leaks or spills will quickly absorb moisture from the air, even in low humidity conditions. When this happens, the material becomes cohesive and sticks to itself or any solid surface it contacts. It ceases to have potential to become airborne very quickly, and is easily removed with a water wash.

The excess alkalinity in the sodium cyanide product can cause skin burns if not washed off. This property is a more immediate hazard than sodium cyanide poisoning, and

ANSWER Test wells will be maintained at appropriate points around the plant. Background data will be obtained prior to startup. Issues dealing with ground water testing, such as the numbers location and size of test wells, depth and frequency of testing, will be determined by an independent consultant. A comprehensive groundwater monitoring programme will be submitted to the EPA and the Water Authority prior to plant commissioning should it be required.

QUESTION 55 What happens if the evaporation ponds cannot cope with the process effluent plus storm water run-off? Is there a back-up system or does the plant shut down?

ANSWER The ponds are being designed to handle the maximum 100 year rainfall event, occurring during the wettest month (August). A waste steam condenser/waste water evaporator will be used to back up natural evaporation. In case of extraordinary events beyond the 100 year expectation, the plant will be shut down. The basis for the evaporation pond design is detailed in Appendix 6.

QUESTION 56 How much hydrogen cyanide and ammonia will be vented from the evaporation ponds?

ANSWER Based on Du Pont's operations in the U.S., no detectable hydrogen cyanide or ammonia is expected to be vented from the evaporations ponds. This is because the low levels of hydrogen cyanide and ammonia existing in the effluent stream will already have been stripped from the cooling tower water in a great excess of air from the cooling tower fans and then further dispersed in the atmosphere.

QUESTION 57 How will bird life be protected from the ponds?

ANSWER Cyanide levels in the ponds will not be high enough to be toxic to birds. Experience at customer's gold mines with storage ponds containing much higher levels of cyanide than would be present in the planned evaporation ponds have revealed no problems of compatibility with birds or other wildlife. Some water birds have been known to spend considerable lengths of time residing and breeding in and around gold mine tailings dams which contain higher levels of cyanide than the planned evaporation ponds.

QUESTION 58 How will the precipitated solid salts (sodium chloride, sodium carbonate and sodium formate) be removed from the evaporation ponds and disposed of?

ANSWER The solids will be analysed, removed from the ponds with a vacuum truck, loaded into containers, and placed in an approved solid waste disposal facility. The location of the solid waste disposal facility is yet to be determined. Both State and Local Government authorities would be

ANSWER The packaging process includes a dust extraction system which prevents any dust escaping during the package filling process. The dust removed by this extraction system is recovered in the scrubber. Other systems which will be in place to prevent hazards due to dust are explained in the answer to question 49.

QUESTION 62 What reagents and procedures are planned for neutralising packaging materials contaminated with cyanide.

ANSWER Decontamination will be done using sodium hypochlorite and/or ferrous sulphate solution. Special sumps and perforated baskets for small parts will be provided to collect wash liquid and direct it to the waste water treatment facilities. If the contamination is heavy, a preliminary wash with steam condensate may precede the chemical wash.

EXISTING FACILITIES

QUESTION 63 Is Du Pont currently involved in the development of new hydrogen cyanide or sodium cyanide plants elsewhere in the world and what is the status of such projects?

ANSWER Du Pont has recently started up a plant in Texas City, Texas, is expanding that plant and its original sodium cyanide plant in Memphis, Tennessee, and is in the initial commissioning phase for a plant in San Martin, Mexico. These sodium cyanide plants will all use existing available hydrogen cyanide producing facilities to supply raw material, or will use available hydrogen cyanide by-product.

QUESTION 64 Does Du Pont currently have any environmental problems with existing hydrogen cyanide or sodium cyanide plants worldwide?

ANSWER Du Pont does not have any environmental problems with existing hydrogen cyanide or sodium cyanide plants. The Texas City plant which was recently commissioned, is currently operating under a 120 day demonstration period to attain conditions decreed by the Texas Air Control Boards Permit to construct. It appears at this time that an entrainment separator may have to be added to the process air scrubber to enable operations at the plant's rated capacity. Emissions are within permit restrictions at current operating rates. To prevent a similar problem at Kwinana, the scrubber gas handling capacity is being doubled.

Appendix 3

Report by independent consultant to the Environmental Protection Authority

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QUALITATIVE REVIEW

of the

PROPOSED DU PONT SODIUM CYANIDE PLANT

at

KWINANA, WESTERN AUSTRALIA

for

ENVIRONMENTAL PROTECTION AUTHORITY

by

Dr J A Goldsmith

December 1989

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Quantarisk pty ltd

TABLE OF CONTENTS

1. INTRODUCTION

The Environmental Protection Authority of Western Australia has requested Quantarisk Pty Ltd to provide advice in relation to the proposed Du Pont Sodium Cyanide plant to be located at Kwinana, W A. The advice required by the EPA is:

- to provide an independent assessment of the technology proposed for the plant
- to provide a qualitative review of the proposal and the Preliminary Risk Analysis prepared by Det norske Veritas

Quantarisk Pty Ltd are consulting chemical engineers and risk analysts specialising in the application of Quantitative Risk Analysis techniques to chemical process safety and to land use safety planning. In addition, we have in the past prepared Environmental Impact Statements for proposals relating to the chemical industry.

The assessments and reviews made in in this document are based solely upon information contained in the Public Environmental Report (Ref 1), the Preliminary Risk Analysis (Ref 2), provisional Process Flow Diagrams (Ref 3), and Piping and Instrumentation Diagrams (Ref 4). The last two items have been released by E I Du Pont de Nemours & Company ("Du Pont") subject to the provisions of a Confidential Information and Invention Agreement signed by Quantarisk Pty Ltd.

2. ASSESSMENT OF THE TECHNOLOGY PROPOSED FOR THE PLANT

In this section, the guidelines required by the EPA for the process description in the PER are noted, and the description offered in the PER is reviewed.

A description of the process is made, indicating pertinent features, and some of the important technological features are identified. The assessment offered is qualitative in nature, and focuses on process safety features and safeguards built into the process.

> Those features of the process technology that promote process safety are highlighted between reduced margins, as in this paragraph. Such features are not there by accident, and are built-in safety features that have beneficial effects at all times.

2.1 EPA Guideline Requirements

From Section 6, Appendix A of the PER (Ref 1), the guidelines relating to process description require:

- a clear description of each stage of the process

- a description of the chemicals used, and the method of storage and handling of these

- an indication of the ultimate capacity of the plant

2.2 Process Infomation provided in the PER

Figure 4.1 of the PER, a simplified Process Flow Diagram, represents the proposed process in a reasonably accurate manner. The text identifies clearly and describes in general, but appropriate, terms the significant sections of the process:

- natural gas pretreatment to remove carbon dioxide

- preparation of the reactants by vaporising liquid ammonia and mixing with natural gas and air

- conversion of the mixture to hydrogen cyanide at elevated temperature

- reaction of hydrogen cyanide with caustic soda to produce sodium cyanide in solution

- crystallisation of sodium cyanide

- separation of the crystals from the slurry

- briquette production and packaging

The raw materials for the process - ammonia, natural gas, air and caustic soda are correctly identified. Ammonia and natural gas are to be supplied by pipeline from off-site sources.

> Eliminating the need for onsite storage and bulk handling measures reduces sources of hazard.

Large quantities of caustic soda will be required, and provision is made for onsite bulk storage of 30000 tonnes in the site layout. The use of air as a raw material is noted indirectly.

The plant capacity of 45000 tonnes per annum is noted clearly, as required.

Section 3.4 of the PER (Ref 1) discusses aspects of the proposed technology and alternate technologies. Some of the advantages nominated for the Du Pont process, namely:

- minimum possible hydrogen cyanide inventory

- minimum possible liquid sodium cyanide inventory

- no hazardous emissions or contaminated solid waste

- low maintenance requirements

may also be advantages of alternative processes. That Du Pont wishes to use its own process, developed and improved since 1950, is entirely reasonable. An important advantage in using the Du Pont process is the practical operating experience and history of operation accumulated by operating existing plants in other parts of the world.

> Application of history and experience is a benefit that is hard to measure; it contributes to optimal process operation, improved process safety and increase awareness of the environmental implications of the process.

2.3 Process Details

Inspection of the information offered by Du Pont indicates the process is characterised by a number of features that promote process safety. Compared to the vast range of chemical plants operated throughout the world, there are a number of general features that enhance safety:

- low operating pressures throughout

- low operating temperatures, except for the conversion stage

- the chemical reactions are well known

- there is a very low hydrogen cyanide inventory in the process

- the heat of reaction is removed quickly by a boiler forming part of the converter

- there is a trade off between decreasing mobility and increasing inventory of materials as they progress through the process; this is identified in later sections of this assessment

- there is continuing conversion of any residual hydrogen cyanide that may be dissolved in the sodium cyanide solution (Section 2.3.2)

- the final product form, briquettes, reduces the consequences of product spillages (Section 2.3.3)

2.3.1. Gas Phase Operations

Ammonia Vaporisation

The ammonia vaporisation section contains significant amounts of liquid ammonia supplied by pipeline from an off-site source. Information provided indicates about seven tonnes is held in an Ammonia Surge Tank, at near ambient temperature and at a pressure of approximately 700 kPa. The function of the Surge Tank is to hold a buffer stock of ammonia on site in case there is a loss of supply by pipeline.

> This stock held on site enables an orderly shut down of the process in the event of the loss of supply; the alternative to no buffer stock would be an emergency shutdown where different operations conditions may prevail.

The main Ammonia Vaporiser is fed from the Surge Tank, and a Blowdown Vaporiser of smaller capacity is fed from the Ammonia Vaporiser. The liquid ammonia inventories of these vessels are not available from the information supplied. The pressure of the ammonia gas when vaporised is about 210 kPa, a superheater subsequently heats the vapour to 100 deg C.

The operating temperatures and pressures in this plant section are not severe, and in addition, the entire section can be isolated by valves operated remotely from the area.

> Should the vaporiser section be isolated, the effect would be to cease production of hydrogen cyanide.

Natural Gas

Natural gas is supplied to the process at a pressure of 690 kPa. Its pressure is reduced to 210 kPa before entering a heater that raises its temperature to 100 deg C. The natural gas heater can be isolated by remotely operated valves. Loss of natural gas heating would not impact greatly on the process other than to reduce the process thermal efficiencies.

Reactant Mixing

Both ammonia and natural gas are flammable. They are mixed and filtered in the absence of air.

> This feature eliminates the possibility of unintended combustion of the raw materials.

The mixing of the flammable gases with air takes place at the last possible moment before entry of the mixture to the converter, at a pressure of 124 kPa and 100 deg C.

Ref 4 specifies this final mixing is to take place virtually adjacent to the converter. At the operating flowrate, the mixture will enter the converter immediately after mixing.

Conversion

In the converter the feed gas mixture is reacted over a platinum/rhodium catalyst to produce hydrogen cyanide:

$$CH_4 + NH_3 + 1.5O_2 \longrightarrow HCN + 3H_2O$$

methane	ammonia	oxygen		hydrogen cyanide	water vapour

The reaction releases heat raising the temperature of the reaction products to about 1100 deg C. The heat of reaction is used to raise steam for process requirements, and this reduces the temperature of the product gases to about 230 deg C before leaving the converter. The reaction is monitored by temperature probes in or near the catalyst bed, and by on-line gas chromatography that measures the proportion of components in the gaseous product. The components in the product gas stream are:

- unreacted ammonia (1.8% w/w)
- hydrogen cyanide (8.75% w/w)
- water vapour (19.7% W/W)
- nitrogen (63.1 % w/w)

and minor amounts of by-products such as hydrogen, carbon monoxide, carbon dioxide, methane and nitriles.

The sensitivity of the product gas composition to reaction conditions for this process is not known to Quantarisk. It is expected this would depend largely on the reaction temperature and the proportions of the feed gases to the converter. Deviations from the target gas composition would probably lead to a reduction in yield of hydrogen cyanide and an increase in by-product generation. The process economics accordingly would be affected adversely. Du Pont therefore has considerable incentive to ensure the conversion section operates in a controlled and reliable manner.

The most mobile materials in the process are the gases that disperse readily if released. The inventory of ammonia or hydrogen cyanide in the gas phase in process is very small, not more than 2 kg (Ref 2).

The inventory of mobile but hazardous materials in the process is very small; this limits the impacts of loss of containment of these materials significantly.

Absorbtion

The Absorber uses a circulating liquid mixture of sodium cyanide and sodium hydroxide to remove the hydrogen cyanide vapour from the converter product gas:

$$HCN + NaOH \longrightarrow NaCN + H_2O$$

HCN	+	NaOH	------>	NaCN	+	H_2O
hydrogen cyanide		caustic soda		sodium cyanide		water

In the context of process safety this operation is most significant. The highly toxic and potentially mobile hydrogen cyanide in the gas phase, that may have considerable off-site impact if released, is converted to the liquid phase sodium cyanide that has considerably less mobility.

Reducing the characteristic mobility of process materials, and their volatilities, reduces the effects of any associated hazards.

The process of absorbtion takes place at near to atmospheric pressure and at about 60 deg C.

It must be noted that all the gas phase operations executed so far in the process have not used blowers, compressors or fans to propel the flammable and/or toxic gases through the process. The energy that produces these gas flows through the process derives from the supply pressure of the natural gas, and from the pressure of the ammonia produced in the ammonia vaporisers.

A common source of hazard usually found in gas phase operation does not exist so far, that is where mechanical energy is imparted to the process gases; thus there are no blowers, pumps, or fans to fail and subsequently leak the gases to atmosphere.

By-product Gas Disposal

The components remaining in the product gas stream after the absorbtion step are the same as those leaving the converter. The proportions of the components have changed because of the removal of the hydrogen cyanide. Nitrogen is the main component (80% w/w), with water vapour at 10% w/w. This gas stream is sent to the flare system to burn the remaining minor amounts of by-products detailed earlier and hydrogen cyanide that is not absorbed.

2.3.2 Liquid Phase Operations

The liquid phase operations commence at the Absorber. A product stream is bled off from the circulating mixture of sodium cyanide and sodium hydroxide that circulates through the Absorber. The product stream is cooled and held for a time in a cyanide solution tank. Some hydrogen cyanide vapour may be dissolved in small concentrations in product stream and be unreacted.

> The excess sodium hydroxide in this stream will continue to react with any dissolved but unreacted hydrogen cyanide in the product stream.

Gases in equilibrium with the sodium cyanide solution at this holding stage are collected by a blower and sent to the flare system for burning.

Conversion of the toxic medium to the liquid phase by the absorbtion step is important. The inventory of the toxic liquid phase is much greater than the inventory of the toxic gas phase. On the other hand the mobility of the liquid phase is greatly reduced compared to the gas phase.

> The trade-off of decreasing mobility and increasing inventory of toxic species in the process is a significant design feature.

Crystallisation

The next stage of the process is the crystallisation of the sodium cyanide. The solution containing the sodium cyanide circulates through the crystalliser and the associated heaters. The circulating solution is heated to 60 deg C, to enhance the rate of evaporation of water from the solution in the crystalliser. The crystalliser operates under a vacuum at about one tenth of the atmospheric pressure.

The water vapour that is evaporated off is scrubbed with a caustic soda wash to remove any remaining hydrogen cyanide that may be evaporated during the crystallisation of the sodium cyanide. The water vapour is condensed and any remaining vapour is sent to the flare system.

A proportion of the solution circulating through the crystalliser, containing sodium cyanide crystals and sodium cyanide working solution is drawn off and sent for filtering.

Filtration

The filtration step separates the sodium cyanide crystals from the working solution using a rotary filter. This operation takes place under a vacuum at near ambient temperatures. The liquid portion of the product, containing sodium cyanide that has not crystallised out of the solution is returned to the Crystalliser.

2.3.3 Solid Phase Operations

The solid phase operations consists of:

- breaking up the solid filter cake of sodium cyanide crystals
- mixing with hot air to both dry and convey the crystals
- separation of the dried crystals from the conveying air
- briquette production
- screening of the briquettes and recycling of the fine material
- packaging of the briquettes

The operations are carried out at near to atmospheric pressure, and at temperatures ranging from 288 deg C, at the start of the drying process, to about 80 deg C prior to storage in the Packing Bin.

The product, although toxic, is being transformed into an even less mobile form. The crystals, whose particle size distribution is not available, are compressed into briquettes, each one being 32 mm by 32 mm by 16 mm.

Production of briquettes reduces the mobility of the sodium cyanide considerably. The crystals are converted to a form that is hard, dense and impact resistant. In the event of a spill material does not disperse far and is easily cleaned up. There is little opportunity available for material to be lost. Briquettes are the least mobile form of sodium cyanide, and the appropriate form in which to store a large stock of product before despatch.

> Briquettes are an appropriate form for a product such as sodium cyanide because the material is not dispersed readily if lost from the process or its packaging, and the least hazard is presented.

Fines particles of sodium cyanide remaining in the gas stream from the Dryer Cyclone are sent to a scrubbing system, where they are removed by water circulating from the Wash Water Tank. The gas stream remaining is vented to atmosphere through a stack.

2.4 Process Instrumentation

The P&ID's (Ref 4) indicate the proposed process will be highly instrumented. Instrumentation will monitor concentrations and flowrates of materials, pressures and temperatures, and speeds and linear movements of equipment. These inputs will be used for process control and for monitoring of alarm and trip conditions.

A distributed control system will be used. Its form is not specified, but it is expected computer control in combination with programmable logic controllers would be used. Information is presented in diagrammatic form on the P&ID's indicating the process control loops proposed. Process interlocks and alarm conditions are not readily identified from the P&ID's and would be usually specified in detail in a separate document.

There is insufficient information in the material provided to make any assessment of the aspects relating to the control of the process. It is considered that the HAZOP (Hazard and Operability) Study, to which the proponent is committed, is the mechanism for assessing the control system. Such a Study should assess the appropriateness of the control procedures in detail, as well as assess the hardware details that are normally considered. Some control issues to address in the HAZOP are:

- sufficiency of control loops, and their locations
- trips and alarms
- start-up and shutdown procedures
- emergency isolation
- integrity and reliability of the process control system

3. REVIEW OF THE PRELIMINARY RISK ANALYSIS

Appendix J of Ref 2 is the Draft EPA Guidelines for a Preliminary Risk Analysis. They cover the preliminary risk assessment requirements for any proposed industrial plant. It is in the context of these requirements that the PRA is reviewed.

The degree to which the PRA meets the requirements of the Guidelines is a matter for the Consultant concerned to decide. Some of the factors that must be weighed up by the consultant when preparing the report are:

- the need to present enough information for a regulatory authority to make an independent assessment
- the need to present sufficient information for the the public reader to be informed
- how much information can be revealed consistent with the proponent's need for an approval for the proposal
- how much information can be revealed consistent with the proponents confidentiality requirements

- how much of the confidential intellectual property of the consultant can be revealed given the constraints of environment within which he or she works

Part of this review is to identify where the expectations expressed in the Guidelines are not met.

The PRA is set out in an order that mirrors the Guidelines, an important feature of the Study. This allows direct comparisons of the requirements of the Guidelines and the content offered in the PRA. This review will deal with the PRA on a section-by-section basis.

3.1 Summary

This is brief and to the point. It states the conclusion of the analysis executed by the consultant and suggests the proposed development will satisfy the EPA Guidelines on risk acceptance.

3.2 Introduction

This section discusses some background, the Study aims and objectives, the general nature of the project. The section on the Philosophy of Approach to Risk Assessment does not include explicit definitions of "risk" as required, and does not present the background and capabilities of the Consultant early in the Study. On the other hand, Appendix E offers a limited summary of this aspect.

The EPA General Criteria for Risk Assessments are quoted. Some discussion on the "acceptability" of the risk levels in WA is required by the Guidelines. It is not clear from the Guidelines the extent to which such a discussion should proceed. Some comment was made in the PRA relating to the acceptability of the cumulative risk in the Kwinana area. No consideration of the acceptability of risk in a wider context was made.

3.3 Project Description

The Guidelines require comment on site location and environment, meteorology, a process description, and other parameters relevant to the risk analysis.

The information relating to the site location and environment is sufficient in the context of a PRA. A clear plant location figure is offered, highlighting the preferred site and the alternatives considered. A provisional site layout for the proposed plant is also offered.

The meteorology relating to the site has been condensed from a more precise set of data. This has been done to reduce the scale of the computations required in the risk analysis, and is a valid approach providing the reduction is justified.

Table 3.2.2 of the PRA nominates 17 combinations of windspeed and atmospheric stability used in the Study. Casual reading of the Study would leave the impression that all 17 combinations were used in the determination of risk. Reference to Appendix 3 indicates that three combinations were used for dispersion calculations in the Study. The method of making this reduction in the number of cases was not detailed or justified (as required in the Guidelines), although it appears to be based on the results of gas dispersion calculations (Appendix I). The stability and windspeed combinations chosen and their probabilities of occurrence were:

(i) stability condition B, windspeed 3 metres/sec: 0.084

(ii) stability condition D, windspeed 4 metres/sec: 0.563

(iii) stability condition F, windspeed 2 metres/sec: 0.353

The use of a surface roughness length of 0.1 metres for gas dispersion calculations is a conservative measure that is appropriate.

The process description is simple but general in style. The Guidelines require "details of the proposal ... sufficiently advanced to enable meaningful risk assessment to be performed". We assume this requirement means that sufficient information should be provided for an alternative risk assessment to be prepared. The information offered is just sufficient to meet this requirement. Process waste products are identified.

Other parameters relevant to the risk analysis are noted in the section on general design considerations; these are directed more toward environmental issues rather than risk issues. Considerations noted relating to the PRA are:

- the quantity of hydrogen cyanide in the process is to be minimised

- prevention of contact between sodium cyanide and acids or weak alkalis

- ammonia and natural gas feedstocks will be supplied by pipeline

- a secondary containment system will be installed around the converter, its waste heat boiler and pipeline, and will be maintained under vacuum

- the presence of adjacent industrial sites is noted

3.4 Factors Affecting the Site Selection and Risk to Public and Nearby Facilities

This is a general section that deals with the hazards of the materials and the process plant. The chemical hazards are dealt with in detail in this section and Appendix A, and highlight the toxic nature of ammonia, hydrogen cyanide, and sodium cyanide.

The Du Pont industrial safety record is quoted, and reference is made to the National Safety Council of the USA annual records supporting the Du Pont safety record.

Recognition is made of possible domino impacts from other sites nearby.

3.5 Risk Assessment

3.5.1 Methodology

The Guidelines require an outline of the method used to quantify risk from the proposal. The PRA lists the input data required in generic terms, itemises the modelling techniques that may be used, and presents a flowchart of the methodology. This information does not present the methodology in a manner that is comprehensible to the public. It is understood the PRA is required to be a public document, and accordingly should be comprehensible. It is considered a member of the public would not understand the PRA methodology unless he or she has access to information other than that provided in the PRA.

3.5.2 Assumptions

The assumptions made in the PRA are presented in Appendix B. Assumptions 2, 3, 4, 6, 7, 9, 11, 13 and 15 all help define the release cases considered in the PRA and their scale.

Assumptions 8 and 10 require relief valve discharges from the ammonia storage vessel and vaporiser to be released to atmosphere at a height that presents no hazard; if this is the case these release cases do not require further consideration.

Assumptions 17, 18 and 19, relating to the presence and regular testing of trips and alarms, are directed toward maintaining the integrity of systems protecting against failure in the process. The frequency of testing is crucial as it can modify the frequencies of hazardous events significantly, in a highly beneficial manner. The time basis of the regular testing is not indicated, and its contribution to the risk contours is not known. This information may not have been available to the consultant at the time of the preparation of the PRA, thus such an assumption has to be made to progress the Study.

The remaining assumptions are qualitative and indicate a high standard of operating and engineering practice should implemented on the proposed plant.

3.5.3 Hazard Identification

This section of the PRA describes "credible chemical release events" and indicates these are the basis for the ensuing quantitative assessment. The basis of what is credible and what is not credible is not indicated. Usually this refers to the concept that an identified event is so unlikely to occur that it can be neglected. No indication is given of the consideration and rejection of such events except that of assumption 15 in Appendix B.

The other criterion for exclusion of "credible chemical release events" from the risk analysis is based on the hazard distance associated with a release event. If the hazard distances associated with an event are contained within the site boundary, then the risk contribution of the event is excluded from the analysis. This criterion is acceptable.

The summary of the release cases considered is presented in Table 5.4 of the PRA. By inspection the contents of the Table, being the scale of the releases, their durations, and their frequencies are reasonably representative of the hazardous events identified. There are some events not entered into the Table that may have been overlooked, and are now noted.

The Ammonia Surge Tank whose working capacity of 7.4 tonnes of liquid ammonia at 690 kPa gauge and 10 deg C appeared not to have been considered. Subsequent information from Du Pont indicates the inventory has been reduced to 3 tonnes, and considered in the PRA as the Bulk Ammonia Storage vessel (Ref 2, page 39).

No indication has been given whether the Blowdown Vaporiser has been considered. The liquid ammonia inventory of this vessel is not known, but ammonia vapour at 100 deg C and 210 kPa gauge is produced. At these conditions there is probably little liquid in the vessel, and the consequences of a release would probably confined within the site boundary.

Assumption 15 of Appendix B assumes the the Absorber has a reliable caustic/NaCN solution supply, and the integral flare stack will be fitted with a flame sensor and reliable pilot gas and ignition system. The implication here is that both the Absorber and the flare system are assumed to not fail at the same time. In the event of the failure of the supply of the caustic/NaCN solution, the flare system burns the converter products if they are not absorbed correctly. Should flare system fail at the same time then the converter products will be emitted directly to the atmosphere. The concentrations after dispersion of such a continuous release of hydrogen cyanide vapour (at 1 kg/sec) will be less than the lowest published lethal human concentration of 178 ppm (Table A2 of the PRA), provided this release occurs at a stack height of at least 30 metres.

The flare flame-out is considered to occur with a frequency of 100 chances in a million in a year (Table 5.4). The probability of the failure of the circulating flow through the Absorber is not indicated. It has not been demonstrated this probability is sufficiently low to justify assumption 15.

Converter rupture is excluded on the grounds that a secondary containment system for the converter will be implemented. No such commitment is made for the Absorber; thus Absorber failure should be considered in the analysis.

The exhaust gases from the Dryer Cyclone are sent to the Scrubber to remove sodium cyanide particulates before emission of the gases to the atmosphere. Should the circulating flow through the scrubber fail the particulates may be emitted to the atmosphere. Assuming sodium cyanide toxicity is similar to hydrogen cyanide toxicity, the hazard distances of such a release probably fall within the site boundary, and are not considered further. It is not clear from the PRA whether the toxicity of sodium cyanide has been considered sufficiently to allow the circulating flow failure to be eliminated from the risk analysis.

Sodium cyanide crystals are conveyed to the Dryer Cyclone at a significant flow rate. No indication has been given in the PRA as to whether failure of the system conveying sodium cyanide crystals has been considered. Depending on the particle size distribution of the sodium cyanide crystals, there may be a significant impact off-site from a release from the conveying system.

3.5.4 Calculation of Consequences of Failure

The Guidelines indicate a comprehensive description of the models used should be included as an appendix, including values of and references for all coefficients. It is unclear from the Guidelines whether details of the mathematical formulation of the models are to be included. Thus the consultant has opted for a description of the approach to the consequence calculations in general terms. In view of this it would have enhanced the PRA to include a tabulation of the hazard distances for the release events identified.

3.5.5 Presentation of Individual Risk

Contours of individual risk of fatality are presented pictorially near the frequency required by the Guidelines - ten chances in a million per year. Comment on the cumulative effect of the contribution of the risk imposed by the Du Pont plant to the cumulative risk is made.

The consultant considered the risk of fatality imposed on individuals in residential areas is acceptable.

A quantitative review of the PRA would require an attempt to reproduce the risk contours resulting from the analysis. Although no consequence distances are quoted, except for some ammonia releases in Appendix H, it would just be possible to generate the risk contours from information provided in the PRA.

3.5.6 Ranking of Consequences

This is required in quantitative terms by the Guidelines. A qualitative ranking of the major release events is presented in Appendix G, and ranks on the basis of consequence and frequency. The ranking indicates there are no events of high consequence and high frequency contributing to the risk imposed by the proposed process.

The meanings of the categories of high to very low consequence are not indicated. If the hazard distances for the incidents identified had been tabulated, then the value of Appendix G would have been enhanced. The meanings of high to extremely low frequencies can be inferred from Table 5.4.

3.5.7 Conclusions of the PRA.

The conclusions made in the PRA refer to off-site risks, in-plant risks, domino effects, cumulative risks. Broadly these are conclusions that could be reasonably expected based on the information presented in the PRA.

Recommendations are made relating to pipelines, preparation of emergency procedures, Hazard and Operability Studies, and a review of the PRA after the process design is finalised.

4. CONCLUSIONS OF THE REVIEW

This qualitative review has assessed the proposed process in the context of the EPA guidelines for Public Environmental Reports and Preliminary Risk Analyses. In addition the review has assessed the technology proposed for the plant in the context of those features of the plant that enhance the process safety in an intrinsic manner. Some of the important features identified are:

- a very small inventory of toxic material that is gaseous and highly mobile in nature
- process operating conditions that are not arduous
- significant reduction in the mobility of toxic materials as the inventories of the materials increase
- a product form (briquettes) that offers little opportunity for uncontrolled spills and loss of material

The process appears not to be complicated when compared to other chemical processes. Its concept is kept simple and shows evidence of careful design with attention being paid to safety. Additional features, such as the commitment to secondary containment of vessels holding hydrogen cyanide, are evidence of the proponents view of the benefits of engineering for safety.

We are unable to make a considered comment on the process control system based on the information available at this time. The Hazard and Operability Study will present an opportunity for the complete assessment of the control system.

With regard to the PRA, comments have been made where it is felt the Guidelines have not been met. A number of possible hazards appear not to have been included. These have been discussed in the text, and may have been excluded for justifiable reasons not made clear in the PRA.

We are unable to comment on the veracity of the contours generated as this was not our remit. However, subject to detailed calculations, it is felt the contours presented would not be altered greatly if the excluded hazards noted above were considered.

5. REFERENCES

1) Public Environmental Report, Proposed Sodium Cyanide Plant, prepared by Kinhill Engineers Pty Ltd, July 1989

2) Preliminary Risk Analysis, Proposed Sodium Cyanide Plant, prepared by Det Norske Veritas, July 1989

3) Process Flow and Material Balance information: Du Pont drawings numbered W1057056, W1069750, W1069749, W1027245, W1063088, W1069751 dated August 1989

4) Process and Instrumentation Diagrams, Sodium Cyanide Manufacturing Facility, Du Pont Engineering Department, Wilmington, Delaware, 1989

Appendix 4

Proponent's commitments

Proponent's commitments

This Appendix presents a summary of all commitments made by Du Pont. It is adapted from the initial set of commitments made in the PER, Section 8.

1. Construction

1.1 All construction materials and practices will strictly comply with relevant Australian or, where Australian codes do not exist, internationally accepted codes of practice relating to sodium cyanide processes and facilities. Where existing Du Pont codes require higher standards, these will be used.

1.2 Appropriate noise suppression devices will be fitted to all construction machinery. Noise levels will comply with the requirements of the Department of Occupational Health, Safety and Welfare, as they relate to the construction workforce and the public, and with the requirements of the Environmental Protection Authority.

1.3 Dust suppression watering practices will be adopted to minimize dust generated during construction activities. Dust levels will comply with the requirements of the Department of Occupational Health, Safety and Welfare and the Environmental Protection Authority.

1.4 Close liaison will be maintained with local authorities to ensure that noise, dust and traffic impacts are minimized.

1.5 Where practicable, buildings will be aesthetically designed and clad in colours so as to be compatible with the surrounding industrial setting and to meet the requirements of the Town of Kwinana.

2. Operation

2.1 Air emissions from the process will be treated and vented through either a flare (in the case of process gases), or a vent stack (in the case of the air heater), or a three-stage reverse flow scrubber (in the case of particulates).

2.2 The plant design will ensure that normal emissions of nitrogen oxides comply with the NHMRC recommended guidelines and with the guidelines adopted by the Victorian Environment Protection Authority.

2.3 Ongoing control of dust will be implemented to ensure that dust levels did not affect the workforce or the public. Dust levels will be maintained at levels that satisfy the Department of Occupational Health, Safety and Welfare and the Environmental Protection Authority.

2.4 The noise levels during the operational phase of the project will comply with the Noise Abatement (Neighbourhood Annoyance) Regulations, 1979 of the Environmental Protection Act 1986 (as amended), administered by the Environmental Protection Authority, and the Occupational Health, Safety and Welfare Act 1988, administered by the Department of Occupational Health, Safety and Welfare.

2.5 The plant site will be attractively landscaped and will include the establishment of a vegetative screen to the satisfaction of the Town of Kwinana. Landscaping will commence as soon as practicable after the completion of the major components of the plant.

2.6 All non-conforming product produced while the plant undergoes commissioning and precision flow balancing that does not comply with specific performance criteria (relating to colour, concentration, solidity, etc.) will be sold as lower-grade product or will be returned for reprocessing. Contaminated packaging material and equipment will be decontaminated with neutralizing solution and then disposed of at an approved sanitary landfill site.

2.7 All waste products will be disposed of in an environmentally safe manner and in accordance with the statutory requirements of the Environmental Protection Authority.

2.8 The process and storage areas will be bunded so that runoff and spillages could be collected for treatment. Plant maintenance washings and first flush stormwater, together with process wastewater, will be directed to wastewater treatment tanks. Treated waste water will be sent to the cooling towers, with purges from the cooling water circuit being discharged to on-site evaporation ponds. The evaporation ponds will be made leakproof to prevent any loss of containment of the wastewater. These facilities will be constructed and operated to the satisfaction of the Water Authority and the Environmental Protection Authority.

2.9 Domestic sewage from amenity facilities will be treated in septic tanks in accordance with the requirements of the Town of Kwinana and the Water Authority.

2.10 The sodium cyanide briquettes will be packaged by the bag/box method, known as IBCs. These will be transported in standard freight containers. Any proposal to use any other form of packaging will be submitted to the Environmental Protection Authority and all other relevant statutory authorities for assessment.

2.11 Where possible, rail and ship will be used to transport the freight containers interstate and to rail terminals nearest gold producing areas. Road transport will be used to deliver the freight containers to the gold processing plants. Where the existing railway network does not extend to gold producing areas with container handling facilities, road transport will be used between Kwinana and the processing plant.

3. Safety features

3.1 The plant will undergo regular preventative maintenance to avoid downtime due to possible component failure.

3.2 A Total Hazard Control Plan (covering auditing, risk analysis, emergency planning and other issues considered appropriate) will be prepared in accordance with the requirements of the Department of Mines.

3.3 A Process Hazard Review will be commissioned prior to the finalisation of the plant design to review the design and operating procedures, and to identify potential hazards and operating difficulties. The methodology of this Review will be to the satisfaction of the Environmental Protection Authority.

3.4 Safety interlocks on equipment whose failure could expose operators to hazards will be designed to minimize the risk of these hazards to a level acceptable to DOHSWA.

3.5 A number of safety features will be incorporated into the design and operation of the plant to ensure minimal risk to the workforce and public through the utilization of the most up-to-date technology. These will include:

- minimisation of the amount of hydrogen cyanide in the process system at any one time;
- installation of a secondary gas containment system around the converter, waste heat boiler and exit gas pipeline to contain the hydrogen cyanide inventory in the event of a credible leak from this equipment. The containment system will allow the process to be shut down, if necessary. The gas containment system will be maintained under a vacuum so that fugitive emissions of hydrogen cyanide do not escape undetected into the atmosphere. The system will be designed to meet Environmental Protection Authority guidelines to be set for achieving gas containment;
- installation of a surge tank between the absorber and the evaporator to allow a rapid shut-down of the plant in the event of a blockage;
- establishment of a network of field-installed cyanide detectors;
- utilization of a distributive control system (DCS) operated from a centralized control room to minimize operator contact with the production process;
- installation of a cyanide monitor in the cooling tower water circulating/purge streams;
- installation of an infra-red device in the flare stack to verify that the pilot flame is always functioning; and
- installation of a wide range of instrumentation to monitor the operations of each major component of the plant.

3.6 The design, construction and operation of the plant will be conducted with the primary objective of maintaining the maximum level of safety to workers and the public. Experienced senior management and operations staff from the proponent's Memphis and Texas City plants will supervise the training of workers in the safe operation of the plant.

3.7 Storage of solid sodium cyanide will be in accordance with the Explosives and Dangerous Goods Act, 1961 and will be approved by the Chief Inspector of Explosives and Dangerous Goods (Department of Mines).

3.8 A fire protection system will be incorporated in the plant in accordance with the requirements of the plant design and the Western Australia Fire Brigade. All plant personnel will be trained in appropriate fire-fighting techniques.

3.9 All employees will be trained in the safe work practices and emergency procedures appropriate to the operation of the plant and the handling of all associated materials.

3.10 Du Pont will participate in the Kwinana Integrated Emergency Management System, being developed by the Department of Resources Development to formulate and execute contingency plans in case of an emergency.

3.11 The method of product transport will comply with all requirements of the Dangerous Goods (Road Transport) Regulations, 1983 and other appropriate legislation administered by the Department of Mines. Personnel involved in sodium cyanide handling and transport will be specifically trained and advised of the nature of the goods, the hazards involved and the procedures to be followed in the event of an accident. All product packaging will be clearly labelled and will outline relevant product and safety information as required by the Department of Mines.

4. Monitoring and auditing

4.1 A comprehensive monitoring programme will be implemented to assess the extent of compliance with the standards and criteria of the Water Authority, the Department of Occupational Health, Safety and Welfare, the Environmental Protection Authority and

Du Pont. This monitoring programme will include reporting to the relevant authority the results of monitoring all plant discharges, airborne emissions, groundwater quality, and noise and dust levels. These separate monitoring programmes will be prepared and undertaken to the satisfaction of the appropriate authorities. Monitoring will commence as soon as practicable after the commissioning of the plant, although baseline monitoring, where required, will commence prior to the plant commissioning.

4.2 Regular safety audits will be conducted to assess the effectiveness of the proponent's commitment to safeguard the public and the environment.

Appendix 5

Cumulative risk analysis for the Kwinana region

Technica

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CUMULATIVE RISK ANALYSIS
OF KWINANA INDUSTRIAL AREA
INCORPORATING DUPONT
SODIUM CYANIDE PLANT

C2151/AHJ/ib
Technica

December 1989

CUMULATIVE RISK ANALYSIS OF KWINANA INDUSTRIAL AREA INCORPORATING DUPONT SODIUM CYANIDE PLANT

CONTENTS | PAGE

1. INTRODUCTION

The Department of Resources Development, Western Australia, has requested that a revised cumulative risk analysis be made of the Kwinana industrial area. This is to show the effects of a proposed sodium cyanide plant on the base case risk contours for the area.

Technica performed the original risk analysis of the Kwinana area and this study uses the same methodologies and computer model (SAFETI) as those described in the report to the Western Australian Government (Kwinana Cumulative Risk Analysis, Technica, March 1987).

2. THE PROPOSED PLANT

Dupont intend to operate a solid sodium cyanide manufacturing plant in the Kwinana industrial area. This will have a design capacity of 45,000 tonnes per annum.

The proposed plant has been the subject of a preliminary risk analysis by Det Norske Veritas (DnV). The analysis is presented in their report to the EPA (Preliminary Risk Analysis of Sodium Cyanide Manufacturing Plant, DnV, July 1989).

The failure cases defined in the DnV report were used in this study to generate the risk contours for the proposed plant.

3. RISK RESULTS

The base case cumulative risk contours are shown in Figure 3.1. These are made up by contributions from the following industries:

WMC Nickel Refinery
Commonwealth Industrial Gases
SECWA Gas Supply Pipeline
WANG pipeline
KNC ammonia plant
CSBP/Norske Hydro Ammonia/Urea plant and jetty facility
Wesfarmers LPG plant and jetty facility
Nufarm Industrial Chemicals
CSBP Fertiliser plant
BP Refinery
Kleenheat LPG Depot
CSBP Chlor-alkali plant
CSBP Sodium Cyanide plant (duplicated)
TI02 pigment plant
PICL petrochemical complex

The cumulative risk contours with the proposed Dupont plant included are shown in Figure 3.2. they show that the individual risk contours close to the proposed site are increased at the 10^{-5}/year and above levels. However the 10^{-6}/year and 10^{-7}/year contours are not altered significantly.

FIGURE 3.1 KWINANA CUMULATIVE INDIVIDUAL RISK LEVELS - BASE CASE

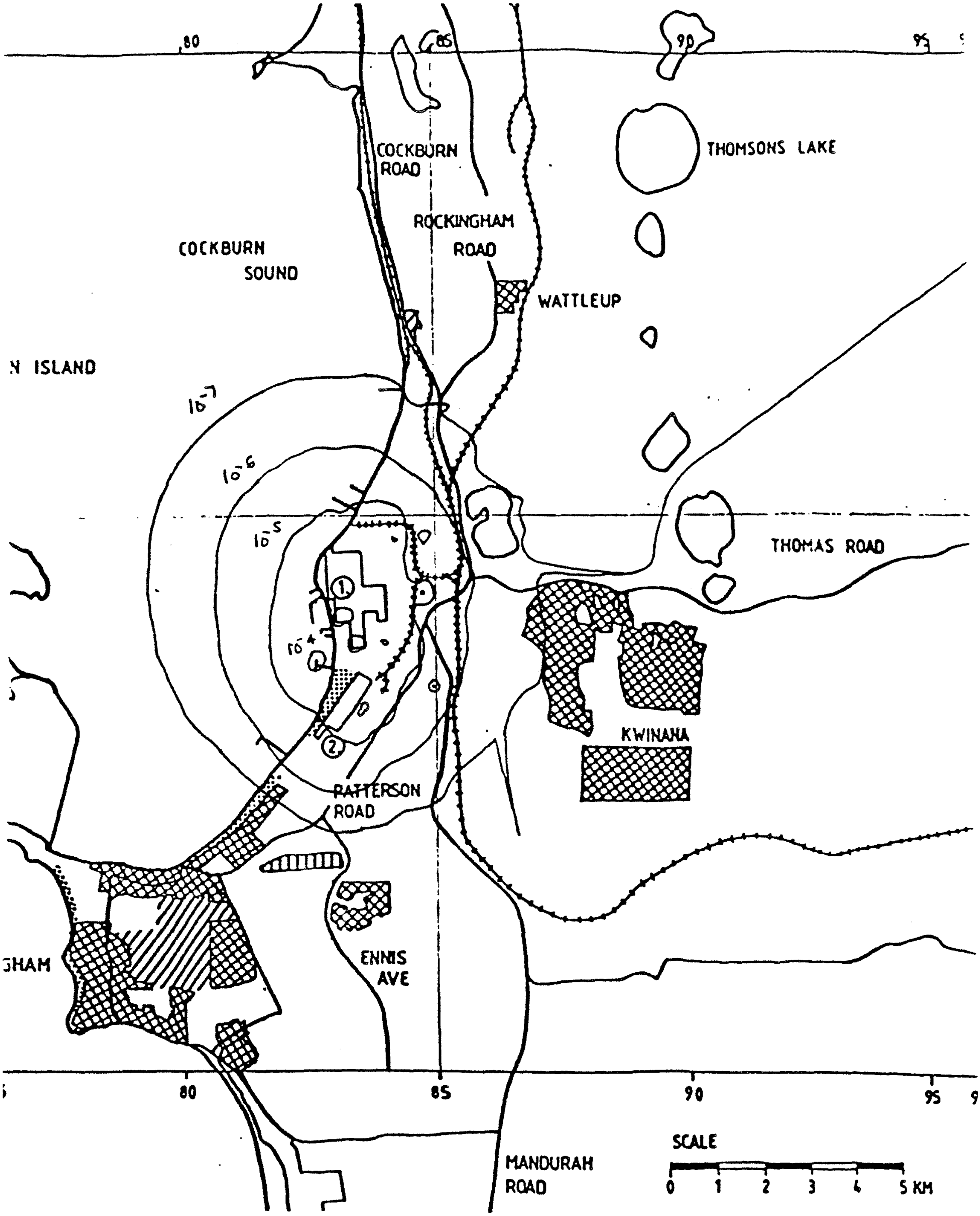
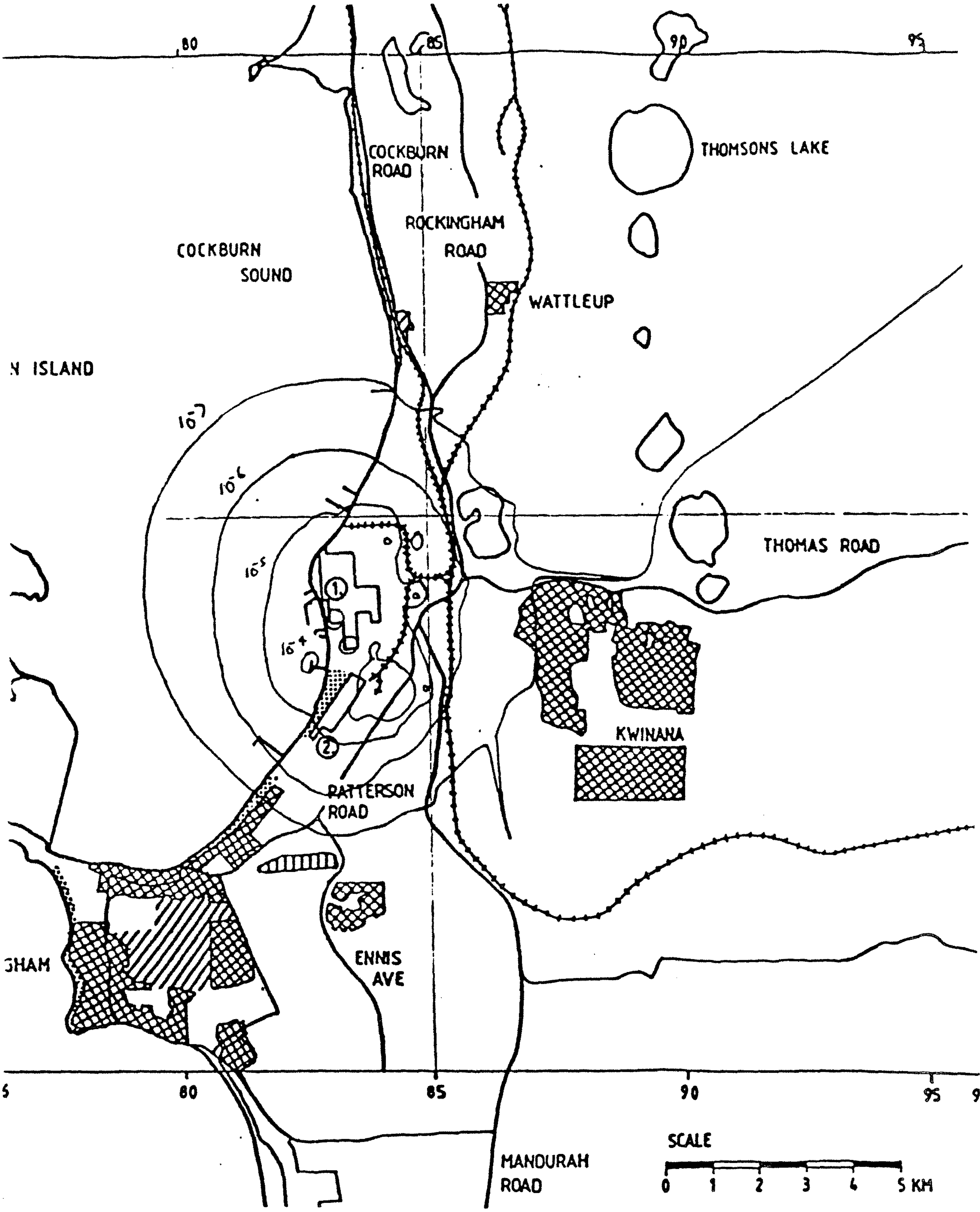


FIGURE 3.2 KWINANA CUMULATIVE INDIVIDUAL RISK LEVELS - INCLUDING SODIUM CYANIDE PLANT



Appendix 6

Letter from the Department of Occupational Health, Safety and Welfare

Department of Occupational Health, Safety and Welfare of Western Australia

Your Ref:
Our Ref: 505/89
Enquiries: Ms Xuan Nguyen
Date: 23 November 1989

ENVIRONMENTAL PROTECTION ...
29 NOV ...

The Chairman
EPA
1 Mount Street
PERTH WA 6000

ATTENTION: DR BRUCE KENNEDY

PROPOSED DUPONT SOLID SODIUM CYANIDE PLANT AT KWINANA

With reference to your letter dated 19 September 1989 requesting further detailed evaluation of the proposed project by this Department with respect to Occupational Health and Safety issues, a review was conducted and our comments are as follows:-

1. In conjuction with the information obtained from the Piping and Instrument Diagrams (P & I Ds) of the solid sodium cyanide handling and packaging section, from the Dupont video of the packaging operations at the Memphis plant, and from the proponent's stated commitments in the Public Environmental Report (PER), it is our opinion that workers' exposure to cyanide dust and gas could be adequately controlled and minimal under normal operating conditions through:

   - fully enclosed system, and/or under extraction ventilation where operators' exposure to cyanide dust/gas is likely.

   - field - installed cyanide detectors at appropriate locations to detect fugitive emissions of cyanide gas and dust in the work environment. The detectors must be equipped with local visual and audible warning devices which can be activated as soon as the cyanide level reaches 5 mg/m^3 (as cyanide) so that appropriate action can be taken by the operators in terms of personal protection.

   - availability of appropriate respirators on site for use in emergency and when the cyanide level is excessive.

   - adequate training, emergency and safety procedures.

031524

WILLMAR HOUSE, 600 MURRAY STREET, (P.O. BOX 294), WEST PERTH 6005, WESTERN AUSTRALIA
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2. It was indicated by the proponent that safety procedures during plant break downs and during maintenance will be made available to DOHSWA prior to the commissioning of the plant and that these procedures will be subjected to the HAZOP study.

3. Based on the information from the Dupont Health and Safety policy and the Memphis plant safety and health procedures that were submitted to DOHSWA by the proponent, it appears that the proponent would have sufficient experience to develop a comprehensive and effective occupational health and safety management program for the Kwinana plant.

The previous submission dated 22 September 1989 from DOHSWA which was signed by the Acting Director of Information and Resource Services Division still reflects DOHSWA's view of the proposed plant.

Brian Bradley
EXECUTIVE DIRECTOR

xn0003(f)

Appendix 7

Letter from State Emergency Service

S.E.S. A8

WESTERN AUSTRALIAN STATE EMERGENCY SERVICE

CB/

TELEX: 93097
TELEGRAMS: "SESWA" PERTH
TELEPHONE: 277 5333

91 LEAKE STREET,
BELMONT 6104.

IN REPLY PLEASE QUOTE
Ref:12-09-01

December, 1989

Director
Evaluation Division
Environmental Protection Authority
1 Mount Street
PERTH WA 6000

Dear Sir

DUPONT (AUSTRALIA) LIMITED - PROPOSED SODIUM CYANIDE PLANT - KWINANA

I refer to your letter of 5 December, 1989 concerning the above plant and the anticipated timings for the development and implementation of the KIEMS.

The stages for the development and implementation of the KIEMS are as follows:

> Stage 1. Review of existing emergency management arrangements and the submitting of recommendations. This Stage commenced in February 1989 and was completed in May 1989. Its findings are published in the KIEMS Stage 1 Report which was endorsed by Cabinet on 10 July, 1989.
>
> Stage 2. KIEMS Stage 2 is concerned with the development of emergency management aspects of the project and is intended to deal with the specific issues identified as deficiencies in Stage 1. This stage is estimated to take some 18 months to complete although a number of individual issues may be resolved in a shorter time frame. Stage 2 was begun in November 1989 having been delayed due to staffing and funding problems which have yet to be finalised. The estimated completion date for Stage 2 is April, 1991. This however does not include any infrastructure

requirements consequent to Stage 2 deliberations. It is anticipated that a provisional KIEMS document will be in place by April, 1991.

Stage 3. This Stage is best described as the implementation and maintenance stage, including infrastructure type activities which may or may not have commenced in Stage 2. Although a separate Stage, it is anticipated that implementation of many aspects of the KIEMS would have commenced in Stage 2. Due to the dynamic nature of the KIEMS this stage is open-ended, although I anticipate the final KIEMS document will be completed early in this Stage.

Notwithstanding what may appear to be a rather lengthy period for the development and implementation of KIEMS it would be remiss of me not to point out the many positive achievements attained since the completion of Stage 1.

As you are no doubt aware the committee structure for managing Stage 2 is now in place with sub-committee composition and terms of reference agreed. All sub-committees have met at least once, if not twice, and are working diligently towards achieving their tasks. Terms of reference for consultant studies are near completion and should be let early in the new year. Work has commenced on examining warning systems, resource availability and media handling arrangements. In addition both industry and local planning has commenced.

I am confident that the overall time frame for the completion of the project can be shortened, provided the resources, particularly funding, are made available. I should also point out that elements of the KIEMS may well be progressively implemented prior to the completion of the final documented emergency management system.

Yours faithfully

T J Carlson

T J CARLSON
CHIEF SUPERINTENDENT
DIRECTOR