Titanium Dioxide Pigment Plant Kwinana

Cooljarloo Joint Venture

Report and Recommendations
of the
Environmental Protection Authority

Environmental Protection Authority
Perth, Western Australia
Bulletin 373 February 1989

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i SUMMARY AND RECOMMENDATIONS

The Environmental Protection Authority (EPA) has assessed a proposal by Cooljarloo Joint Venture to establish a 54 000 tonnes per year chloride process, titanium dioxide pigment plant at Kwinana. Cooljarloo Joint Venture is a joint venture between Minproc Australia and Kerr McGee of USA.

This represents the final stage of a four part vertically integrated mineral sands industry consisting of:

- a mineral sands mine at Cooljarloo;
- a dry separation plant at Muchea;
- a synthetic rutile plant at Muchea; and
- a pigment plant at Kwinana.

The plant is proposed to be located adjacent to the proposed petrochemical industry at Kwinana. The Authority has concluded that this proposed site is an acceptable location for this type of plant.

In assessing this project, the EPA considered the environmental impacts of the plant and the individual and cumulative risks and hazards associated with the plant. The impacts assessed include:

- the suitability of the site;
- construction and commissioning stage impacts;
- the individual and cumulative risks from this plant to the surrounding area;
- water supply and the disposal of liquid effluents;
- the disposal of solid wastes;
- the emissions to air under normal and "plant upset" conditions;
- radiation; and
- noise impacts.

After examining the ERMP, the additional information supplied by the proponent and conducting its own investigations into various aspects of the project, it is the Authority's expectation that the proponent can construct and operate the proposed plant at this site with acceptable environmental impacts. In the unlikely event that the environment in which this plant will operate alters to a significant extent, or that the plant's operational characteristics do not match those predicted and detrimental environmental impacts result, the EPA will require that the proponent modify its plant and/or operations to the satisfaction of the EPA.

RECOMMENDATION 1

The Environmental Protection Authority concludes that this proposal is environmentally acceptable and recommends that it could proceed subject to:

- the EPA's recommendations in this Assessment Report.
- the relevant commitments made by the proponent listed in Appendix 2 of this Report; and
- the provision of a satisfactory Environmental Management Programme.

The EPA also concludes that regardless of the recommendations, commitments and conditions in this report, the proponent is always responsible for the environmental impacts of the plant.

Impacts During Construction and Commissioning

The following recommendations are principally orientated toward the pre-operation phase of the project. They are associated with amelioration of environmental impacts during construction and commissioning of the plant.

RECOMMENDATION 2

The Environmental Protection Authority recommends that the proponent include in the Environmental Management Programme a plan to minimise construction stage impacts including noise, dust from site works and site run off. This programme should be to the satisfaction of the Environmental Protection Authority before construction begins.

RECOMMENDATION 3

The Environmental Protection Authority requires that there are no unacceptable impacts from sources such as air emissions and effluent discharge during startup of the plant. The Environmental Protection Authority recommends that the proponent include in the Environmental Management Programme details of management provisions which will be used to minimise startup impacts. This programme should be to the satisfaction of the Environmental Protection Authority before commissioning begins.

Risks and Hazards Analysis

As part of the ERMP, the proponent submitted a Preliminary Risk Analysis. After examining this Analysis, the Environmental Protection Authority has concluded that the individual and cumulative risks from the plant meet the criteria adopted by the Environmental Protection Authority (in EPA Bulletin 278).

The Environmental Protection Authority has identified the storage of chlorine as a significant contributor to the risks and hazards arising from this plant. As a consequence the Authority has made a comprehensive recommendation with the objective of minimising these potential risks.

RECOMMENDATION 4

The Environmental Protection Authority recommends that chlorine should be stored with comparable safeguards as have been implemented at other modern plants in the Kwinana area.

This includes:

- no more than 50 tonnes of chlorine to be stored in three 25 tonne containers;
- the containers will hold the chlorine in liquid form in a refrigerated state;
- one tank shall be left empty at all times in a ready state to receive chlorine;
- full height bunding, roofed and vented to chlorine scrubber;
- insulation tiles in the bunds;
- foam suppression system; and
- isolating values on the main storage tanks and process items. Storage isolation values require two actuation points;

The Authority has made the following recommendations concerning the implementation of measures to control the risks and hazards associated with this plant and to integrate this plant into the emergency plans for the Kwinana area. The following recommendations cover the preparation of programmes, installation of appropriate equipment and the training of staff.

RECOMMENDATION 5

The Environmental Protection Authority recommends that the proponent include in the Environmental Management Programme a comprehensive hazard identification and risk management programme in consultation with the Department of Mines and to the satisfaction of the Environmental Protection Authority.

The comprehensive hazard identification and risk management programme should include, but not be limited to, the following;

1. safety engineering design;
2. quantified risk assessments;
3. hazard and operability studies (HAZOP) 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 for assessment and also be forwarded to the Department of Mines.

In the event that the Environmental Protection Authority finds that the results of the programme are unacceptable, the proponent shall be required to modify its process and/or operations.

RECOMMENDATION 6

The Environmental Protection Authority recommends that the proponent shall:

- maintain the process equipment, instrumentation and alarm systems consistent with the safety and reliability assessment of the plant;
- minimise the risk of damage to electrolytic cells as a result of fire or explosions; and
- install very high integrity instrumentation in the control of the plant and in the detection and response to any unplanned releases

to the satisfaction of the Environmental Protection Authority on the advice of the Department of Mines.

RECOMMENDATION 7

The Environmental Protection Authority recommends that, prior to commissioning, the proponent develop and implement, to the satisfaction of the Environmental Protection Authority and relevant agencies, a plant 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 (KIEMS).

Water Supply

The proponent is proposing to use 3000 megalitres per year of scheme water for process and cooling. The proponent has reported that approximately 40% of this will be used as process water, the remainder for cooling and other purposes. The EPA is concerned that this volume represents a significant amount of scheme water and that its use for industry needs close examination so as to maximise the possibility for water recycling in the plant and investigation of alternative water supplies of suitable quality.

RECOMMENDATION 8

The Environmental Protection Authority recommends that during the detailed design stage the proponent examines ways of reducing its water consumption and submits a report of this examination to the Environmental Protection Authority and the Water Authority of WA for their assessment prior to commissioning of the plant. Furthermore, the Environmental Protection Authority recommends that in the event of a major water recycling project commencing in the Kwinana area, the proponent should utilise this water if required to do so by the Ministers for Environment and Water Resources and the Minister administering the Mineral Sands (Cooljarloo) Mining and Processing Act 1988.

Wastewater Disposal

The proponent has identified two options for the disposal of liquid effluent. These are to Cockburn Sound or to the WA Water Authority's Cape Peron outfall. There is also the possibility of the construction of an integrated industrial effluent treatment plant and outfall at Kwinana at some time in the future. The Authority considers that the two disposal options identified by the proponent are acceptable provided there is no change to the beneficial uses of the receiving waters and there is no discharge of nutrients into the Cockburn Sound. In its assessment of the WA Water Authority's Cape Peron outfall (EPA Bulletin 114, May 1982) one of the

Environmental Protection Authority's conditions of environmental acceptability was that a further public environmental assessment would be required should there be any proposal to discharge industrial effluent from the pipeline. This requirement remains, notwithstanding the EPA having no objections in principle to discharge of this effluent through the Cape Peron outfall. Consequently, the Environmental Protection Authority has made a recommendation for monitoring the effects of the outfall.

RECOMMENDATION 9

The Environmental Protection Authority requires that there should be no detrimental effect on the beneficial uses of the waters to which discharge is occurring. Consequently, the Environmental Protection Authority recommends that six months prior to commissioning the proponent shall prepare and implement a monitoring programme of both physical and biological parameters of the receiving water and effluent. If there is any unacceptable change in the receiving water quality the proponent shall modify its plant to the satisfaction of the Environmental Protection Authority.

If any discharge is proposed to the Cape Peron outfall this should be the subject of further assessment by the Environmental Protection Authority.

The plan shall be to the satisfaction of the Environmental Protection Authority and include regular reporting of results to the Environmental Protection Authority as part of the Environmental Management Programme.

The Authority has also recognised the future benefit of an integrated industrial waste treatment facility and has recommended accordingly.

RECOMMENDATION 10

The Environmental Protection Authority considers that there are potential environmental benefits from the integrated management and disposal of liquid effluents from the Kwinana area. Consequently, the Environmental Protection Authority recommends that the proponent should configure the plant so that it can be connected into such a scheme at a later date if required to do so by the Minister for Environment.

Solid Waste Disposal

The solid waste generated from this plant will have an expected total soluble salt concentration of approximately 2500 parts per million in a 50% water filtercake. This is proposed to be disposed at the proponent's mine site at Cooljarloo.

RECOMMENDATION 11

The Environmental Protection Authority considers it important that the quality of groundwater at the minesite be protected and that the rehabilitation of the mine not be jeopardised by disposal of solid waste. Consequently, the Environmental Protection Authority recommends that a full and detailed assessment be made of the disposal of the solid residue paying particular attention to the amount and fate of the dissolved solids in the residue. The Environmental Protection Authority sees this as an issue of environmental significance and recommends that as part of the Environmental Management Programme the proponent prepare a report on this matter to the Environmental Protection Authority's satisfaction six months prior to commissioning.

The Authority also considers that the effect of disposal of the residue should be closely monitored and if unacceptable impacts on the groundwater are occurring the proponent shall modify its disposal practices.

RECOMMENDATION 12

The Environmental Protection Authority recommends that the proponent report on the performance of its solid residue disposal in the Environmental Management Programme. In the event of unacceptable impacts on the groundwater or vegetation rehabilitation the proponent should modify its disposal practices to the Environmental Protection Authority's satisfaction.

Air Emissions

In the ERMP, the proponent proposed the use of certain air emission control technology and listed levels of emissions of various gases. The Environmental Protection Authority found the potential levels of gaseous emissions of reduced sulphur compounds and the possible venting of chlorine and titanium tetrachloride to be unacceptable. Following extensive discussions with the Environmental Protection Authority, the proponent has proposed extensive modifications and upgrading of its air emission control technology.

The Environmental Protection Authority has made the following recommendations about the emission of reduced sulphur compounds, the detection of leaks in the chlorine and pigment plants, the supply of further information relevant to licencing of the plant and the preparation of a monitoring plan. These are listed below.

RECOMMENDATION 13

The Environmental Protection Authority recommends that the proponent shall design and operate the plant such that there shall be no odour of reduced sulphur compounds, emanating either fully or partially from the plant which are detectable in residential areas.

RECOMMENDATION 14

The Environmental Protection Authority recommends that the proponent shall prior to commissioning, as part of the Environmental Management Programme submit a report to the satisfaction of the Environmental Protection Authority describing the procedures for leak detection and repair within the chlorine plant.

RECOMMENDATION 15

The Environmental Protection Authority recommends that as part of the Environmental Management Programme the proponent shall prepare a fault tree analysis of conditions leading to any emissions which may occur during plant upset conditions (notably via emergency vents) to the satisfaction of the Environmental Protection Authority.

If any of the events appear to be potentially unacceptable the Environmental Protection Authority may require further dispersion analysis of the emissions and subsequently engineering modifications to reduce the emission rate and/or frequency.

RECOMMENDATION 16

The Environmental Protection Authority recommends that the proponent shall, prior to commissioning as part of the Environmental Management Programme submit a report to the satisfaction of the Environmental Protection Authority describing the procedures for leak detection and repair within the pigment plant.

RECOMMENDATION 17

The Environmental Protection Authority recommends that the proponent shall prior to construction of the plant provide details of:

(i) the characteristics of emitted gas streams;

(ii) the emission control devices; and

(iii) the final stack design heights.

RECOMMENDATION 18

The Environmental Protection Authority recommends that the proponent shall, at least 6 months prior to commissioning the chlor-alkali and pigment plants prepare and implement a report to the satisfaction of the Environmental Protection Authority providing details of the monitoring programme proposed for gaseous emissions and the ambient air environment around the plant.

Radiation

The Environmental Protection Authority has examined possible sources of radiation from the plant and the entrainment of radioactive materials into the waste streams. The Environmental Protection Authority considers the possibility of risk from radiation exposure to be very low.

RECOMMENDATION 19

The Environmental Protection Authority considers that radiation should be monitored throughout the plant, and that potential effects from radiation at the discharge of liquid effluent and disposal of solid waste should also be monitored and managed. Therefore, Environmental Protection Authority recommends that prior to commissioning, the proponent shall prepare a radiation management programme for the proposed plant and disposal of liquid and solid wastes. This programme should be to the satisfaction of the Radiological Council.

Noise

The Environmental Protection Authority examined potential for noise emissions during both construction and operation. The Environmental Protection Authority has concluded that the proponents will have to achieve significant reductions in noise levels so that noise levels in the Hope Valley area are acceptable.

RECOMMENDATION 20

The Environmental Protection Authority recommends that:

(i) the proponent incorporate noise control as a fundamental criterion in the design of the plant, and that all attenuation measures considered necessary to address the tonality of the plant noise emissions and meet the noise level deemed acceptable by the Authority be incorporated during construction;

(ii) after commissioning the plant, the proponent should undertake monitoring to determine the effectiveness of the attenuation measures designed and built into the plant; and

(iii) the proponent should prepare a noise level measuring programme to be incorporated into the Environmental Management and Monitoring programme, to the satisfaction of the Environmental Protection Authority.

Environmental Management Programme

The Environmental Protection Authority considers that an Environmental Management Programme should be prepared to provide a means by which the Environmental Protection Authority can maintain an ongoing overview of the proponents environmental performance.

RECOMMENDATION 21

The Environmental Protection Authority recommends that the proponent prepare, in stages as appropriate, an Environmental Management Programme which deals with specific aspects of the proposal including:

- construction and commissioning impacts (Recommendations 2 and 3)

- reduction in water use (Recommendation 8)

  monitoring of solid waste disposal at Cooljarloo (Recommendations 11, 12,);

- monitoring of the liquid effluent receiving waters (Recommendation 9)

- detection of leaks in both the chlorine and pigment plants (Recommendation 14 and 16)

- air emissions and air quality monitoring (Recommendations 15, 17, 18)

- radiation monitoring (Recommendation 19)

- noise level measurement and control (Recommendation 20)

The Environmental Management Programme should include the submission of brief annual and comprehensive triennial reports to the Environmental Protection Authority on the environmental monitoring and management of the project.

This Environmental Management Programme should be to the satisfaction of the Environmental Protection Authority.

8. DECOMMISSIONING

RECOMMENDATION 22

The Environmental Protection Authority considers that when the plant ceases operation permanently the decommissioning and site cleanup should be the responsibility of the proponent. Consequently, the Environmental Protection Authority recommends that the proponent be responsible for decommissioning the plant and surrounds, and that 6 months before decommissioning and the proponent submit decommissioning plans to the satisfaction of the Environmental Protection Authority.

1. INTRODUCTION

The proponent, Cooljarloo Joint Venture (previously TiO_2 Corporation), proposes to establish a chloride-process plant within the Kwinana industrial area, (Figure 1) producing 54 000 tonnes per year (tpy) of titanium dioxide product.

The proponent is proposing a four part vertically integrated mineral sands industry consisting of:

- a mineral sands mine at Cooljarloo;
- a dry separation plant at Muchea;
- a synthetic rutile plant at Muchea; and
- a pigment plant at Kwinana.

The Environmental Protection Authority has already assessed the proposed mine, dry separation plant and synthetic rutile plants and found them environmentally acceptable.

The main raw materials for the proposed plant would be synthetic rutile from the proponent's plant at Muchea, chlorine, oxygen, carbon and nitrogen. The plant's main product would be titanium dioxide pigment which is predominantly used in the paint and plastic industries.

The total cost of the proposal is estimated to be approximately $135 million.

1.1 PROCESS UNITS

The proposed pigment plant consists of five principal process units.

. synthetic rutile and coke handling;
. chlorination of synthetic rutile;
. oxidation of titanium tetrachloride;
. treatment of titanium dioxide and chlorine gas recovery/recycling; and
. utilities and chemical storage.

The operation of, and interactions between, these process units is discussed in Chapter 3.

1.2 PROCESS DESCRIPTION

The process consists of the conversion of titanium dioxide, in the mineral form of synthetic rutile, into the pigment form of titanium dioxide. This is accomplished by reacting the rutile with chlorine to produce titanium tetrachloride as an intermediate, then further reacting the titanium tetrachloride with oxygen to produce titanium dioxide pigment and chlorine gas. The chlorine gas is then recycled into the process.

The chlorine will be manufactured on-site in a chlor-alkali plant.

1.3 THE ASSESSMENT PROCESS

The proponent referred this proposal to the Environmental Protection Authority in May 1988. The Authority subsequently determined that an Environmental Review and Management Programme (ERMP), incorporating a Preliminary Risk Analysis, would be required in order to adequately assess the proposal, and accordingly issued guidelines in June 1988.

The documentation was released for public comment for a period of ten weeks starting 18 July 1988. The Authority received 18 submissions.

A set of questions seeking clarification and/or further information from the proponent was developed after considering the issues identified in the ERMP, the preliminary risk analysis and the public submissions, and forwarded to the proponent for response. The questions and responses can be seen in Appendix 1. The responses as well as other information provided by the proponent, the submissions and the EPA's own investigations have been utilised by the Authority in the assessment of the project. In carrying out its assessment, the Authority sought information from a variety of sources, including the Ohio (USA) Environmental Protection Agency (which has had experience with this type of plant). In recent years the Authority has also built up considerable internal experience through the assessment of a similar pigment plant at Kemerton and a chlor-alkali plant at Kwinana.

Throughout the environmental impact assessment process there has been ongoing interaction between the proponent and the EPA examining the proposed project and modifying it to decrease its environmental impacts. Some of these modifications have arisen as a consequence of issues raised in the public and other submissions.

The EPA considers that this is a demonstration of the effectiveness of the environmental impact assessment process in that, as a consequence of the EPA's examination including public comments, a project can be modified to an extent which minimises its impacts on the environment, to the point where those impacts are acceptable.

Given the potential for the three major units (chlor-alkali, air separation and pigment plants) to be owned or operated separately, the Authority has framed its recommendations in this Report so that the Minister for Environment may readily set environmental conditions for each unit separately.

1.4 ONGOING ENVIRONMENTAL ASSESSMENT

At the time the ERMP was prepared, the proponent had not made a final decision on specific means of disposal of liquid effluent, although two potentially viable options were available. During the assessment process this was narrowed down to one favoured option. This is discussed later in this report. The details of disposal of solid effluent at the proponent's mine and air emission control technology are the subject of ongoing discussion between the EPA and the proponent as part of the EPA's assessment of the proponent's Environmental Management Programme for the mine and the Works Approval and Licencing for the pigment plant. The Authority is confident that the work already undertaken by the proponent in these areas and the recommendations in this report provide a detailed framework in which such issues can be successfully managed. In particular, the EPA will require the preparation of an Environmental Management Programme for the pigment plant to cover such issues.

A preliminary risk assessment as required by the EPA was carried out for the pigment plant, on behalf of the proponent, and was published as Volume 2 of the ERMP.

Well-established hazard analysis techniques were used in the preliminary risk assessment:

- to identify hazards 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 the cumulative levels already calculated for the Kwinana industrial area, and appears in Figure 3. The cumulative risk levels were then evaluated against the criteria adopted by the EPA and was found to meet these criteria.

2. ASSESSMENT OF OPTIONS

2.1 SITE SELECTION OPTIONS PRESENTED BY THE PROPONENT

The proponent identified two possible sites. These were at Muchea and Kwinana.

The general siting requirements were as follows:

. infrastructure, eg
  - power;
  - water (of sufficient quality and quantity);
  - communications;
  - port facilities.
. availability of process chemicals, eg chlorine, nitrogen, oxygen and others;
. disposal facilities for wastewater and solid wastes; and
. workforce (skilled and unskilled).

Also included were the following environmental criteria:

. potential noise, air and waste disposal impacts; and
. additional risk brought to the region by the proposed plant operations.

Other factors include:

. community acceptance of the proposed operations;
. social impacts from the potential changes in the local community structure; and
. potential stresses on the area's existing infrastructure, such as water supply, roads, power and transport facilities.

The Muchea site was in the vicinity of the proponent's proposed synthetic rutile plant. The Kwinana site is next to the proposed Petrochemical Industries Company Limited plant (See Figure 1).

2.2 SITE SELECTION

The proponent considered that the advantages of the Muchea location were:

. power and gas is available and there is good road and rail access;
. services available to the dry process plant and synthetic rutile plant can be shared; and
. reduced stockpiles of synthetic rutile are required, the synthetic rutile plant being nearby.

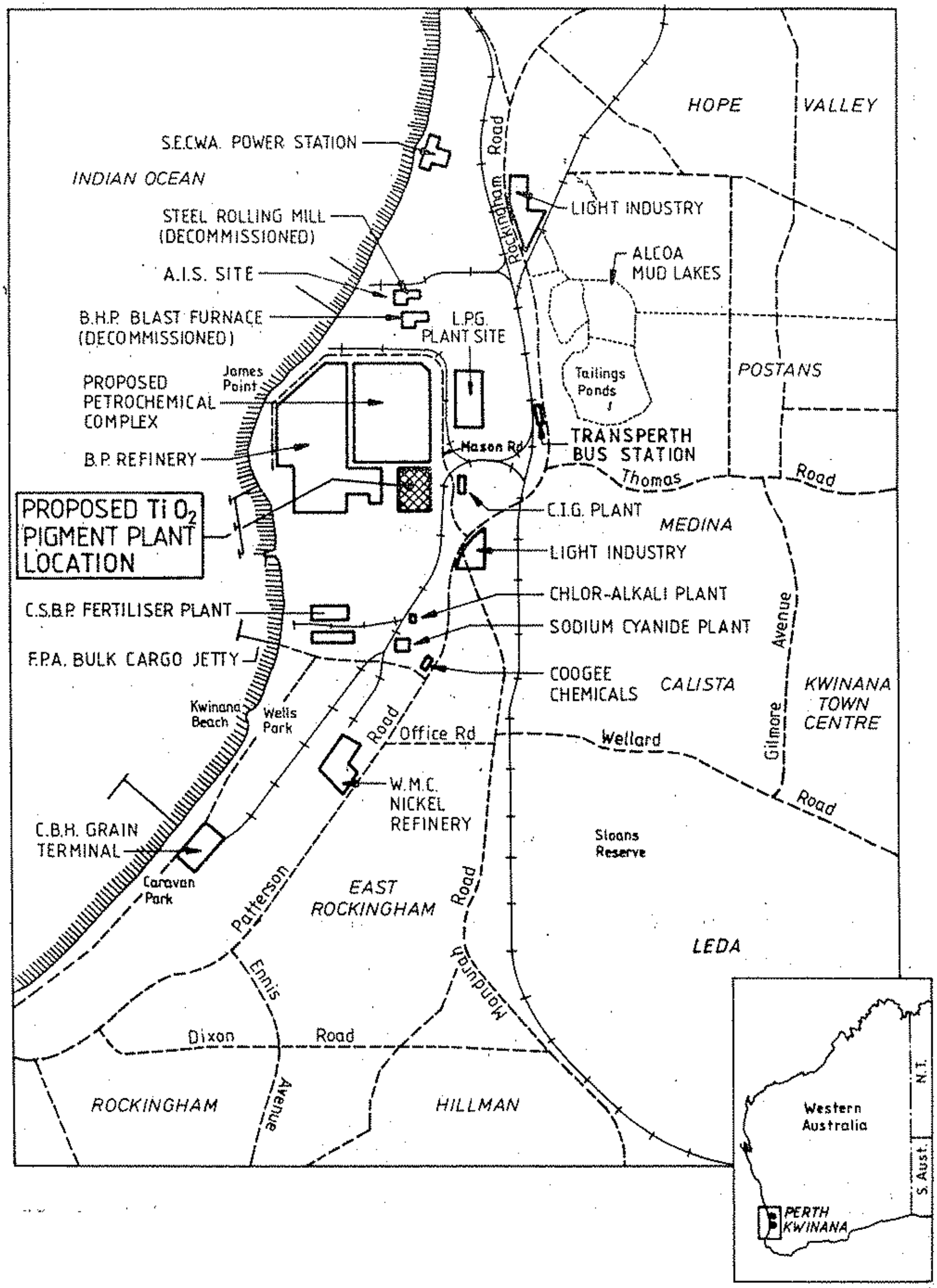


Figure 1. Kwinana Site Plan showing existing industrial development and landuse. (Source ERMP).

The proponent identified the major disadvantages for a Muchea location are:

- it would be some 35 km from the coast. The brine effluent pipeline would need right of way through private and crown land. The discharge facility would be in an isolated location where controls would be more costly;
- water supplies from groundwater resources would be difficult to acquire for the quantities needed (3000 megalitres per year) and available scheme water would not meet the process needs;
- the titanium dioxide plant would use significant quantities of process chemicals, which would need to be transported via road to the site;
- there is no commercial and service infrastructure in the area to support the plant; and
- residential background noise conditions are significantly lower than for the Kwinana areas.

The advantages of the Kwinana location for the proponent are:

- general infrastructure services such as 132 kV power supply can be shared with adjacent plants;
- scheme water for processing is available in the required quantities with minimal treatment for process requirements;
- access to skilled construction and operational workforce;
- most chemical inputs can be readily supplied without extended road transport;
- heavy industrial land and infrastructure is available;
- an established export port is close by; and
- options for brine effluent disposal, either via the Cape Peron outfall or via submarine pipeline into Cockburn Sound do not require lengthy right of ways to remote locations.

2.3 KWINANA REGIONAL STRATEGY

The overall planning of the Kwinana region is the subject of the Kwinana Regional Strategy. This strategy identifies major uses for both the land and water portions of the Kwinana area. The proposed site for the pigment plant lies approximately central to the major southern portion of the industrial area. This location provides an important buffer zone between residential areas and industry. The buffer zone allows the area capacity for dilution of air emissions and separation from risks and hazards so that residents of Western Australia will be able to benefit from an appropriate environmental quality.

2.4 EPA's ASSESSMENT OF THE PROPONENT'S PREFERRED SITE

In its assessment of the proposed 54 000 tpa chloride-process titanium dioxide plant at Kwinana, the EPA makes the following comments.

Kwinana has the general site characteristics for this project as identified by the proponent.

Air emissions will not be a constraint given the commitments made by the proponent and the recommendations in this Report.

As solid waste will be transported back to the minesite for disposal, there should be no problem with solid waste disposal in the Kwinana area.

Two disposal options have been identified for liquid wastes. These are to Cockburn Sound or into the Water Authority's Cape Peron outfall.

The investigation of the risks and hazards arising from this project shows that the contribution from this plant to the overall risks arising from the Kwinana industrial area to the surrounding residential areas will continue to result in total cumulative risks being within the average risk of one in one million per year level considered acceptable by the EPA.

After considering the risks and hazards profile of the plant, expected air and noise emissions, the solid and liquid waste disposal options, and the commitments made by the proponent, the Environmental Protection Authority concludes that the proponent's site for the plant is environmentally acceptable subject to the proponent meeting its commitments and the further requirements of the Authority, as outlined in this Report.

RECOMMENDATION 1

The Environmental Protection Authority concludes that this proposal is environmentally acceptable and recommends that it could proceed subject to:

- **the EPA's recommendations in this Assessment Report.**
- **the relevant commitments made by the proponent listed in Appendix 2 of this Report; and**
- **the provision of a satisfactory Environmental Management Programme.**

The EPA also concludes that regardless of the recommendations, commitments and conditions in this report, the proponent is always responsible for the environmental impacts of the plant.

3. DESCRIPTION OF THE PROPOSAL

The proposal as put forward by the proponent in the ERMP consists of the following:

- Construction of a 54 000 tonnes per year (tpy) titanium dioxide manufacturing plant based on the chloride-process.
- Construction of a 10 000 tpy chlor-alkali plant with three 25 tonne chlorine storage tanks.
- Construction of an air separation plant to supply 30 000 tpy of nitrogen and 35 000 tpy of oxygen.
- The production of 5 000 tpy hydrochloric acid and sodium hypochlorite.
- Disposal of 2 200 megalitres per year (MLpy) of brine effluent either to Cockburn Sound or to the Water Authority Cape Peron outfall.
- Disposal of 20 000 tpy of solid process wastes by landfill at the Cooljarloo minesite.

3.1 RAW MATERIALS AND OUTPUTS

The major inputs and outputs as described in the ERMP and updated by the proponent in the responses to questions are listed in the following tables.

Table 1A. Estimates of major inputs. (Source ERMP)

INPUT	SOURCE	USE	QUANTITY
Synthetic rutile	The proponent's synthetic rutile plant at Muchea	Titanium dioxide (TiO_2) feedstock	63 000 tpy
Water	Water Authority scheme water	Process and cooling	3 000 MLpy
Petroleum Coke	USA or Australia	Reacted in pigment production	20 000 tpy
Salt	Western Australian supplier	Raw material for Chlorine plant	17 000 tpy
Oxygen	Atmosphere	For use in the pigment plant	35 000 tpy
Nitrogen	Atmosphere		30 000 tpy

Table 1B. Estimate of major outputs. (Source ERMP and Proponent's Responses to Submissions).

OUTPUT	USE/DESTINATION	QUANTITY
Titanium dioxide pigment	Markets (paint and plastic)	54 000 tpy
Hydrochloric acid HCl	Market	5 000 tpy
Sodium hypochlorite	Markets (swimming pools)	
Caustic soda	Markets	11 200 tpy
Solid wastes	Mine site at Cooljarloo	
- coke/ore mixture		8 000 tpy
- metal hydroxides		5 400 tpy
- calcium sulphates carbonates		6 000 tpy
Waste water warm brine	Cockburn Sound or Water Authority Outfall at Cape Peron	2 200 MLpy

3.2 UTILITIES

3.2.1 WATER SUPPLY

The proponent is requiring the use of 3000 megalitres per year of water to be drawn from the Water Authority of WA (WAWA) scheme to supply this plant for both process and cooling water.

The current requirement to use scheme water for both process and cooling water purposes in preference to groundwater supplies will ensure that there will be no local impacts on groundwater as a result of the project. Consequently the overall availability of groundwater for other industries within the area, established and proposed, will not be reduced. However, the use of the proposed amount of scheme water is discussed later in this report.

3.2.2 WASTE WATER DISPOSAL

With regard to waste water disposal, two options are currently available to the proponent. These are; to dispose of the effluent to the Water Authority's Cape Peron outfall, or to discharge into Cockburn Sound via a submarine pipeline and diffuser located on the AIS jetty at Kwinana.

3.2.3 ENERGY

Natural gas and electricity are available in the area with only minor additions to the existing power and gas mains.

3.3 TRANSPORT INFRASTRUCTURE AND EXPORT FACILITIES

The Kwinana Industrial Area is well serviced with road, rail and shipping links. The synthetic rutile from Muchea will be off loaded at the Australian Iron and Steel (AIS) rail siding and trucked to the pigment plant. Coke will be shipped to the AIS jetty, stored in covered stockpiles and also trucked, as required to the pigment plant.

Other raw materials will be trucked to the site.

The product will be shipped from the AIS jetty to overseas markets.

3.4 THE PROCESS

The pigment plant is made up of three major components. They are:

- chloride pigment plant;
- chlorine production; and
- air separation plant.

3.4.1 THE CHLORIDE-PROCESS PIGMENT PLANT

The chloride-process for producing titanium dioxide pigment (see Figure 2) consists of the following stages:

Chlorination: Titanium-rich feedstock is reacted with chlorine to produce titanium tetrachloride.

The titaniferous synthetic rutile feedstock is firstly reacted with petroleum coke and chlorine gas at about 1 000° C in a fluid bed chlorinator. Titanium tetrachloride ($TiCl_4$) produced by this process is condensed and purified by distillation. The reaction can be expressed chemically as:

$$TiO_2 + 2Cl_2 + C \rightarrow TiCl_4 + CO_2$$

Purification: Impurities are separated from the titanium tetrachloride.

At this stage residual chlorine gas is scrubbed out of the product stream for the production of hydrochloric acid.

Oxidation: Titanium tetrachloride is reacted with oxygen to produce titanium dioxide.

$TiCl_4$	+ O_2 ------>	TiO_2	+	$2Cl_2$
(Intermediate)	+ (oxygen)	(product)	+	(recovered chlorine gas)

The hot product stream is cooled and the TiO_2 particles collected. The chlorine gas is filtered to remove the last traces of product, then compressed and recycled to the chlorination unit. As a result of this recycling the amount of chlorine consumed by the process is relatively small.

Pigment separation: Produces solid pigment through filtration.

In the treatment and wet milling area the titanium dioxide is mixed with water, ground in a wet mill, treated with small amounts of chemicals, filtered, dried and reground for packaging in 25 kg bags.

3.4.2 CHLORINE PRODUCTION

The chlorine for the pigment plant is supplied from a chlor-alkali plant.

The chlor-alkali process is based on the electrolysis of purified, saturated brine solution to give the following reaction:

$$2\ NaCl + 2H_2O \text{ ------> } H_2 + Cl_2 + 2\ NaOH$$

The simplified block diagram is given in Figure 3. The salt is first dissolved in water to form a brine. The brine is then purified by chemical precipitation and then ion-exchange. Electrolysis takes place in membrane cell electrolysers, producing gaseous chlorine and hydrogen, and caustic soda.

The chlorine gas is cooled to condense out most moisture before being dried with sulphuric acid. It is then compressed and sent to the pigment plant. The plant itself has some chlorine storage (3 x 25 t bullets; with no more than 50 t stored at any time)) to ensure continuous operation during interruptions to power supply. The ERMP reports that the chlorine will be stored under pressure and at low temperature. In the proponents commitments the storage tanks are described as refrigerated. The EPA's requirements for chlorine storage are discussed more fully in Section 6.4.3. The storage tanks will be designed to the standard recommended in the preliminary risk analysis.

The hydrogen gas is to be collected and compressed. Some is to be used to produce hydrochloric acid, some as fuel on-site, and the remainder to be vented to the atmosphere. Small amounts of chlorine and hydrogen will be sent to a hydrochloric acid plant.

Off gases carrying traces of chlorine are piped to the scrubber unit for scrubbing prior to discharge to atmosphere (Figure 3). The chlorine and dilute caustic soda react to produce sodium hypochlorite. The scrubber has an important safety function because of its ability to absorb all the chlorine produced in the chlor-alkali plant for a period of 30 minutes in

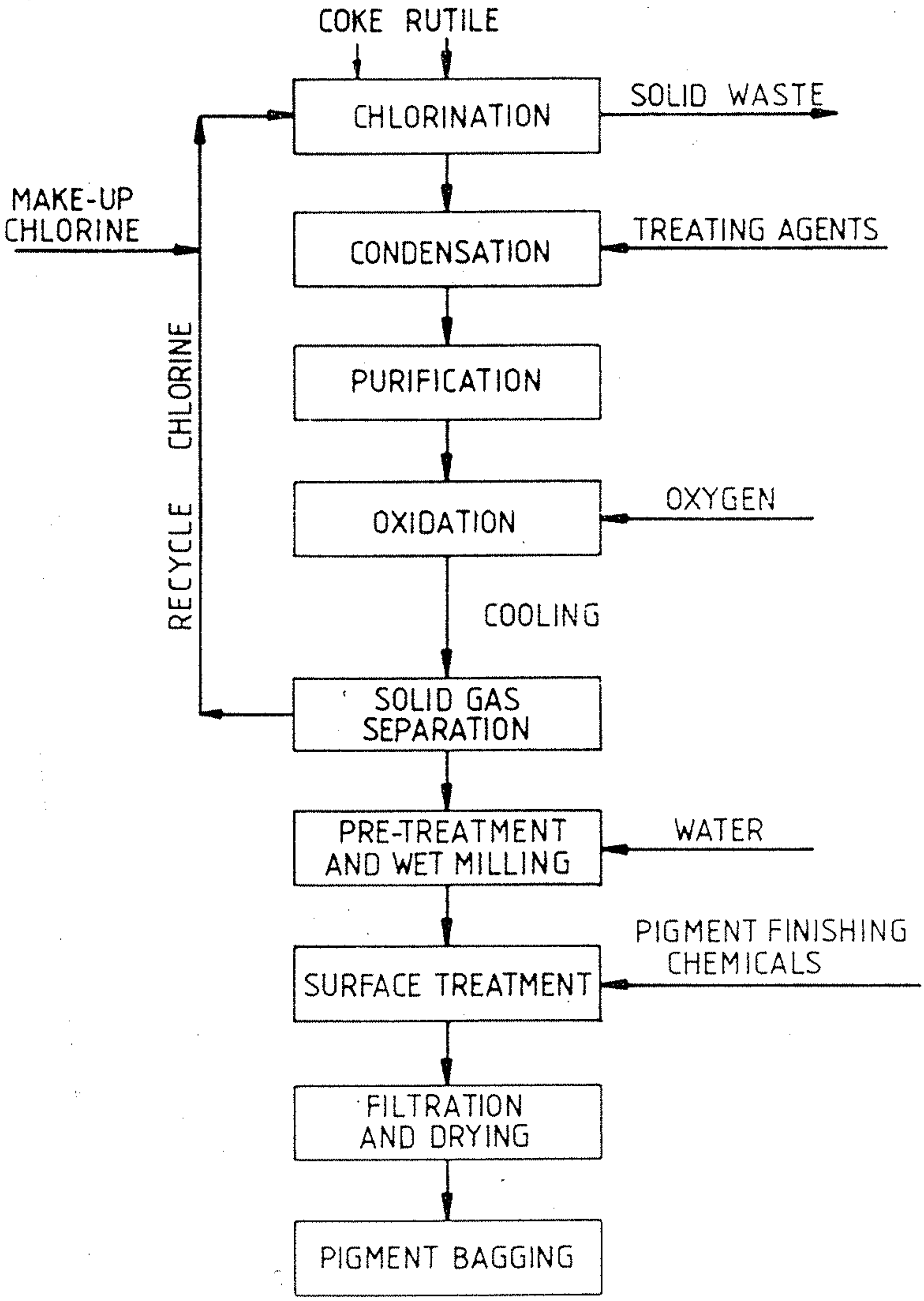


Figure 2. Chloride process and ancillary support processes. (Source ERMP)

the event of a plant malfunction. Excess sodium hypochlorite will be either acidified to recover chlorine with the residue returned to the brine circuit or taken off-site for conversion to swimming pool water treatment chemicals.

3.4.3 AIR SEPARATION PLANT PROCESS

The air separation process involves the extraction and separation of specific gases from the atmosphere. Repeated compression and expansion allow the controlled refrigeration of the air stream to temperatures sufficiently low that the oxygen and nitrogen are successively liquefied and removed for storage. Remaining unwanted gases would be returned to the atmosphere.

3.4.4 THE DESIGN OF THE PLANT

The titanium dioxide process plant will be designed using concepts of layout, equipment and materials selection and process controls, which have been proven with experience. It will be divided into the following five principal process units: (See Figure 4)

- synthetic Rutile and coke handling (Unit 100);
- chlorination of synthetic rutile (Unit 200);
- oxidation of titanium tetrachloride (Unit 300);
- treatment of titanium dioxide and chlorine gas recovery/recycling (Unit 400); and
- utilities and chemical storage (Unit 500).

This plant is similar in design to one operated by Kerr McGee at Hamilton, Mississippi, USA. The chlor-alkali and air separation plant will be operated by other parties either under agreement with Cooljarloo Joint Venture or as freehold.

4. DESCRIPTION OF THE EXISTING ENVIRONMENT

4.1 BIO-PHYSICAL ENVIRONMENT

The proposed location of the pigment plant is in the Kwinana industrial region, the State's major industrial area. The site is east of the existing BP oil refinery. The climate of the area is basically hot, dry summers with easterly winds and cool, wet winters with westerly winds. Climatic data, which are adequately described in the various support documents, were largely derived from the Kwinana Air Modelling Study (Department Conservation and Environment, 1982). This information was used to carry out the preliminary risk analyses and the air pollution study, assessed later in this Report.

The present vegetation on the site is a scattered distribution of coastal sand plain associations, with introduced grasses and weed species. The Authority has assessed the value of the vegetation for conservation purposes as low.

Four aquifers underlie the site. The groundwater varies in quality from generally low salinity at the surface to salinities up to several thousand milligrams per litre in the deeper formations.

The hydrogeology of the site has not been investigated by the proponent. However, the decision not to use groundwater, and the commitments to management of water on-site means that the hydrogeology is not a factor in this assessment.

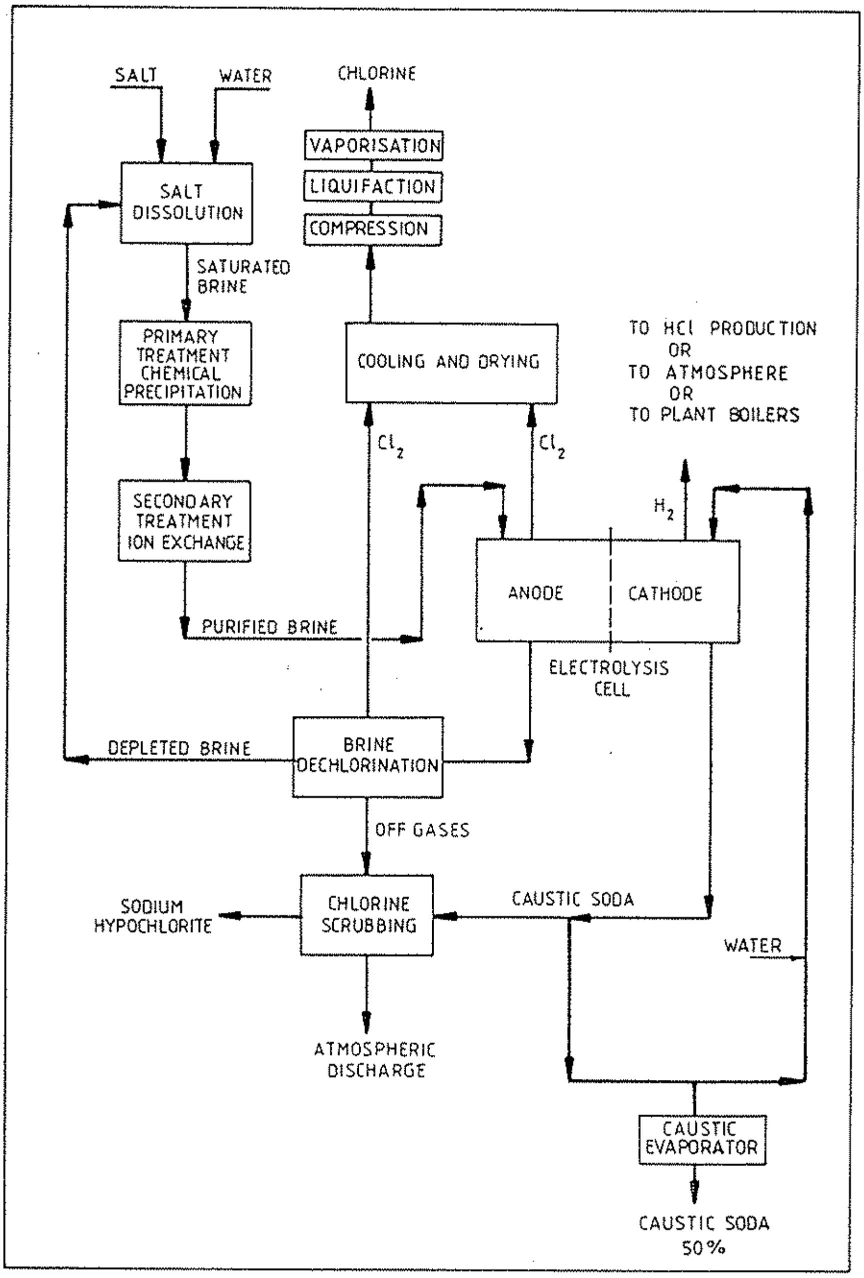


Figure 3. Chlorine Process Flowsheet (Source ERMP).

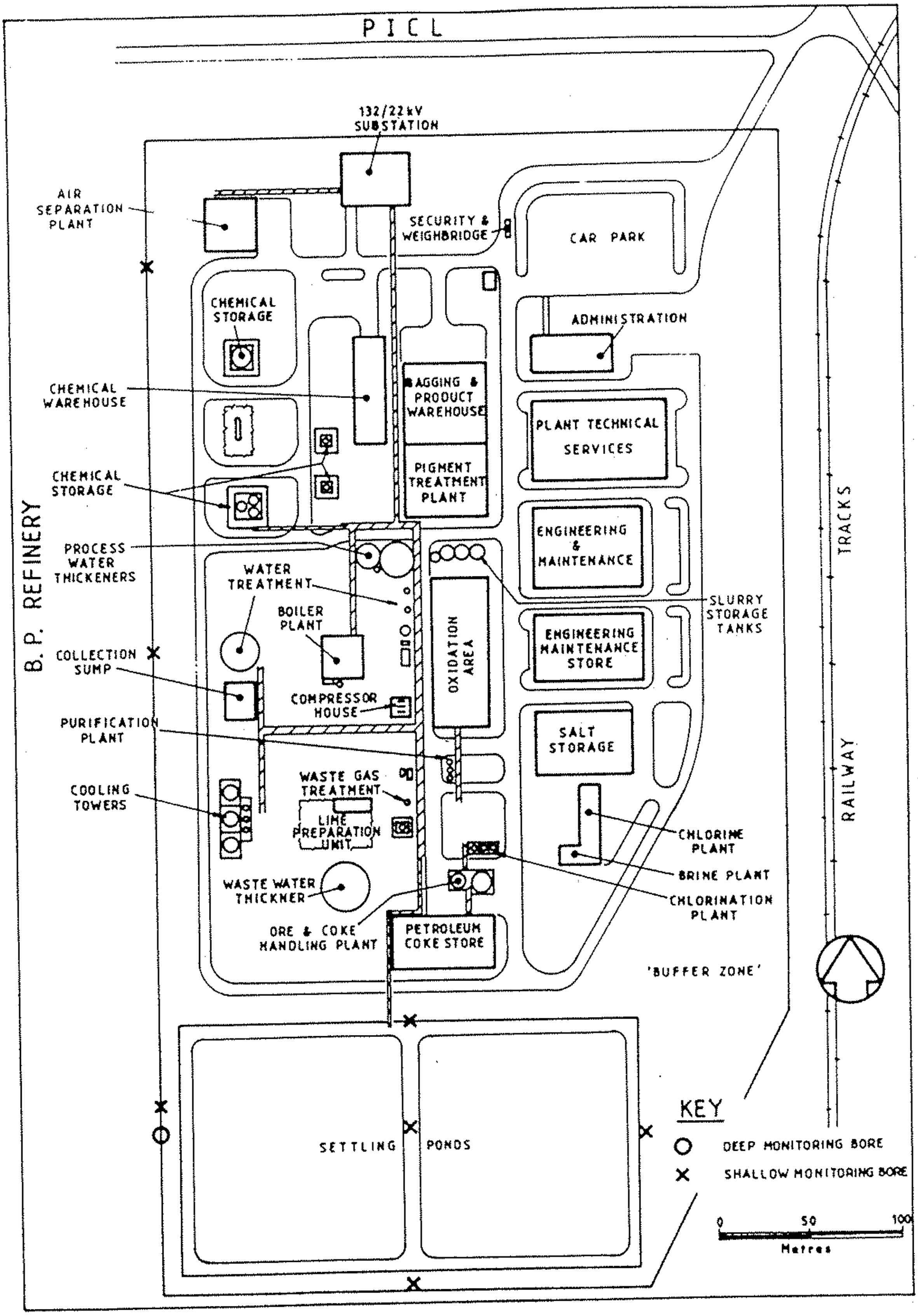


Figure 4. Proposed Plant Layout (Source Proponent's Responses to Submissions).

4.2 LAND USE, ZONING AND TRAFFIC

Figure 1 (taken from the ERMP) shows the general land use and zoning around the project area. The site is appropriately zoned as industrial. The relative locations of other industrial developments are shown in Figure 1.

Kwinana townsite is located 3 km east-southeast. The southern boundary of the Hope Valley residential area is some 2.5 km to the north east of the site boundary. Regional population distribution, trends and the socio-economic profile are described in the ERMP.

Rockingham Road is the present major highway link from Perth and Fremantle to Kwinana and other areas to the south. Access to the site from Rockingham Road is along Mason Road.

4.3 MARINE WATER QUALITY

Water quality in Cockburn Sound has been assessed in the Cockburn Sound Environmental Study (DCE 1975). In addition, recent water quality monitoring undertaken by the EPA and the University of Western Australia has shown a marked improvement in water quality since the study of 1979. It should be stressed however that the Sound is currently in a "state of balance" and that any additional input of pollutants may result in unacceptable impacts upon the marine environment.

The Cockburn Sound environment has a number of beneficial uses including preservation of aquatic ecosystems, fishing, contact recreation, mussel farming and industrial water supply. Within this type of multiple use environment all beneficial uses must be protected. Cockburn Sound is recognised as being of great value to the people of Western Australia and industrial concerns alike. Schedule 7 (3) of Water Quality Criteria for Marine and Estuarine Waters of WA (DCE 1971) lists levels of pollutants and parameters which should not be exceeded within the waters of the Sound. All beneficial uses will be protected if levels listed in the Bulletin are maintained below those stated in Schedule 7 (3). For industries currently or proposing to discharge effluent to the Sound the EPA provides the industry with a mixing zone of fixed area around the exit point of the discharge pipeline. Within this mixing zone beneficial use criteria can be exceeded to within formulated mixing zone requirements. However, outside the mixing zone Schedule 7 (3) criteria must not be exceeded.

Should the proponent wish to discharge effluent to Cockburn Sound Schedule 7 (3) criteria will be expected to be complied with, outside of a mixing zone to be determined by the Environmental Protection Authority. However, approval for discharge into the Sound will be subject to a variety of other considerations including the cumulative impact of the discharge.

Water quality must also be maintained in the open ocean in the vicinity of the Cape Peron outfall. However, the location of the pipeline exit at this location ensures effluent dilution of wastes in an environment which is, in comparison to Cockburn Sound, extremely well flushed. Emissions discharged through the Cape Peron outfall are rapidly diluted and dispersed in the open marine environment.

Water quality in the open ocean environment in the vicinity of the Cape Peron Outfall has been described in the ERMP prepared by the (then) Metropolitan Water Supply, Sewerage and Drainage Board, for the Cape Peron Outlet 1982.

4.4 AIR QUALITY

The Authority considers that the present air quality of the Kwinana area is generally within accepted criteria for those parameters measured to date.

4.5 RISK LEVELS AND PUBLIC SAFETY

'Kwinana Cumulative Risk Analysis - Main Report' (1987) prepared by Technica for the Department of Resources Development, indicates the Individual Risk levels due to present, and proposed (at that time), industrial developments in the Kwinana area. It shows that background risk levels in residential areas due to industrial developments are below the one-in-one-million per year level which is considered to be within the range of risk that has previously been determined to be acceptable by the Environmental Protection Authority (see EPA Bulletin 278). Updates of this study are carried out for new proposals on a cumulative basis. The most recent update which includes both this project and the proposed integrated petrochemical plant shows that risk levels are acceptable.

4.6 NOISE LEVELS

In its assessment of noise emissions from industrial developments the EPA considers that the noise standards of the Assigned Outdoor Neighbourhood Noise Levels from the noise regulations under the Environmental Protection Act 1986 provide guidance to the maximum noise level appropriate to a range of situations. These are not design criteria but represent the point beyond which the EPA may prosecute an industry if the noise levels produced exceed the standard.

In residential areas outside the Kwinana Industrial area buffer zone the maximum acceptable background noise levels are:

Day time	45 dB(A).
Night time	35 dB(A).

In the ERMP the proponent has indicated background noise levels in the vicinity of the potentially affected Hope Valley residential area were:

Day time	41 dB(A).
Night time	34 dB(A).

This indicates that in the Hope Valley area noise levels are only marginally below the maximum acceptable levels for purely residential areas.

5. REVIEW OF PUBLIC SUBMISSIONS

A total of 18 public submissions were received as a result of the public review phase of the ERMP.

The principal issues raised in the public submissions are outlined below, in order only of the frequency of comment.

1. RADIOACTIVITY

1. All radionuclides entering the process and eventually being disposed of must be accounted for.

2. Equipment should be regularly monitored for radioactive build-up and a plan for disposing of contaminated waste materials must be produced.

3. The Company should develop a radiation management plan.

4. Radiation levels of solid/liquid waste should conform to requirements of the Radiation Safety Council and a plan submitted.

5. Disposal of radioactive wastes in a tailings pond on-site is hazardous to people living in the region and to the local of intended disposal of radioactive wastes.

6. Radioactive wastes should not be transported to the goldfields for disposal, making WA an international waste disposal site.

7. Transporting radioactive materials for export or disposal is dangerous.

8. Suitable methods of disposing of mildly radioactive filters and boiler scales must be found before production commences.

9. The proponent should indicate how all types of radioactive wastes will be disposed of.

10. The proponent should explain how the problem of radioactive contamination of the rutile end product will be overcome.

11. The build-up of residual radioactivity in the chlorinator brick work/bed should be monitored.

2. SAFETY

1. The proponent's assessment of radiation and safety issues is adequate

2. The proposed plant should be subject to assessment by the Inter Departmental Committee under the Safety Coordinator in the Hazardous Goods Section of the Mines Department.

3. Large quantities of hazardous chemicals should not be stored on-site. Storage vessels should be reinforced and bunded, and an integrated disaster management plan for the Kwinana Industrial Strip is essential.

4. Care should be taken to ensure that no disasters are caused by explosive and toxic gases.

5. This proposal should not be approved pending the long awaited integrated emergency plan for the area.

6. The proposed plant will use highly toxic and explosive chemicals. It is too hazardous and will increase the disaster risk in Kwinana.

7. The industry is highly toxic, flammable and explosive; it is potentially very hazardous.

2. SAFETY (Cont'd)

8. The proponent should assure maximum safety during operation of the electrolyser in view of the danger of hydrogen/chlorine explosions.

9. The proponents commitment to safety management and safety audits should be adhered to. Emergency procedures should be coordinated with the integrated Kwinana Emergency Plan.

3. ANTI-POLLUTION PRECAUTIONS

1. A sulphur recovery unit should be fitted to the principal plant stack if sulphur emissions are likely to occur.

2. Titanium tetrachloride and chlorine emissions should be controlled and monitored.

3. Additional scrubbers and after-burners should be installed to eliminate the risk of air pollution.

4. A variety of monitoring and backup safety devices should be installed, including de-watering and monitoring bores, stack emission monitors and backup scrubbers which will operate even in the event of power failure.

   Special attention should be paid to liquid and gaseous effluents because of their potential to cause serious pollution.

5. Adequate de-watering capacity is required to prevent pipe-line ruptures from contaminating the groundwater and to prevent contamination plumes from polluting Cockburn Sound.

6. Hydrogen gas produced should be used, wherever possible, to produce hydrochloric acid and steam with minimal discharge to the atmosphere.

7. Concern is expressed over hydrogen sulphide odours emitted from the plant. The plant should be fitted with an after-burner.

4. EFFLUENT DISCHARGES

1. All spillages must be contained with concrete aprons using sealed settling ponds and regular monitoring wells to confirm that seepage is not occurring.

2. No liquid effluent quality values are given for the plant.

3. The Kwinana Plant must conform to effluent discharge standards before WAWA will accept the proposal.

4. The effect of the brine solution on the overall effluent quality needs to be determined to allow adequate assessment.

4. EFFLUENT DISCHARGES (Cont'd)

5. The main environmental matters from a chemical perspective are emissions of gases and disposal of solid and liquid wastes. The Royal Australian Chemical Institute does not foresee any problems arising out of combinations of chemicals being disposed of.

6. The dispersal modelling results compare unfavourably with cited Victorian EPA standards in some instances.

5. EMISSIONS TO THE ATMOSPHERE

1. The emissions from this proposal should be considered in the regional context, not in isolation.

2. Projected levels of sulphur dioxide and chlorine emitted are unacceptably high and will need to be lowered.

3. Any discharge to the environment should take into account existing and projected disposal loads as well as that expected from the chlorine-titanium dioxide plant.

4. The plant will add to cumulative pollution in the Kwinana area.

5. No mention is made of dust emissions caused by loading and unloading ships and railcars.

6. WASTE DISPOSAL

1. Inert wastes and plant trash should be disposed of as directed by the Town of Kwinana.

2. Details on sewerage treatment and disposal should be provided to the Department of Health unless connection to deep sewer is intended.

3. Chemical changes that have occurred in the reactants during processing may render them unsuitable for disposal at the minesite at Cooljarloo because nuclides are now more mobile.

4. Waste disposal at Cooljarloo should not lead to increased levels of groundwater nuclides or to increased levels of salinity.

7. EFFLUENT DISCHARGE TO COCKBURN SOUND

1. Liquid waste should not be disposed of in Cockburn Sound. If liquid waste is to be disposed of in the ocean it should be piped to the open sea.

2. Effluent discharges to Cockburn Sound should meet EPA standards.

3. Discharge of liquid effluent to Cockburn Sound would need to be sanctioned by the EPA.

4. Concern was expressed over the impact of the project on groundwater quality and impacts of leakages on Cockburn Sound.

REVIEW OF PUBLIC SUBMISSIONS (Cont'd)

8. WATER CONSUMPTION

1. Water use by the project will place excessive demand on available scheme water. Other sources of water, preferably recycled, will have to be found.

2. The plant will use large quantities of high quality water which will place excessive demand on resources of the Jandakot Mound. Recycled water should be used as an alternative in this industry.

3. The proposed plant will use large quantities of high quality water.

4. The proponent should indicate the proportion of scheme water required to be treated prior to use for production.

9. TRAFFIC

1. In view of the increased heavy vehicle traffic involved in supplying raw materials for the project, the developer should engage with others in a road improvement programme to service the area.

2. Rail transport should be used, particularly for moving hazardous goods.

3. The plant may increase traffic delays in the area. These delays may not be tolerable and staggered shift changes may therefore be desirable.

4. There are some inaccuracies in the "current" and "predicted" traffic volumes presented in the ERMP.

10. PLANT NOISE

1. Noise emissions should be suppressed and monitored once the plant is operating.

2. Levels of noise emissions should be minimised.

3. The plant will be a source of noise and air pollution.

4. There is a likelihood that the actual noise level may be somewhat higher than that predicted in the noise assessment.

11. SETTLING PONDS

1. A "pump-back" facility is recommended to maximise the capacity of the emergency settling ponds.

2. The ERMP does not provide figures for the depth of settling ponds required to contain three weeks' liquid effluent as would become necessary in the case of prolonged malfunction of filter units.

3. Comments are sought from the proponent in relation to the capacity of the evaporation ponds to cater for prolonged periods of effluent intake in the high rainfall winter months.

REVIEW OF PUBLIC SUBMISSIONS (Cont'd)

12. MONITORING PROGRAMMES

1. The EPA should insist on a continuous monitoring programme of the air, groundwater and level of noise.

2. Continuous monitoring procedures for hydrogen sulphide and an established emergency procedure should be mandatory.

13. PLANT SITING

1. The plant should be located at Narngulu.

14. OPERATIONAL INFORMATION FROM THE HAMILTON, MISSISSIPPI, (USA) PLANT

1. Information about plant operation derived from the Hamilton Plant cannot be assumed to be directly applicable to the Kwinana Plant. Specific information should be supplied for the Kwinana Plant.

15. MINING

1. Mining rare earth is dangerous and rehabilitation techniques are not yet proven to be satisfactory.

16. POWER REQUIREMENTS

1. Assurances are sought that SECWA can supply sufficient power in view of expanding residential and industrial development in the area.

The issues identified above have been included in the Authority's assessment of the project, and many have been included in questions to the proponent (see Appendix 1).

In Table 2 below the major issues identified in the public submissions are listed with corresponding responses and/or changes to the project arising from the Environmental Protection Authority's environmental impact assessment process.

6. ASSESSMENT OF ENVIRONMENTAL IMPACTS

6.1 INTRODUCTION

The Authority considers that as the principal issues of:

- risks and hazards;
- air emissions;
- solid waste disposal;
- radiation; and
- liquid effluents;

can be satisfactorily managed general approval can be given to the proposal but with a requirement for a follow-up Environmental Management Programme (EMP) to deal with other aspects of the proposal in more detail. This EMP must be to the satisfaction of the Authority, and this requirement will be reflected in the works approval and licence conditions imposed by the Authority. The EMP will be made public by the Authority, together with the Authority's review of it. The function of the EMP is further discussed in Section 7.

Table 2. Responses to issues arising in Proponent's Response to Submissions.

Radioactivity	The Radioactive component in the raw material, product and waste materials is very low. The proponent will prepare a radiation management programme.
Safety - Risks and Hazards	The project has been the subject of extensive analysis of risks and hazards arising from this plant. The risk of danger to life are within the EPA criteria. Chlorine store is the subject of a specific recommendation by the EPA.
Effluent Discharge	Back up power supply and duplicate treatment systems will be provided.
Wastewater Discharge	Wastewater discharges will not diminish the beneficial uses of the receiving waters.
Air Emissions	The proponent is installing an incinerator (with backup) and SO_2 scrubbing. Process and emergency vents will be scrubbed to prevent release of chlorine or $TiCl_4$.
Solid Waste Disposal	The EPA is requiring further reporting on disposal of solid waste. The disposal site at the Cooljarloo mine will be monitored.
Water Consumption	The EPA is requiring further reporting on ways of reducing water consumption.
Noise	The EPA is requiring reduction of operating noise.
Monitoring	The EPA is requiring the preparation of an Environmental Management Programme.

6.2 CONSTRUCTION STAGE IMPACTS

The construction phase is planned to take 24 months. It is expected that the principal impacts during this period will result from:

- generation of noise;
- generation of dust; and
- water runoff and waste effluents.

Noise generation will be restricted by confinement of construction activities to 0700 to 1900 hours for six days per week. (Monday to Saturday inclusive).

The ERMP does not give details of how dust will be minimised during construction or how water runoff and waste effluents will be controlled.

The EPA considers that the proponents plans to control dust, minimise noise and control runoff, wastes and effluents , should be detailed in the EMP.

RECOMMENDATION 2

The Environmental Protection Authority recommends that the proponent include in the Environmental Management Programme (referred to in Recommendation 21) a plan to minimise construction stage impacts including noise, dust from site works and site run off. This programme should be to the satisfaction of the Environmental Protection Authority before construction begins.

6.3 COMMISSIONING STAGE IMPACTS

The commissioning stage of a project can be difficult, in that the plant is being 'tried out' for the first time. It is at this stage that various untoward emissions (atmospheric, liquid and noise) may occur. The Authority requires details on, and methods of coping with, such potential commissioning stage impacts; to be submitted to it for approval before commissioning. This should include recognised constraints on start up such as time of day and prevailing atmospheric conditions. These details are to be included in the Environmental Management Programme.

RECOMMENDATION 3

The Environmental Protection Authority requires that there are no unacceptable impacts from sources such as air emissions and effluent discharge during startup of the plant. The Environmental Protection Authority recommends that the proponent include in the Environmental Management Programme (referred to in Recommendation 21) details of management provisions which will be used to minimise startup impacts. This programme should be to the satisfaction of the Environmental Protection Authority before commissioning begins.

6.4 RISKS AND HAZARDS IMPACTS

6.4.1 INTRODUCTION

A preliminary risk assessment as required by the EPA has been carried out for the pigment plant on behalf of the proponent, and was published as Volume 2 of the ERMP. Guidelines for the preliminary risk assessment appear as Appendix 1 of the Preliminary Risk Assessment.

The following assessment of the preliminary risk assessment is based on Volume 2 of the ERMP and the responses by the proponent to questions raised by EPA. These responses are included in this Report as Appendix 1.

Well-established hazard analysis techniques were used in the preliminary risk assessment:

- 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 the cumulative levels already calculated for the Kwinana area, and appears as Figure 5 of this Report. The cumulative risk levels were then evaluated against the criteria adopted by the EPA.

Details of the preliminary risk assessment, and the Authority's assessment of the results, are presented in the following sections.

6.4.2 INCIDENT IDENTIFICATION

The hazardous materials to be handled on the site were identified as chlorine, titanium tetrachloride, hydrogen, hydrogen chloride, sulphuric acid, caustic soda and LPG.

The toxic effects of chlorine and hydrogen chloride are well-known and are documented in the preliminary risk assessment and other public documents. Titanium tetrachloride is formed as an intermediate compound in the production of the pure titanium dioxide pigment. It is hazardous mainly because it reacts with water (including that in air), to produce hydrogen chloride and titanium oxychlorides.

The other materials are not present in sufficient quantities or in a form which could result in off-site effects. Therefore, they are not considered further in the preliminary risk assessment. This approach is acceptable to the EPA.

Processes which could lead to releases of hazardous materials include chlorine manufacture, conversion of synthetic rutile to titanium tetrachloride, and oxidation of titanium tetrachloride to titanium dioxide with recirculation of the released chlorine. There are significant storages of chlorine and titanium tetrachloride on site which must be considered in the analysis.

The whole plant was analysed to identify all possible failures which could result in loss of hazardous materials. The list was culled to identify 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.

In identifying possible failure incidents, and later in assigning failure frequencies, the consultant look 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.

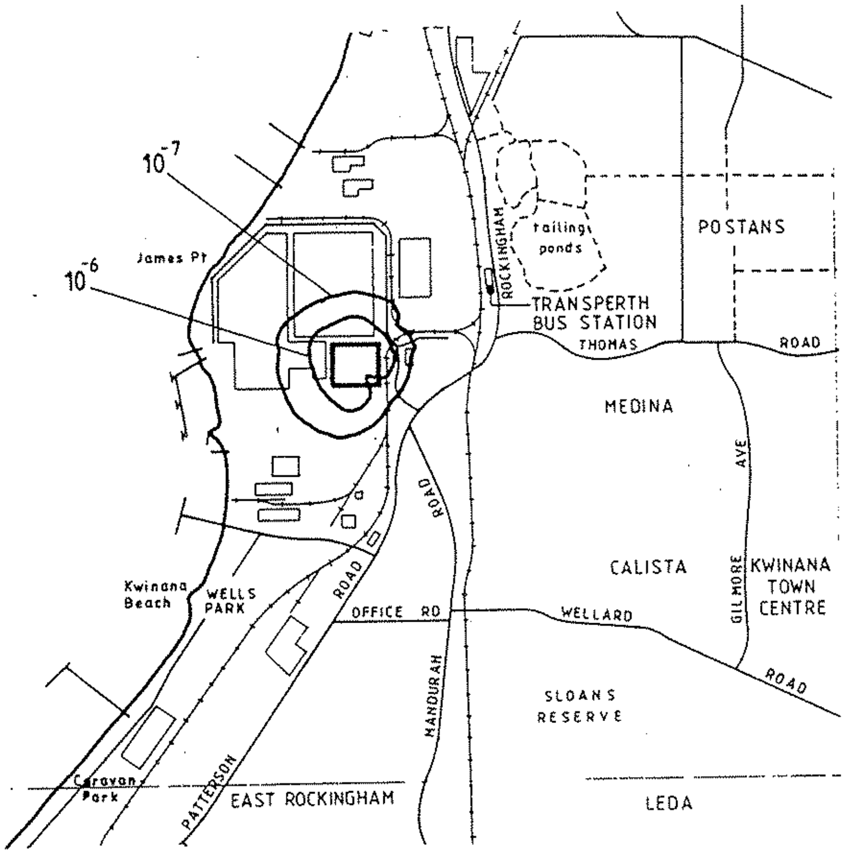


Figure - 5A. Individual risk contour for proposed plant. (Source ERMP.)

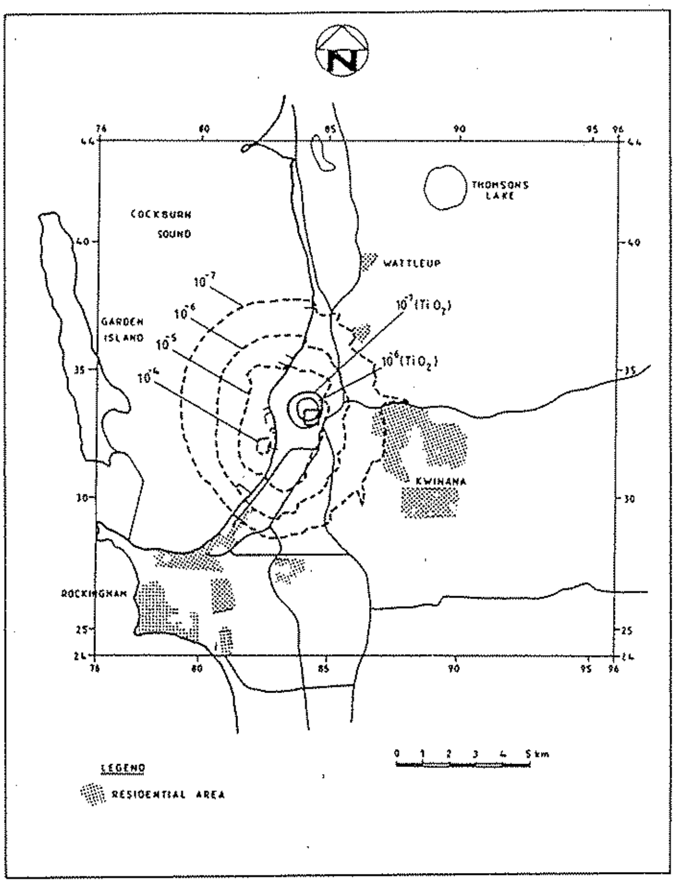


Figure - 5B. Superposition of Individual Risk Contours on existing contours including the proposed PICL plant (Source ERMP.)

Part of this 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 advised that separation distances and other safeguards are adequate to prevent this.

The proponent's consultant also has shown that there is no potential for effects of explosion overpressures or of heat radiation beyond the site.

The above process resulted in a final list of eight failure cases given in Table 3. The Authority is satisfied that the list is comprehensive, and adequate for the preliminary risk assessment.

6.4.3 RISK ESTIMATION

The consequences for each incident listed in Table 3 were analysed by the proponent's risk consultant. In this case, the release rate of toxic gases was combined with meteorological factors to give plume dispersion for all weather conditions. The methods used are acceptable to EPA.

Known toxicity relationships have been used to give the probability of fatality at each point in the plume. The Authority accepts the relationships used in the preliminary risk assessment.

The above results were then multiplied by the probability of wind in each direction. The proponent has used the same weather information as used for all other studies in the Kwinana area.

By reviewing the safety records of similar facilities, and combining with other data on pipe, process and storage failures, an analyses was made of predicted failure frequencies. Those used in this study are different from those used for other plants assessed by the EPA. However, they are sufficiently justified to be acceptable to EPA. The analysis carried out as part of the cumulative risk study resulted in similar risk levels, and led to the same conclusion on environmental acceptability. The failure frequencies used are listed in Table 3.

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 fatalities per million years. Figure 1.1 of the preliminary risk assessment presents the overall result.

The risk contours for this plant were integrated on the existing risk contours, including the proposed Integrated Petrochemical Plant, reported on in EPA Bulletin 331. This is shown in Figure 1.2 of the preliminary risk assessment. The pigment plant is not a significant contributor (less than one percent) to the risk at this level. It also shows that the plant meets the criterion of a cumulative risk level of less than one-in-one-million fatalities per year at the nearest residential areas.

The risk levels from this proposed plant have been incorporated into the cumulative risk analysis carried out for the Kwinana area. To do this the risks for the pigment plant were recalculated using the SAFETI computer package. The results are similar to those produced by the proponent's consultant and show that the cumulative risk levels meet the EPA criterion for risk levels at residential areas.

Table 3. List of Hazardous Incidents Considered in the Study. (Source Proponent's Responses to Submissions):

INCIDENT NO.	EVENT	MATERIAL	RELEASE RATE (kg/s)	DURATION (mins)	FREQUENCY (PER YEAR)
1.	Catastrophic failure of chlorine storage tank	Chlorine	11.6	5	6.0×10^{-9}
2.	Chlorine storage to vaporiser pipe failure (50 mm hole of fracture)	Chlorine	3.3	5	1.3×10^{-8}
3.	Chlorine storage tank, 50 mm hole	Chlorine	1.19	30	9.6×10^{-9}
4.	Titanium tetrachloride pump casing failure	HCl	1.4	20	3.6×10^{-5}
5.	Chlorine storage tank, 25 mm hole	Chlorine	0.33	30	9.0×10^{-5}
6.	$TiCl_4$ release from - crude $TiCl_4$ quench - surge tank failure - crude $TiCl_4$ surge tank facilities - crude $TiCl_4$ storage tank facilities	HCl	0.65	20	9.0×10^{-8}
7.	Failure in recycle piping between oxidiser and chlorinator Chlorinator trip and scrubber failure	Chlorine	0.6	5	1.45×10^{-4}
8.	Chlorine storage tank, 25 mm hole - chlorine cells to header pipe failure - chlorine compressor to liquefier pipe failure - chlorine liquefier to storage pipe failure - chlorine vaporiser to chlorinator pipe failure	Chlorine	0.33	5	1.61×10^{-4}

Since the ERMP was released, the proponent has proposed to install two chlorine scrubbers in series, with each scrubber having the capacity to absorb all chlorine at the full production rate. This has been accepted by EPA as a commitment, and effectively eliminates chlorine storage failure as a significant risk. This means that the risk levels are over-predicted in the ERMP by a large margin.

The ERMP does not describe in detail the proposed method of storage of chlorine. The ERMP indicates that the chlorine will be manufactured on-site then compressed and condensed in a liquefaction unit to -34°C before being fed to on-site storage of three 25 tonne pressure vessels. A maximum of 50 tonnes will be held across these three vessels at any one time. The EPA considers that 50 tonnes of stored chlorine is acceptable. However, there should be one tank empty at all times to receive the total contents of one tank in the event of a leak.

In the revised commitments the proponent says that the chlorine storage tanks will be refrigerated and has made other commitments to safeguard the storage of chlorine in the Responses to Public Submissions. The EPA considers that storage of this quantity chlorine under pressure as unacceptable and that refrigerated storage should be utilised.

The EPA believes that the safeguards for this plant should be comparable to those implemented at similar plants in the Kwinana area. This includes complying with Australian standard 1210 as a minimum construction standard, and should be designed in accordance with the "best modern standard" as described in Harris (1987). This means that any spills of chlorine from storage will be directed to a closed well, from which chlorine vapour is vented to a caustic scrubber for destruction.

RECOMMENDATION 4

The Environmental Protection Authority recommends that chlorine should be stored with comparable safeguards as have been implemented at other modern plants in the Kwinana area.

This includes:

- **no more than 50 tonnes of chlorine to be stored in three 25 tonne containers;**

- **the containers will hold the chlorine in liquid form in a refrigerated state;**

- **one tank shall be left empty at all times in a ready state to receive chlorine;**

- **full height bunding, roofed and vented to chlorine scrubber;**

- **insulation tiles in the bunds;**

- **foam suppression system; and**

- **isolating values on the main storage tanks and process items. Storage isolation values require two actuation points;**

6.4.4 COMPLIANCE WITH EPA GUIDELINES

The PRA complies with "EPA Guidelines for a Preliminary Risk Analysis" as contained in Volume 2 of Appendix 1. The risk levels comply by a large margin with the criterion for cumulative risks to life from industrial developments to be less than "one per one million fatalities per year" in residential areas. The Authority concludes that the proposal is acceptable from the point of view of risk to the community.

The proponent's risk consultant has identified the major reasons for the low risk as:

. the licensing company's 24-year experience in the design and operation of titanium dioxide pigment plants with continued improvements in design; and

. state-of-the-art technology to be adopted for chlorine storage, incorporating refrigerated storage, special storage design, fully enclosed tank area, pit venting to a caustic scrubber, and chlorine detectors and alarm system.

6.4.5 RISK MANAGEMENT STRATEGY

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

The proponent's consultant made the following general technical and management recommendations for effective and responsible risk management:

. a hazard and operability (HAZOP) study be undertaken at the detailed design stage;

. a physical check that the results of the HAZOP study are incorporated in the plant;

. pre-commissioning safety inspection;

. post start-up check;

. a full set of safety management systems be developed for the facility, including a system of periodic safety audits;

. re-evaluation of process risks at final design stage;

. an emergency plan be developed for the plant, including catering for possible emergencies at adjoining facilities, and that this plant be integrated into the Kwinana Integrated Emergency Management System being developed at present; and

. a fire safety study be carried out for the facility.

It is noted that the proponent has given a commitment to incorporate these features in the proposed pigment plant. They form the basis of a hazard identification and risk management programme for the project.

RECOMMENDATION 5

The Environmental Protection Authority recommends that the proponent include in the Environmental Management Programme (referred to in Recommendation 21) a comprehensive hazard identification and risk management programme in consultation with the Department of Mines and to the satisfaction of the Environmental Protection Authority.

The comprehensive hazard identification and risk management programme should include, but not be limited to, the following;

1. safety engineering design;

2. quantified risk assessments;

3. hazard and operability studies (HAZOP) 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 for assessment and also be forwarded to the Department of Mines.

In the event that the Environmental Protection Authority finds that the results of the programme are unacceptable, the proponent shall be required to modify its process and/or operations.

This recommendation applies to the Chlor-alkali Plant and the Titanium Dioxide Plant. The Air Separation Plant and Utilities do not involve significant hazards.

The EPA also considers that it is essential to ensure the reliability and safety of process equipment, instrumentation and alarm systems.

RECOMMENDATION 6

The Environmental Protection Authority recommends that the proponent shall:

- maintain the process equipment, instrumentation and alarm systems consistent with the safety and reliability assessment of the plant;

- minimise the risk of damage to electrolytic cells as a result of fire or explosions; and

- install very high integrity instrumentation in the control of the plant and in the detection and response to any unplanned releases

to the satisfaction of the Environmental Protection Authority on the advice of the Department of Mines.

An appropriate risk management and accident prevention policy is also required for the plant. The risk consultant has recommended that the corporate safety policy of the Kerr McGee Chemical Corporation (one of the joint venture partners) should be adapted to the requirements of the plant.

The consultant also recommended that formal written policies should be developed in the following areas:

. safety;
. emergencies;
. health Protection;
. environmental protection; and
. toxic substances.

The consultant has recommended that the safety policy should commit the joint venturers to the safety of employees and resources as a prime consideration in all operations and activities. Management systems should be developed and established for implementing the policy through the following measures:

. maintaining safe work practices and safe work environment;

. active involvement of Kerr-McGee corporate safety services department to assist operations personnel in developing, coordinating and maintaining effective safety programmes at the Kwinana Pigment Plant;

. an accident incident reporting and investigation system;

. accident prevention programmes;

. clearly defined responsibilities for divisional managers, factory managers, supervisors and other employees for effective implementation of safety policy;

. compliance with all governmental regulatory requirements through design, inspection and audit; and

. procedures for safe handling of toxic substances on-site.

In addition, a safety handbook outlining the safety policy, personal conduct, use of safety equipment and safe work procedures should be distributed to every employee of the Kwinana Pigment Plant and it should be ensured that the employees read and understand the contents of the handbook.

Safety training should be provided to ensure the effectiveness of policy implementation.

The proponent has given a commitment to adopt the consultant's recommendation.

The implementation of a 'Permit to Work' system for contractors is also required, as many accidents on industrial sites are caused by non-site, contractual personnel, who are not involved in the training requirements for those working on the site full time.

The proponent should follow good engineering and management practices and employ suitably qualified personnel as part of the total safety package for the design, construction and operation of the proposed plant. Rigorous operator and maintenance personnel training for the plant is also required.

The proponent should develop detailed written procedures covering all process work, including start-up, shutdown, plant testing, plant modification, inspection and emergency action. These shall be made available on request for inspection by relevant government agencies.

In ensuring the safe operation of the complex, the proponent should liaise with the Safety Coordinator in the Mines Department. The Environmental Protection Authority also considers that the proponent should develop appropriate staff training and procedures manuals prior to commissioning.

6.4.6 EMERGENCY RESPONSE

Emergency response requirements can be categorised as:

- plant emergency response; and

- regional emergency response.

A plant emergency plan will need to be developed, and this has been recommended by the risk consultant The risk consultant also recommended that a fire safety study be carried out. This study would include the fire hydrant system and fire extinguishers.

The proponent will be required to liaise with emergency response organisations (eg State Emergency Service, Police, WA Fire Brigade) in order to ensure that the plant emergency plan is compatible with their equipment and operational requirements.

Some submissions to EPA noted the potential difficulty of access to, and egress from, the plant site, or to the jetty, in the event of an emergency. Mason Road is the only road servicing a number of industries, including BP Refinery, BHP, Wesfarmers LPG plant, Nufarm, and the proposed petrochemical plant. It is clear that other access points are required. The Authority is aware that this matter is currently under discussion by government agencies.

Greater effort in regional planning for emergency response is required. In its assessment of the ammonia/urea proposal (Bulletin 309) the Authority recommended the development of an integrated Kwinana Emergency Plan.

The need for such a plan was re-emphasised by the Authority in its assessment of the petrochemical plant (EPA Bulletin 331).

The Authority is aware that the State Government has initiated mechanisms for the development of a regional emergency plan. However, implementation needs to be expedited given the recent start-up of several plants in the area with their own requirements to link into such a regional contingency plan.

RECOMMENDATION 7

The Environmental Protection Authority recommends that, prior to commissioning, the proponent develop and implement, to the satisfaction of the Environmental Protection Authority and relevant agencies, a plant 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 (KIEMS).

6.4.7 CONCLUSION

The Authority concludes that the risk levels imposed on residential areas by the proposed pigment plant, when added to those levels which exist at present, are so low as to be acceptable and meet the criterion adopted by the Authority in Bulletin 278. This conclusion is subject to adherence to the commitments made by the proponent (listed in Appendix 2) and to the recommendations made above.

6.5 WATER SUPPLY AND WASTE WATER DISPOSAL IMPACTS

6.5.1 WATER SUPPLY

The proponent has a stated requirement for the use of 3000 megalitres per year of scheme water. The EPA is concerned that this proposed water usage, in concert with other large industrial water uses proposed for the Kwinana area, could represent a comparatively large demand on Perth's currently available water resources. This quantity of water represents approximately one quarter of the projected water production from the proposed extension to the North Dandalup dam. Consequently the EPA does not consider that such a resource should be allocated on the basis of providing water to meet any demand without a full and investigation by the potential user of ways of minimising water requirements or utilising other water resources other than that available through the Water Authority scheme.

In the additional information supplied to the EPA the proponent states:

> "The pigment plant requires 3000 megalitre per year (340 m^3/hr) of water, 132 m^3/hr of which will be treated for use as process water, The majority of the treated water will be used in the Chemical Treatment and Utilities Units. The untreated water will be used for cooling water and other plant water needs".

The EPA questions the requirement to use 208 m^3/hr of scheme water for cooling and other plant water needs and considers that there may be other more appropriate sources of supply of water for these purposes.

The EPA is also aware of investigations under way for a major water recycling project using treated sewerage effluent as a feed source for industry in the Kwinana area.

RECOMMENDATION 8

The Environmental Protection Authority recommends that during the detailed design stage the proponent examines ways of reducing its water consumption and submits a report of this examination to the Environmental Protection Authority and the Water Authority of WA for their assessment prior to commissioning of the plant. Furthermore, the Environmental Protection Authority recommends that in the event of a major water recycling project commencing in the Kwinana area, the proponent should utilise this water if required to do so by the Ministers for Environment and Water Resources and the Minister Administering the Mineral Sands (Cooljarloo) Mining and Processing Act 1988.

6.5.2 WASTEWATER AND DISPOSAL

There are two major sources of liquid wastes:

- brine effluent from the Wastewater Treatment Plant; and
- stormwater.

The proponent has supplied figures related to the quantity and quality of liquid wastes to the EPA both within its ERMP and in its responses to EPA questions. The impact of these pollutants upon the environment will be dependent upon which disposal option is used by the proponent. Options for disposal include via submarine pipeline to Cockburn Sound or via the existing Cape Peron ocean outfall.

Approximately 6 megalitre per day of wastewater will be generated on-site. Liquid wastes from the pigment plant make up 94% of the total liquid waste. The chlorine plant effluent is responsible for the 6% balance. The composition of these streams are summarised below in Table 4.

The presence of radio active elements in the liquid effluent stream is discussed in the Section dealing with Radioactivity.

Table 4. Liquid effluent composition (parts per million) (Source ERMP and Proponent's Responses to Submissions.)

ANIONS AND CATIONS	PIGMENT PLANT	CHLORINE PLANT
Na	1 900	103 000
Cl	6 500	91 000
SO_4	300	33 000
ClO_3	-	2 400
Ti	0.21	-
Al	1.0	-
Cr	0.2	-
Fe	2.0	-
Nb	0.03	-
Mg	4.0	-
Mn	1.0	-
V	0.03	-
Zr	0.01	-
pH	6.5-8.5	>7
Solids ($CaCO_3$ $Mg(OH)_2$)	-	Approx <40 000
Temperature	35°C	<50°C
% of effluent flow	94%	6%
Quantity	2068 Megalitre per year (MLpy)	132 (MLpy)

Since the ERMP was released the proponent has revised the wastewater scheme for the pigment plant. The revised scheme is shown in Figure 5. The modification is designed to enhance the recovery of solids from the process.

The treatment system receives slurry from the pigment washing and filtering area. The slurry initially passes to a solids thickener where solids are settled out of solution. Solids from this area are returned to the process whilst the liquid fraction is directed to a neutralisation tank where lime is added to precipitate heavy metals. The resulting solids are then removed prior to disposal by landfill. The clarified effluent is directed to a surge tank which directs the treated effluent to one of two lagoons. These lagoons will be lined with impervious membranes and occupy an overall area of 30 000 m^2.

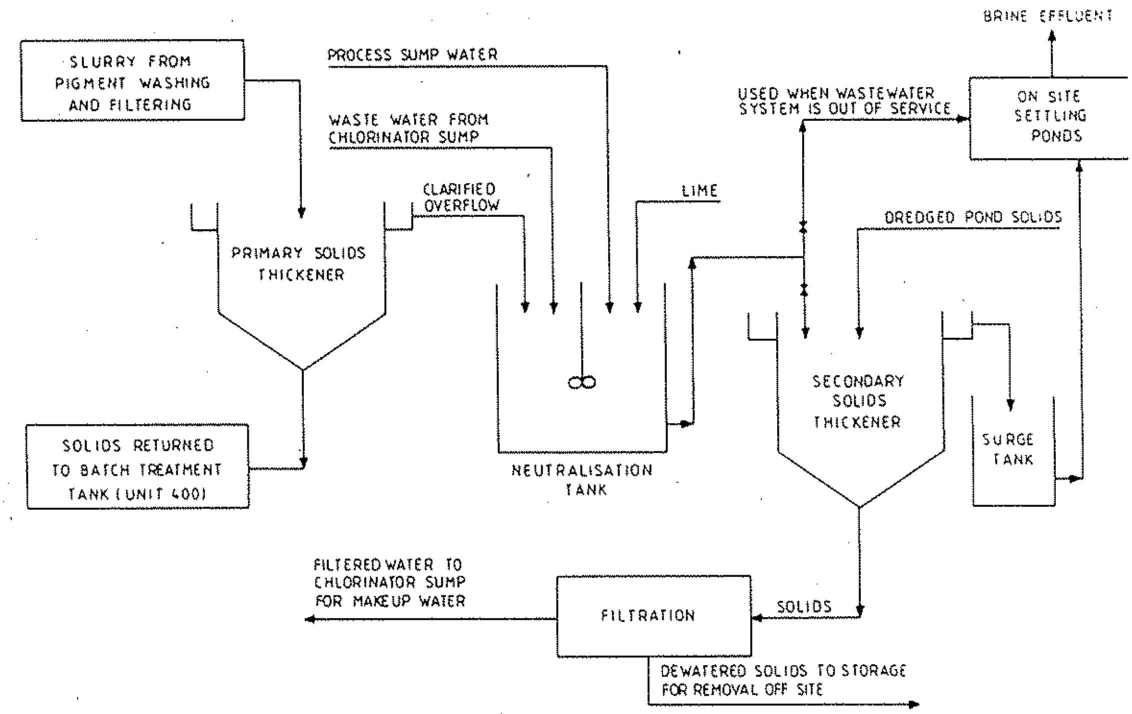


Figure 5. Revised Wastewater Scheme for the Pigment Plant. (Source Proponent's Responses to Submissions).

In the event of failure of the treatment plant or during plant maintenance the neutralised wastewater will be directed to the lagoons, which will be used as settling ponds. Settled material will later be removed by a floating dredge. Both ponds will be used to ensure that adequate retention time is available for solids removal.

It is proposed to direct both wastes from hard standing areas and from stormwater run-off directly to the on-site lagoon systems.

Based on the information on waste water quality supplied to the EPA by the proponent the EPA considers that either of the waste water disposal options are environmentally acceptable. The total dissolved salt loading in the waste water is approximately half that of seawater and other chemical species except for calcium, are with in the criteria set for the maintenance and preservation of aquatic ecosystems.

Calcium is only marginally above the criteria and is not, in this case, considered to be of environmental significance. The thermal load of the effluent is less than 1% of that for the SEC WA Kwinana Power Station and will result in a less than or equal to 1°C rise in temperature at the point where the plume rises to the surface. The design of the outfall has been calculated to achieve a better than 20 fold initial dilution.

In its assessment of the WA Water Authority's Cape Peron outfall (EPA Bulletin 114, May 1982), one of the Environmental Protection Authority's conditions of environmental acceptability was that a further public environmental assessment would be required should there be any proposal to discharge industrial effluent from the pipeline. This requirement remains notwithstanding the EPA having no objections in principle to discharge of this effluent through the Cape Peron Outfall.

Despite the reported quality of the effluent being environmentally acceptable the EPA requires that the quality of the water before discharge commences and during plant operation should be monitored. The objective of the monitoring programme will be to verify the results contained in the ERMP and to monitor the effects of discharge upon biological communities within the marine environment.

RECOMMENDATION 9

The Environmental Protection Authority requires that there should be no detrimental effect on the beneficial uses of the waters to which discharge is occurring. Consequently, the Environmental Protection Authority recommends that six months prior to commissioning the proponent shall prepare and implement a monitoring programme of both physical and biological parameters of the receiving water and effluent. If there is any unacceptable change in the receiving water quality the proponent shall modify its plant to the satisfaction of the Environmental Protection Authority.

If any discharge is proposed to the Cape Peron outfall this should be the subject of further assessment by the Environmental Protection Authority.

The plan shall be to the satisfaction of the Environmental Protection Authority and include regular reporting of results to the Environmental Protection Authority as part of the Environmental Management Programme (referred to in Recommendation 21).

Discussion is currently occurring within Government concerning the use of the Cape Peron outfall for industrial effluent and also the possibility of the construction and operation of an integrated industrial effluent treatment and outfall system for the Kwinana industrial area.

As stated previously the Environmental Protection Authority considers that either discharge option is environmentally acceptable provided the discharge does not affect the beneficial uses of the receiving waters. However, the Authority also recognises the future environmental benefit of being able to manage all liquid effluents from the Kwinana area in an integrated manner. Consequently the Authority considers that the proponent should be able, if required in the future, to connect its discharge into such an integrated system.

RECOMMENDATION 10

The Environmental Protection Authority considers that there are potential environmental benefits from the integrated management and disposal of liquid effluents from the Kwinana area. Consequently, the Environmental Protection Authority recommends that the proponent should configure the plant so that it can be connected into such a scheme at a later date if required to do so by the Minister for Environment.

6.6 SOLID WASTES

Two solid waste streams will be produced, which are:

. solid process wastes; and
. inert wastes and plant trash.

The second, approximately 600 tpa of inert wastes and plant trash, will be disposed of in a approved sanitary land fill.

The solid process wastes stream is expected to be approximately 20 000 tonnes per year and will consist of the following solid waste streams:

. coke/ore mixture	-	from the oxidation area	8 000 tpa
. metal hydroxides	-	from the wastewater treatment plant	5 400 tpa
. calcium sulphates	-	from the chlorine purification and pigment treatment area	6 000 tpa

The characteristics of this residue are similar to the solid process wastes stream from a plant operated by Kerr McGee at, Hamilton, Mississippi USA. The various analysis of solid residue quoted in this report are from analysis of the residue from the Hamilton plant.

The solid process wastes are proposed to be disposed of at the proponent,s mine at Cooljarloo

The proponent has reported that the total dissolved solids (TDS) of the ground water at the minesite is in the vicinity of 720 ppm. This level of TDS is suitable for stock supply, irrigation and, if mixed with lower salinity water to bring the TDS below 500 ppm, suitable for human consumption.

As part of the assessment of the Cooljarloo mineral sand mining proposal the proponent committed itself to the rehabilitation of the minesite. The Environmental Protection Authority has endorsed this proposal.

The ERMP provides an analysis of the heavy metals in the solids.

These are listed below in Table 5:

Table 5A. Heavy metal concentrations in Hamilton Plant solids. (Source ERMP)

PARAMETER	CONCENTRATION IN SOLIDS (ppm)
Antimony	<5
Arsenic	<5
Cadmium	<2
Chromium	587
Copper	6
Lead	60
Mercury	<1
Nickel	35
Selenium	<1
Silver	<1
Zinc	46
Zirconium	4000

Table 5B. Leachate test results on Hamilton Plant Solid Wastes (mg/1)
(Source ERMP)

PARAMETER	1985 RESULTS			1987 RESULTS			USEPA MAX ALLOW CON
	Test 1	Test 2	Test 3	Test 1	Test 2	Test 3	
Arsenic	<0.05			0.002	0.003	<0.002	5.0
Cadmium	<0.05			<0.003	<0.003	<0.003	1.0
Chromium	<0.05	0.06	<0.05	0.16	0.16	0.03	5.0
Lead	<0.05			0.004	0.046	0.042	5.0
Mercury	<0.05			<0.0002	<0.002	<0.000	0.2
Selenium	<0.05			<0.02	<0.02	<0.02	1.0
Silver	<0.05			0.015	0.021	0.021	5.0

Table 5B reports the results of a USEPA leachate test on the Hamilton plant residue. The results of these leachate tests shows that the heavy metal leachates are well below the USEPA Maximum Allowable Concentration.

The Environmental Protection Authority considers that while the USEPA leachate test may give an estimate of the leachability of heavy metals under certain conditions it does not give information about the salinity of leachate from the residue or provide an understanding of the likely impact which may result from the leaching of salt from the residue into the groundwater at the minesite.

The filter cake from the waste water treatment section of the Hamilton plant was analysed for total soluble salts. The results showed a total soluble concentration of approximately 2 500 ppm with a filter cake moisture content of approximately 50% water.

The EPA considers that the salinity of the solid residue may cause unacceptable environmental impacts on the groundwater below the mine site due to the leaching of salt from the residue.

The Environmental Protection Authority has the objective that neither the quality of the groundwater below the mine site, or the vegetation rehabilitation programme be jeopardised in any way by the disposal of solid residue.

RECOMMENDATION 11

The Environmental Protection Authority considers it important that the quality of groundwater at the minesite be protected and that the rehabilitation of the mine not be jeopardised by disposal of solid waste. Consequently, the Environmental Protection Authority recommends that a full and detailed assessment be made of the disposal of the solid residue paying particular attention to the amount and fate of the dissolved solids in the residue. The Environmental Protection Authority sees this as an issue of environmental significance and recommends that as part of the Environmental Management Programme (referred to in Recommendation 21) the proponent prepare a report on this matter to the Environmental Protection Authority's satisfaction six months prior to commissioning.

The Authority also considers that the effect of disposal of the residue should be closely monitored and if unacceptable impacts on the groundwater are occurring the proponent shall modify its disposal practices.

RECOMMENDATION 12

The Environmental Protection Authority recommends that the proponent report on the performance of its solid residue disposal in the Environmental Management Programme (as referred to in Recommendation 21). In the event of unacceptable impacts on the groundwater or vegetation rehabilitation the proponent should modify its disposal practices to the Environmental Protection Authority's satisfaction.

6.7 ATMOSPHERIC EMISSIONS

The atmospheric emissions from each of the major sections of the plant are discussed under separate headings below:

6.7.1 AIR EMISSIONS FROM THE CHLOR-ALKALI PLANT

The significant air pollutants arising from the chlor-alkali are chlorine and hydrogen. Chlorine is an irritant toxic gas which is heavier than air and has a distinctive pungent odour. It poses a serious risk to public health if elevated levels occur outside the plant. Hydrogen on the other hand is highly flammable, non toxic and lighter than air. The primary area of concern with hydrogen is the potential for fires or explosions.

Chlorine is one of the major products of the chlor-alkali plant. It is generated in gaseous form and after purification liquefied for storage in refrigerated vessels. A number of waste gas streams are generated which contain quantities of chlorine on either a continuous basis or as a result of upset conditions within the plant. The plant design incorporates a caustic scrubber designed to remove chlorine from these gas streams prior to release to atmosphere.

In addition to the waste gas streams mentioned above there is a potential for failures of pipework or storage vessels handling chlorine. Such failures have the potential for releasing large quantities of chlorine to atmosphere and causing significant impacts off site. This type of failure is generally addressed under the heading of risks and hazards in both the ERMP and this Report.

The discussion of the air impacts from the chlor-alkali plant in the ERMP, while extremely brief, is considered to be factual and accurate.

6.7.2 AIR EMISSIONS FROM THE AIR SEPARATION UNIT

Little or no information is provided on the air emissions from the air separation unit. As such plants operate by fractionation of atmospheric air there is little likelihood of significant adverse gaseous emissions from this area of the plant.

6.7.3 AIR EMISSIONS FROM THE PIGMENT PRODUCTION PLANT

The pigment production plant is the section of the plant with the most significant air pollutants. The continuous process vent associated with the chlorination section of the plant has the potential to emit significant quantities of chlorine, titanium tetrachloride, hydrogen chloride, reduced sulphur compounds and carbon monoxide. Chlorine and the concerns associated with this material are detailed above.

Titanium tetrachloride ($TiCl_4$) is a liquid at normal atmospheric temperatures and temperatures however it reacts with moisture in the atmosphere to form hydrogen chloride. Hydrogen chloride is toxic irritant gas with a distinctive pungent odour. High concentrations of this gas would pose a serious threat to public health.

Carbon monoxide is toxic odourless gas, however there is little threat of this gas causing serious off site effects. Notwithstanding this careful design of control equipment and stack heights is required to prevent elevated levels occurring in the vicinity of the plant.

The term reduced sulphur compounds describes a large family of sulphur compounds which tend to be toxic at moderate to low concentrations and extremely odorous even at very low concentrations. Several reduced sulphur compounds may be formed in the chlorinator including hydrogen sulphide (rotten egg gas), carbon disulphide and carbon oxysulphide. All three gasses are extremely odorous at very low concentrations and in each case the odour is extremely unpleasant. Whilst these materials are considered to be toxic there is little or no potential for them to released to atmosphere at levels which will create more than an odour nuisance.

In addition to the above the ERMP and the supplementary report indicate that there is a potential to form highly toxic phosgene gas during certain plant upset conditions. The proponent has undertaken to install instrumentation which will detect the conditions under which phosgene may be formed at an early stage and to shut the chlorination plant down immediately. In any case scrubbing equipment will be installed to remove all traces of phosgene from the waste gas stream.

There are a number of furnaces on the plant which burn natural gas and emit the usual products of combustion. These emissions are not considered to have significant environmental impact.

As well as the continuous releases there are several emergency vents associated with the pigment plant. These vents, unless fitted with appropriate control equipment have the potential to cause serious pollution events off site. The major pollutants of concern are from the emergency vent systems are chlorine, $TiCl_4$ and HCl.

As with all plants handling materials of this nature there is a potential for fugitive releases of materials to the atmosphere through leaking valves and pump seals etc. The EPA has identified the need for procedures for leak detection and recommended accordingly. Appropriate management strategies must be in place to detect and repair such leaks.

6.7.4 AIR QUALITY CRITERIA

The EPA has not adopted a fixed set of air quality criteria. Instead the policy has been to set criteria for each proposal depending on the nature and location of the industry and the "Beneficial Uses" assigned for surrounding areas. However, in general, the air quality criteria developed and published by the Victorian EPA are considered to be a sound basis for assessing what constitutes an acceptable level of environmental impact.

Table 6 is a reproduction of a table in the supplementary report provided by the proponent. This table sets out the criteria which were used by the proponent to assess impact of the gaseous emissions from the plant on the surrounding environment. The criteria proposed in this table are, with the exception of the figure for sulphur dioxide, acceptable to the EPA. It should however be noted that the figures in the table are quoted at reference temperature of 25° C rather than 0° C which is the standard reference temperature used by the EPA.

Table 6. Ground Level Concentrations Guidelines for Atmospheric Emissions (Source Proponent's Responses to Submissions).

EMISSION	AVERAGE	STANDARD (ug/m^3)
Sulphur dioxide (SO2)	1 hr	445 Acceptable VIC EPA
Nitrogen dioxide (NO2)	1 hr	282 Acceptable VIC EPA
Carbon monoxide (CO)	1 hr	34 285 Acceptable VIC EPA
Hydrogen Chloride (HCl)	3 min	200 Design VIC EPA
Chlorine (Cl2)	3 min	100 Design VIC EPA
Carbon Disulphide (CS2)	3 min	130 Design VIC EPA
	odour threshold 200	WHO
Particulates	3 min	330 Design VIC EPA
H2S	3 min	0.14 Design VIC EPA
	odour threshold 7	WHO
Carbon oxysulphide (COS)		No standard available

It should also be noted that the figures in Table 6 above for the various reduced sulphur compounds (ie. H2S, CS2, COS) are based on odour threshold. As there is considerable variation in the published values for odour thresholds the EPA considers that odour detection becomes a condition of approval, in order to ensure that the plant does not become a source of odour complaint.

RECOMMENDATION 13

The Environmental Protection Authority recommends that the proponent shall design and operate the plant such that there shall be no odour of reduced sulphur compounds, emanating either fully or partially from the plant which are detectable outside the Kwinana buffer zone.

Criteria for ground level concentrations of sulphur dioxide not to be exceeded in the Kwinana area are being prepared by the Environmental Protection Authority as part of a draft Environmental Protection Policy (EPP) for the Kwinana region. This draft EPP will be released by the EPA for public comment. Following receipt of public comments the Authority will finalise the Environmental Protection Policy for submission to the Minister for Environment for Government approval.

In the interim the EPA are utilising the following ground level concentrations guidelines (see Table 7) for sulphur dioxide emissions in the Kwinana area. These guidelines are based on figures recently published by the World Health Organisation.

Table 7. Interim Ground Level Concentration Guidelines for Sulphur Dioxide Emissions

BENEFICIAL USE	CRITERIA
Residential Area	350
Industrial Buffer Zone	500
Industrial Area	700

Note: All concentrations expressed in micrograms per cubic metre quoted at $0^{o}C$, 1 atmosphere

Measurements averaged over 1 hour and represent expected maximum for 99.9 percent of the time. Coercive, not to be exceeded, limits may be twice these levels.

It must also be recognised that adherence to emissions criteria does not always guarantee that there will be no adverse environmental impact. In view of this it is a requirement that the proponent clearly demonstrate that emissions are either controlled at the source or sufficiently well dispersed to ensure that ambient air quality criteria are not exceeded.

Cumulative Impacts

The EPA recognises the State Government's commitment to the continued use and development of the Kwinana Industrial Area. it is also recognised that the cumulative emissions from the existing industry in the area impose a background level of air pollution which constrains the level impact which can be allowed from new industries.

In view of the above, the EPA is currently developing a management strategy for the airshed in the Kwinana region which will ensure that air quality will meet accepted environmental standards. The management strategy must also ensure that emissions from existing and already proposed development do not preclude further industrial development in the region.

At this time much research is required before the strategy can be fully implemented. As an interim measure it is proposed that the emissions from any single industry should not result in ground level concentrations in excess of 50% of adopted ambient ground level concentration criteria being used to assess the project. The criteria used in assessing sulphur dioxide emissions from this plant are taken as 50% of the criteria in Table 7. Therefore for a one hour average the EPA requires that the ground level concentrations of sulphur dioxide from this plant in residential areas should not exceed 175 ug/m^3.

The implications of this interim strategy for this plant are that emissions have been assessed against criteria which are only half of the figures quoted in the tables above. This requirement differs slightly from the approach used by the proponent where emissions from the plant were assessed against a figure of 60 - 70% of the adopted criteria in order to account for existing background levels of pollution.

6.7.5 ASSESSMENT OF AIR EMISSIONS

The air emissions of the three major components of the proposal are discussed under separate headings below. The assessment has been based on the situation that Section 5.5 of the proponent's responses to public submissions supersedes the information presented in Section 6.3.5 of the ERMP.

6.7.5.1 Assessment of Air Emissions from the Chlor-Alkali Plant

Section 6.7.1 identified chlorine and hydrogen as the primary pollutants of concern from this plant.

Waste gas streams containing chlorine are generated in several areas of the chlor-alkali plant. All of these streams are directed to a single caustic scrubber with sufficient capacity to absorb the full production the plant for 30 minutes. The caustic scrubber also scrubs air vented from the bulk chlorine storage enclosure so that in the unlikely event of a major chlorine leak in the chlorine storage area no chlorine is vented to the atmosphere.

The proponent has made commitments to provide emergency back up power systems to ensure that the caustic scrubber will remain operational at all times, even during a power failure. In addition the design of the system is such that all ducting upstream of the scrubber is maintained under negative pressure to ensure that in the event of a minor leak occurring, air will leak into the ducting rather than chlorine leaking to atmosphere.

Dispersion modelling of the emissions from the scrubber was conducted based on an emission concentration of 1 ppm chlorine in the tail gas from the scrubber and assuming a stack height of 55m. The ambient levels resulting from this emission concentration are very low (0.1 ug/m^3), when compared with the Victorian EPA design criteria of 100 ug/m^3, and are therefore acceptable. The emission concentration of 1 ppm chlorine in tail gas from the scrubber was the subject of a verbal commitment by representatives of the proponent and is in line with what is currently achievable using modern technology. It will therefore be adopted by the Environmental Protection Authority as a requirement in the licence conditions for the plant.

The chlorine waste gas scrubber and associated systems are in line with accepted practice and are acceptable to the Authority although a more detailed examination of the system will be required at the works approval stage.

No clear commitments are provided in the ERMP regarding detection and control of fugitive emissions. It is recommended that the proponent compile a suitable report on the procedures proposed in this area.

RECOMMENDATION 14

The Environmental Protection Authority recommends that the proponent shall prior to commissioning, as part of the Environmental Management Programme (refered to in Recommendation 21) submit a report to the satisfaction of the Environmental Protection Authority describing the procedures for leak detection and repair within the chlorine plant.

6.7.5.2 Assessment of Air Emissions from the Air Separation Unit

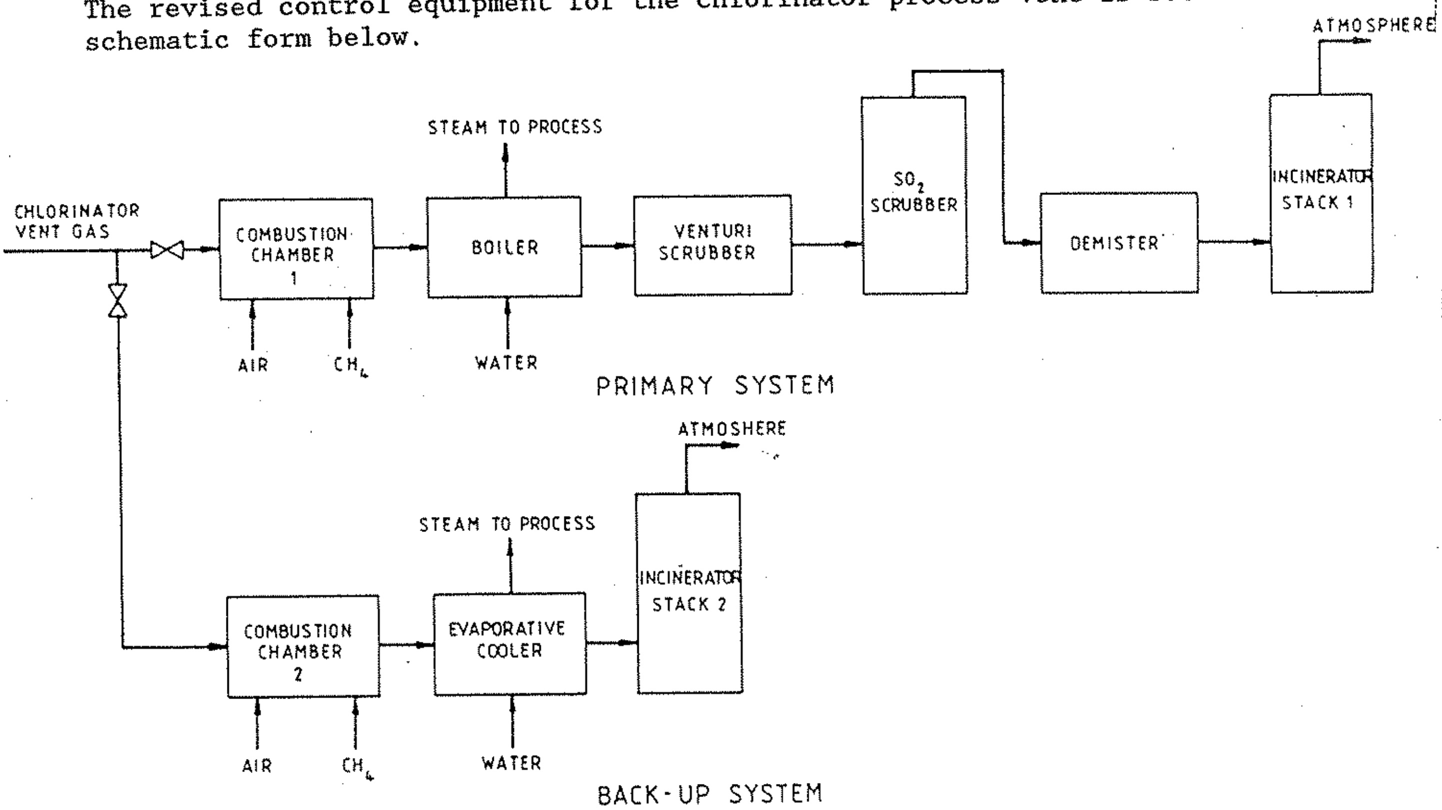
Insufficient information is provided to allow a thorough assessment of the air emissions from the air separation plant. However, the nature of the plant is such that there should be no significant air emissions. In order to ensure that no adverse impacts result from emissions from this section of the plant, the proponent will be required to provide full details of all atmospheric emissions as part of the works approval process.

6.7.5.3 Assessment of Air Emissions from the Pigment Plant

Section 6.7.3 describes the potential areas of concern for air emissions from this section of the plant.

The ERMP does not address the subject of emissions control systems in any great detail. However, as a result of questions raised by the EPA a revised emissions control system has been developed to greatly reduce the emission of reduced sulphur compounds and carbon monoxide.

The revised control equipment for the chlorinator process vent is set out in schematic form below.



Note: Gas is scrubbed to remove chlorine prior to entering the incinerator system.

Figure 6. Incinerator system for the Pigment Plant (Source Proponent's responses to Public Submissions).

The chlorinator is the only source of sulphur dioxide in this plant. Emissions from the chlorinator also include carbon monoxide and reduced sulphur compounds.

Under normal operating conditions gaseous emissions from the chlorinator will pass through the main vent gas scrubber to remove chlorine. Following the removal of chlorine, it is directed to the primary incinerator to convert carbon monoxide to carbon dioxide and reduced sulphur compounds to sulphur dioxide. After this it passes through a waste heat recovery boiler, which cools the gas. The gas is finally scrubbed with a venturi scrubber to remove particulate matter and an sulphur dioxide scrubber to remove the majority of the sulphur dioxide. The effluent gas is then emitted to atmosphere via a stack. Sulphur dioxide is emitted at a rate of 0.072 ug/s.

Table 8 lists the calculated maximum ground level concentrations of sulphur dioxide (SO_2) and nitrous oxide (NO_2) for a variety of stack heights for normal operating conditions. Examination of these figures shows that under normal operating conditions sulphur dioxide emissions are acceptable with any of the stack heights and well within the ground level concentration criteria for sulphur dioxide in residential areas of 175 ug/m^3

Table 8. Maximum ground level concentrations of SO_2 and NO_2 emissions from the primary incinerator for the stack heights shown,. One hour averages (Source Proponent).

AIR STABILITY CLASS	STACK HEIGHT (m) 27.4		30		40		45.7	
	SO_2	NO_2	SO_2	NO_2	SO_2	NO_2	SO_2	NO_2
A	7.0	12.6	4.1	7.3	2.4	4.3	3.2	5.8
B	8.7	17.4	5.0	8.9	2.0	3.6	1.5	2.8
C	14.1	25.3	7.2	12.8	2.5	4.4	1.8	3.2
D	18.4	34.8	8.8	17.8	2.5	4.5	1.7	3.0
E	25.8	46.3	13.2	23.7	2.4	4.2	1.5	2.6
F	38.7	69.5	19.8	35.6	2.1	3.7	1.3	2.2

In the event of a failure of the primary incinerator system (estimated to occur less than 10% of the operating time) the air emission treatment system is equipped with a bypass incinerator gases from the by-pass incinerator are cooled and released directly to atmosphere. Clearly sulphur dioxide emissions of 38.7 g/s will be much higher in these circumstances than under normal operating conditions. The resulting maximum ground level concentrations for sulphur dioxide from the bypass incinerator are shown below in Table 9.

Table 9. Maximum ground level concentrations of SO_2 and NO_2 from the bypass incinerator for the stack heights shown. One hour averages. (Source Proponent)

AIR STABILITY CLASS	STACK HEIGHT (m) 27.4		30		40		45.7	
	SO_2	NO_2	SO_2	NO_2	SO_2	NO_2	SO_2	NO_2
A	2551.8	8.6	1297.0	4.4	444.0	1.5	441.4	1.5
B	3508.7	11.8	1783.4	6.0	514.9	1.7	381.9	1.3
C	5103.5	17.1	2594.1	8.7	619.4	2.1	439.2	1.5
D	7017.3	23.6	3566.8	12.0	588.6	2.0	382.1	1.3
E	9356.4	31.4	4755.8	16.0	546.3	1.8	316.9	1.1
F	14034.7	47.1	7133.7	24.0	497.3	1.6	224.1	0.8

This table shows that even with a stack height of 45.7 m the ground level concentrations would exceed the interim criteria. This, however, needs to be considered in the following contexts:

- the system is a backup system operating less than 10% of operating time;
- the decision on stack heights will be made at the final design stage. A further increase in stack height would result in acceptable concentrations even when the bypass incinerator is operating;
- for A & B class air stabilities it is likely that the maximum ground level concentrations will occur within the plant boundaries. For E & F class air stabilities the maximum concentrations are likely to occur 2-3 km from the site; and
- the proponent is currently investigating whether gas from the bypass incinerator can be directed to the sulphur dioxide scrubber. If this is feasible the resulting sulphur dioxide concentrations would be similar to those for the primary incinerator system.

Based on the above, the EPA is confident that the proponent will be able to meet the Authority's criteria for sulphur dioxide under normal operating conditions and when the bypass incinerator is operating.

The ERMP mentions the potential for phosgene to be produced in the chlorinator. Section 4.5 of the response to public submissions addresses this concern and states that phosgene can only be formed in the event of chlorine slip occurring and would be quickly detected by the operator. In any case the scrubbing equipment associated with the chlorinator process vent would effectively scrub the phosgene form the waste gas stream. A commitment has been provided to shut the chlorinator down immediately whenever conditions are such that phosgene could be formed.

In view of the hazardous nature of phosgene the proponent will be required to monitor for the presence of phosgene in the waste gas stream during chlorine slip conditions.

The EPA believes that the emissions from the chlorinator can be controlled to acceptable levels.

The remaining continuous process vents in the plant are not considered to be significant sources, although a detailed analysis is require to ensure that stack heights are adequate to ensure sufficient dispersion of the various pollutants. The work presented by the proponent in regard to analysis and modelling of these and other air emissions is presented in Section 6.7.6.

The proponent has provided commitments in the response to public submissions to scrub all gases directed to the emergency vent system prior to release to the atmosphere. The proposed systems are described in conceptual form. However, the approach taken by the proponent is considered to be acceptable in principle and should ensure that even in the event of upset conditions the plant will not cause unacceptable impacts off site. The final design of these control systems must be examined in detail during the works approval process.

In addition, commitments are provided to provide to fit one boiler at the pigment plant with steam turbine driven feed pumps to ensure that the boiler remains operational during power failures, provide steam turbine driven generators for emergency power, and to fit steam turbine backup drivers for all circulating pumps and blowers on scrubbing systems to ensure that they remain fully operational even during power failures. A further commitment is given that under most emergency shutdown conditions the shutdown is controlled by the control system and emissions directed to appropriate scrubbers without the lifting of relief valves or breaching of bursting discs. Even in the event of bursting disc failure or activation of relief valves the emissions are directed to the scrubbers serving the emergency vents.

Notwithstanding the above it is recommended that a full analysis is undertaken by suitable risk consultant of all events which have reasonable probability of causing off site impacts in the life of the plant.

RECOMMENDATION 15

The Environmental Protection Authority recommends that as part of the Environmental Management Programme (referred to in Recommendation 21) the proponent shall prepare a fault tree analysis of conditions leading to an emissions which may occur during plant upset conditions (notably via emergency vents) to the satisfaction of the Environmental Protection Authority.

If any of the events appear to be potentially unacceptable the Environmental Protection Authority may require further dispersion analysis of the emissions and subsequently engineering modifications to reduce the emission rate and/or frequency.

No clear commitments are made in the reports regarding the control of fugitive emissions in the pigment plant. Satisfactory control of such emissions can only be endured by a comprehensive leak detection and monitoring programme. Such a programme would also incorporate an on site ambient monitoring programme for materials like chlorine.

RECOMMENDATION 16

The Environmental Protection Authority recommends that the proponent shall, prior to commissioning as part of the Environmental Management Programme (referred to in Recommendation 21), submit a report to the satisfaction of the Environmental Protection Authority describing the procedures for leak detection and repair within the pigment plant.

6.7.6 DISPERSION MODELLING

Calculation of worst case ground level concentrations for individual sources was performed using conventional point source dispersion theory. The effect of building wakes on plume dispersion was conservatively estimated by assuming that all plumes are affected by the largest building on site.

Emissions data for the pollutants are listed in Table 1 of Appendix 3 in the supplementary report. These data show the value of incineration in reducing carbon monoxide and reduced sulphur compound, emissions as well as the reduction of sulphur dioxide emissions by the caustic scrubber. The level of residual chlorine concentration after the caustic scrubber, whilst not unacceptable, is considered high and should be investigated as part of the plant design.

Model results show that with appropriate stack heights it will be possible to achieve acceptable ground level concentrations of all pollutants. The SO^2 results from the by-pass incinerator, are relatively high. However, as stated previously this system should only operate for a relatively small fraction of the time (approx. 10%) during which time the caustic scrubbing system would not operate. The proponent has indicated that investigations are in hand to determine whether it will be feasible to also direct waste gases from the by-pass incinerator to the caustic scrubber and thereby reduce sulphur dioxide levels.

The attempt by the proponent to model cumulative impact of point source emissions via an evenly distributed line source is not considered to provide representative results. As a condition of works approval the proponent will be required to employ a multi source model, accounting for sources within and outside the plant, to predict cumulative impacts. The EPA will assist the proponent to quantify emissions sources from other industries.

In summary the proposed air quality impact associated with all continuous and intermittent gaseous emissions form the plant appears to be acceptable given appropriate engineering design. Final EPA approval of all:

- types of pollutants emitted;
- mass flow rates of pollutants;
- volume flow rate, exit velocity and exit density (primarily determined by exit temperature) of all emission streams;
- proposed emission control devices (notably the efficiency and reliability of incinerators and scrubbers); and
- stack heights in the light of
  - (i) the wakes of adjacent structures
  - (ii) cumulative ground level concentration limits

will be required as conditions of works approval, prior to the issuing of an operating licence.

RECOMMENDATION 17

The Environmental Protection Authority recommends that the proponent shall prior to construction of the plant provide details of:

(i) the characteristics of emitted gas streams;

(ii) the emission control devices; and

(iii) the final stack design heights.

6.7.7 MONITORING OF AIR EMISSIONS

The ERMP makes some general commitments regarding monitoring of pollutant levels both at source and in the ambient environment within the plant.

The EPA considers it essential that continuous chlorine monitors are fitted to the stacks of the chlor-alkali plant caustic scrubber and that duplicate chlorine monitors are installed on the chlorinator process vent in the pigment plant.

In addition it is normal operating practice in plants handling large amounts of chlorine to install a network of ambient chlorine detectors to provide early warning of any leaks. It is expected that the proponent will submit details of the ambient chlorine monitor network for approval prior to commissioning.

In addition to the above the proponent should submit details of monitoring programmes for monitoring the levels of reduced sulphur compounds, hydrogen chloride, carbon monoxide, phosgene and particulate material at source.

RECOMMENDATION 18

The Environmental Protection Authority recommends that the proponent shall, at least 6 months prior to commissioning the chlor-alkali and pigment plants prepare and implement a report to the satisfaction of the Environmental Protection Authority providing details of the monitoring programme proposed for gaseous emissions and the ambient air environment around the plant.

6.8 <u>RADIATION</u>

The mineral sands from which synthetic rutile is derived are very mildly radioactive. Most of the sources of radioactivity are removed when the monazite is separated from the ilmenite during the dry separation process. However, there is some carry over of radioactive nuclei with the ilmenite into the synthetic rutile plant. Some of the radioactive nuclei are also removed during this part of the process leaving only a very small proportion of radioactive nuclei carried over into the pigment plant.

The proponent estimates that virtually all the radioactive constituents of the synthetic rutile which are carried over into the pigment plant will end up in the solid residue. The absorbed dose rate from the stored waste at the plant would be of the order of 1 micro Grey per hour. This is considered to be a very low dose. The proponent proposes to dispose of the solid residue at the mine site at Cooljarloo.

The EPA does not consider that the very small amount of radio active constitutents in the solid residue will cause any significant environmental effects.

Radioactivity in liquid effluent occurs as a result of the carry over of various radioactive materials from the process into the liquid effluent. Based upon information supplied from Kerr McGee's Hamilton (USA) plant, levels of radioactivity are expected to be as follows:

Total alpha	<1000	Bequerel per cubic metre (Bq/m^3)
Total beta	<5000	Bq/m^3
Total radium		
- soluble	100	Bq/m^3
- insoluble	30	Bq/m^3
Radium 226		
- soluble	37 ± 40	Bq/m^3
- insoluble	2 ± 6	Bq/m^3

The proponent has assessed the level of radioactivity within the effluent stream as being within public health guidelines. In particular, a level of 37 ± 40 Bq/m^3 of soluble Radium 226 was found to be equivalent to that level naturally found within the Perth groundwater supply.

The ERMP describes two disposal methods for the liquid effluent, either to Cockburn Sound or through the Cape Peron outfall. In Section 6.5.2 of this report, the EPA comments on the acceptability of these options and recommends monitoring of the proposal outfalls. The Authority considers that the emissions of radioactive materials to the environment from those sources as being assessed in this section of the report.

Although the potential radiation from both the solid and liquid waste is very low, the Authority considers that these should be monitored and managed in accordance with a radiation management programme to the satisfaction of the Radiological Council.

There are various parts of the plant such as filters, pipes and pumps and tanks which may, over time during normal operations, accumulate radioactive materials. The management of these should also be the subject of the radiation management programme.

RECOMMENDATION 19

The Environmental Protection Authority considers that radiation should be monitored throughout the plant, and that potential effects from radiation at the discharge of liquid effluent and disposal of solid waste should also be monitored and managed. Therefore, Environmental Protection Authority recommends that prior to commissioning, the proponent shall prepare a radiation management programme for the proposed plant and disposal of liquid and solid wastes. This programme should be to the satisfaction of the Radiological Council.

6.9 NOISE IMPACTS

The proponent has considered noise from the plant for both the construction and operational phases of the project. Using data gathered by the Authority in previous background noise level studies, the proponent's consultant has compared predicted noise level emissions with existing noise levels to assess the likely impacts.

In its assessment of noise emissions from industrial developments the EPA considers that the noise standards of the Assigned Outdoor Neighbourhood Noise Levels from the noise regulations under the Environmental Protection Act 1986, provide guidelines to the maximum noise level appropriate to a range of situations.

These are not design criteria but represent the point beyond which, the EPA may take action against an industry if the noise levels produced exceed the standard.

In residential areas outside the Kwinana Industrial area buffer zone the maximum acceptable background noise levels are:

Daytime	45 dB (A)
Night time	35 dB (A)

For residential areas within the buffer zone including Hope Valley noise levels will, at times approach the maximum acceptable background noise levels for residential areas outside the buffer zone as a consequence of this proposal.

6.9.1 CONSTRUCTION STAGE IMPACTS

The assessment, by the consultant, of construction phase noise shows a likely maximum noise level in the Hope Valley area (identified as the most critical area for noise reception) of 44 dB (A). This level may be compared with measured and assigned noise levels as follows:

Daytime background (0700-1900)	41 dB (A)
Nighttime background (1900-0700)	34 dB (A)
Assigned level Monday-Friday 0700-1900 hours	45 dB (A)
Assigned level Saturday 0700-2200 hours	40 dB (A)

(Source EPA)

The Authority notes that as construction progresses different items of equipment and plant will occupy the site resulting in lower maximum predicted noise levels. Further, it is recognised that conditions reaching to levels of 44 dB (A) at Hope Valley occur for only approximately 28% of the time.

6.9.2 PLANT OPERATION IMPACTS

Analysis of the acoustical output of a standard unattenuated plant shows a likely noise level in Hope Valley of 49 dB (A). Further, this noise is likely to have tonal components which will increase the annoying affect of this noise. Current assessment methods provide for a +5 dB (A) penalty on measured noise levels for additional annoying effects due to the presence of tonal components, giving a total level of 54 dB (A).

Due to the longer term nature of the noise output during the operational phase and the twenty four hour per day operation of the plant greater scope for annoyance from noise exists during this phase of the project. It is therefore necessary to compare predicted noise emissions with existing noise levels for the more critical night hours when ambient noise levels are lower.

As a consequence the Authority considers that the proponent will have to achieve significant reductions in noise levels by appropriate design changes. The Authority will assist the proponents to establish a noise monitoring regime by specifying noise levels to be met at the site boundary as licence conditions.

RECOMMENDATION 20

The Environmental Protection Authority recommends that:

(i) the proponent incorporate noise control as a fundamental criterion in the design of the plant, and that all attenuation measures considered necessary to address the tonality of the plant noise emissions and meet the noise level deemed acceptable by the Authority be incorporated during construction;

(ii) after commissioning the plant, the proponent should undertake monitoring to determine the effectiveness of the attenuation measures designed and built into the plant; and

(iii) the proponent should prepare a noise level measuring programme to be incorporated into the Environmental Management and Monitoring programme (referred to in Recommendation 21), to the satisfaction of the Environmental Protection Authority.

6.10 TRAFFIC IMPACTS

In its submission, the Main Roads Department was concerned about delays and congestion at the intersection of Mason Road and Rockingham Road, particularly during peak periods (eg shift change-overs at BP Refinery). MRD believes that there has been a serious under-estimation in the ERMP of traffic volumes in Rockingham Road and Mason Road, and considers that an upgrading of Mason Road, as well as the Mason Road/Rockingham Road intersection, may be necessary.

It is clear that the issue of regional roads vs local roads will need to be resolved in another forum. The issue of Mason Road being the only access road (not only to this plant, but also to PICL, Nufarm, CSBP, BP Refinery and BHP) has emergency response ramifications, and should be addressed in the development of a Kwinana Intergrate Emergency Management System which was referred to in Section 6.4

6.11 VISUAL IMPACTS

The proposed plant is adjacent to the PICL plant and BP Refinery. It will have stacks up to 46 m. This plant will add to the industrial nature of the Kwinana Industrial Area but will not add greatly to the surrounding skyline. The proponent has made a commitment to landscape the site.

6.12 OCCUPATIONAL HEALTH AND SAFETY MATTERS

The responsibility for assessing the acceptability of occupational health and safety matters rests with the Commissioner for Occupational Health and Safety. In addition, the Safety Co-ordinator, located in the Explosives and Dangerous Goods Division of the Mines Department, is also involved in the safe operation of such plants. Accordingly, the Authority notes that the proponent liaise with the Commissioner and the Safety Co-ordinator on these matters.

7. ENVIRONMENTAL MONITORING AND MANAGEMENT

Throughout this report, the EPA has identified issues arising from its assessment of this project which require ongoing monitoring and management. These were:

- the examination of ways of reducing water consumption;
- the monitoring and management of liquid discharges to the ocean;
- the disposal of solid residue at the Cooljarloo mine site;
- monitoring of air emissions;
- monitoring and management of radiation in the plant, in liquid discharge and in the solid residue at the mine site; and
- noise emissions.

The Environmental Protection Authority places a great deal of emphasis on the management of environmental impacts and the monitoring of both the management programme and the impacts to ensure that appropriate steps are taken to ameliorate and minimise adverse affects.

7.1 ENVIRONMENTAL MANAGEMENT OUTLINED IN THE ERMP

The environmental management commitments made in the ERMP and subsequent documents, are listed in Appendix 2 of this Assessment Report. The Company's key commitments to environmentally manage the proposal are:

- preparation of an Environmental Management Programme (EMP);
- comprehensive planning to control risks and hazards from the plant;
- landscape the site;
- keep air emissions to agreed criteria;
- install an incinerator with back up and emission scrubbing equipment;
- minimise water use;
- maintain water quality of the liquid effluent receiving waters;
- further research is taking place into environmentally responsible disposal of solid residue;
- meeting of guidelines for noise emissions and monitoring of noise emissions; and
- monitoring of radiation.

7.2 ENVIRONMENTAL MANAGEMENT PROGRAMME

The EPA sees an Environmental Management Programme as an appropriate means of pulling together issues arising from this assessment report and informing the EPA of the proponents environmental performance and any planned changes to the company's project which may affect the environment. The EMP should also take account of, and interface with, other management plans being prepared for other parts of the proponents project, specifically the mine and the dry process/synthetic rutile plant.

RECOMMENDATION 21

The Environmental Protection Authority recommends that the proponent prepare, in stages as appropriate, an Environmental Management Programme which deals with specific aspects of the proposal including:

- **construction and commissioning impacts (Recommendations 2 and 3)**

- **reduction in water use (Recommendation 8)**

  monitoring of solid waste disposal at Cooljarloo (Recommendations 11, 12,);

- **monitoring of the liquid effluent receiving waters (Recommendation 9)**

- **detection of leaks in both the chlorine and pigment plants (Recommendation 14 and 16)**

- **air emissions and air quality monitoring (Recommendations 15, 17, 18)**

- **radiation monitoring (Recommendation 19)**

- **noise level measurement and control (Recommendation 20)**

The Environmental Management Programme should include the submission of brief annual and comprehensive triennial reports to the Environmental Protection Authority on the environmental monitoring and management of the project.

This Environmental Management Programme should be to the satisfaction of the Environmental Protection Authority.

8. DECOMMISSIONING

RECOMMENDATION 22

The Environmental Protection Authority considers that when the plant ceases operation permanently the decommissioning and site cleanup should be the responsibility of the proponent. Consequently, the Environmental Protection Authority recommends that the proponent be responsible for decommissioning the plant and surrounds, and that 6 months before decommissioning and the proponent submit decommissioning plans to the satisfaction of the Environmental Protection Authority.

9. CONCLUSION

The purpose of this assessment report is to provide an environmental input to decision making on the proposed pigment plant. The report has been prepared in accordance with the provisions of the Environmental Protection Act and will form the basis of setting environmental conditions. In preparing this Report the Authority has considered the ERMP prepared by the proponent, which included supporting several technical reports, and has been assisted by contributions from the public and other government agencies.

The Authority has identified a number of issues regarding the proposal which will require ongoing assessment.

The Authority has reached the following conclusions:

- it is possible to operate a chloride base pigment plant in a manner which is environmentally acceptable;
- the proposed site for the plant within the Kwinana industrial area is environmentally acceptable;
- the individual and cumulative risk from the proposed plant are low enough to be acceptable
- air emissions from the plant can be made acceptable and are manageable;
- noise emissions from the plant will need to be attenuated but should be acceptable;
- the disposal of liquid effluent will not diminish the beneficial uses of the receiving waters;
- the disposal of solid residue requires further investigation to ensure its disposal at the Cooljarloo minesite will not have an adverse impact on the ground water at the site;
- the radiation hazard from this plant is extremely low; and
- the ongoing management of the plant will be reported to the EPA in an Environmental Management Programme. The EPA will prepare an assessment of this programme.

10. REFERENCES

DCE (1979) "Cockburn Sound Environmental Study 1976-1979", Department of Conservation and Environment, Report No 2.

DCE (1982) "Kwinana Air Modelling Study" Department of Conservation and Environment, Report No 10.

DCE (1982) "Cape Peron Ocean Outlet, Metropolitan Water Supply, Sewerage and Drainage Bores", Report and Recommendations by the EPA, DCE Bulletin 114.

EPA Bulletin 278 'Environmental Protection Authority Guidelines for Risks and Hazards of Industrial Developments on Residential Areas in Western Australia'.

Harris C (1987) "Mitigation of Accidental Toxic Gas Releases" Internation Symposium on Preventing Major Chemical Accidents, Feb 3-5 1987. Washington DC.

National Health and Medical Research council (1985), 'National guidelines for control of emission of air pollutants from new stationary sources'.

State Planning Commission and Kwinana Industries Coordinating Committee (1987). "Kwinana Region Strategy".

Technica (1987) 'Kwinana Cumulative Risk Analysis - Main Report' prepared for The Department of Resources Development of the Government of Western Australia.

Victorian EPA (1982) "State Environment Protection Policy (The Air Environment)". Environment Protection Act 1970.

APPENDIX 1

PROPONENT'S RESPONSES TO PUBLIC SUBMISSIONS

COOLJARLOO JOINT VENTURE

TITANIUM DIOXIDE PIGMENT PLANT AT KWINANA

RESPONSES TO PUBLIC SUBMISSIONS

DECEMBER 1988

TABLE OF CONTENTS

1. INTRODUCTION

The Cooljarloo Joint Venture submits the following document in response to public submissions to the Titanium Dioxide Pigment Plant Environmental Review and Management Programme (ERMP). Updated details of plant design and operations are also included.

The Cooljarloo Joint Venture has been presented with three sets of questions from the EPA, Department of Mines, and the Health Department. The responses to all these questions have been combined in this document under related headings. For ease of reference, a system has been designed so that the answer to a particular question can be located.

Questions from the EPA are referenced with the prefix EPA followed by the page number in the ERMP that the question relates to. In the event that there is more than one question per page a suffix a, b etc. denotes the relevant part of the question. The Department of Mines' questions are referenced with the prefix M and a suffix corresponding to the question number. The questions from the Department of Health are referenced by the prefix H followed by the corresponding question number. HC is used to denote questions raised in the covering letter from the Health Department.

2. FURTHER DOCUMENTATION

M12, M14, M15, M21, M26c, M30, Hg

On receipt of the Works Approval other studies will be commissioned to ensure safe operation and minimal environmental impact of the plant. These studies will include an Environmental Management Plan (EMP), a Hazard and Operability (HAZOP) Study, and a Total Hazard Control Plan (THCP).

The EMP will supply baseline data, monitoring programmes and reporting procedures for the plant. It will be developed in consultation with the appropriate authorities and submitted to the EPA for their approval prior to the commissioning of the plant.

The detailed HAZOP study will also be undertaken prior to commissioning and submitted to the EPA/Department of Mines. The risk assessment in the ERMP is a preliminary assessment and will be expanded upon in the HAZOP study. The HAZOP study will include consideration of the transport of process materials, the transfer pipeline from the chlorine plant to the pigment plant and detailed design plans.

The proponent is committed to preparing a THCP in consultation with the Mines Department. The THCP will be prepared in two parts. The construction section of the THCP will be submitted to the EPA prior to construction of the plant and the remaining operations and maintenance sections will be submitted prior to commissioning.

A cumulative risk analysis for industry in Kwinana including the pigment plant has been completed by the Department of Resource (DRD) and the results meet the requirements of the EPA.

3. PLANT REQUIREMENTS

3.1 Site Selection

EPA14

The option of locating the project at Narngulu was considered in detail in the Cooljarloo Mineral Sands Project Environmental Review and Management Plan (ERMP) but was rejected due to high transport costs. Narngulu is 140km further away from Cooljarloo than is Muchea. Transportation costs of the locally purchased chemicals for the synthetic rutile and titanium dioxide pigment plant would also be greater as they largely come from the Kwinana area.

The quality and quantity of the water available in Narngulu are also not sufficient for the pigment plant.

3.2 Water Supply

EPA27a

The Water Authority of Western Australia (WAWA) is responsible for balancing the potential water demand with the water supply for the State. The Cooljarloo Joint Venture has been advised that WAWA will be able to meet the project requirements for both quantity and quality of water from existing resources.

3.3 Bulk Solid Feed

EPA32a, EPA37

Dust emissions due to the handling and storage of bulk solids will be kept to negligible amounts through careful handling. Stockpiling and reclamation of petroleum coke and feedstock will be carried out within enclosed storage areas. Unloading of petroleum coke from ships will be carried out in compliance with Port of Fremantle Authority requirements.

The Hamilton pigment plant operated by Kerr-McGee Chemical Corporation (KMCC) in Mississippi USA has successfully utilised various ores as feedstock including slags with a titanium content of 78% and different synthetic rutiles supplied from India, Japan, Australia and the USA. Blends of natural rutiles, slags, and synthetic rutiles have also been utilised successfully. Tests have indicated that the potential contaminants in the synthetic rutile that will be used at Kwinana are not different from those in other ores that have been run successfully. There will be no significant difference in the quality of waste water generated from the process for discharge into Cockburn Sound or Cape Peron compared to wastes from the Hamilton Plant. There may be a slight variation in the quantity and composition of the non-hazardous waste solids produced. However, these waste solids will be well within the range generated at the Hamilton Plant.

4. PLANT OPERATIONS

4.1 Site Layout

EPA20

The current site layout is shown in Figure 1.

4.2 In Plant Use of Water

EPA27b, EPA32b

Use of waste water from WAWA Woodman Point sewage treatment plant was considered by the Cooljarloo Joint Venture. However, this source was rejected on the basis of uncertainties associated with the consistency of quality and supply, and potentially high treatment costs.

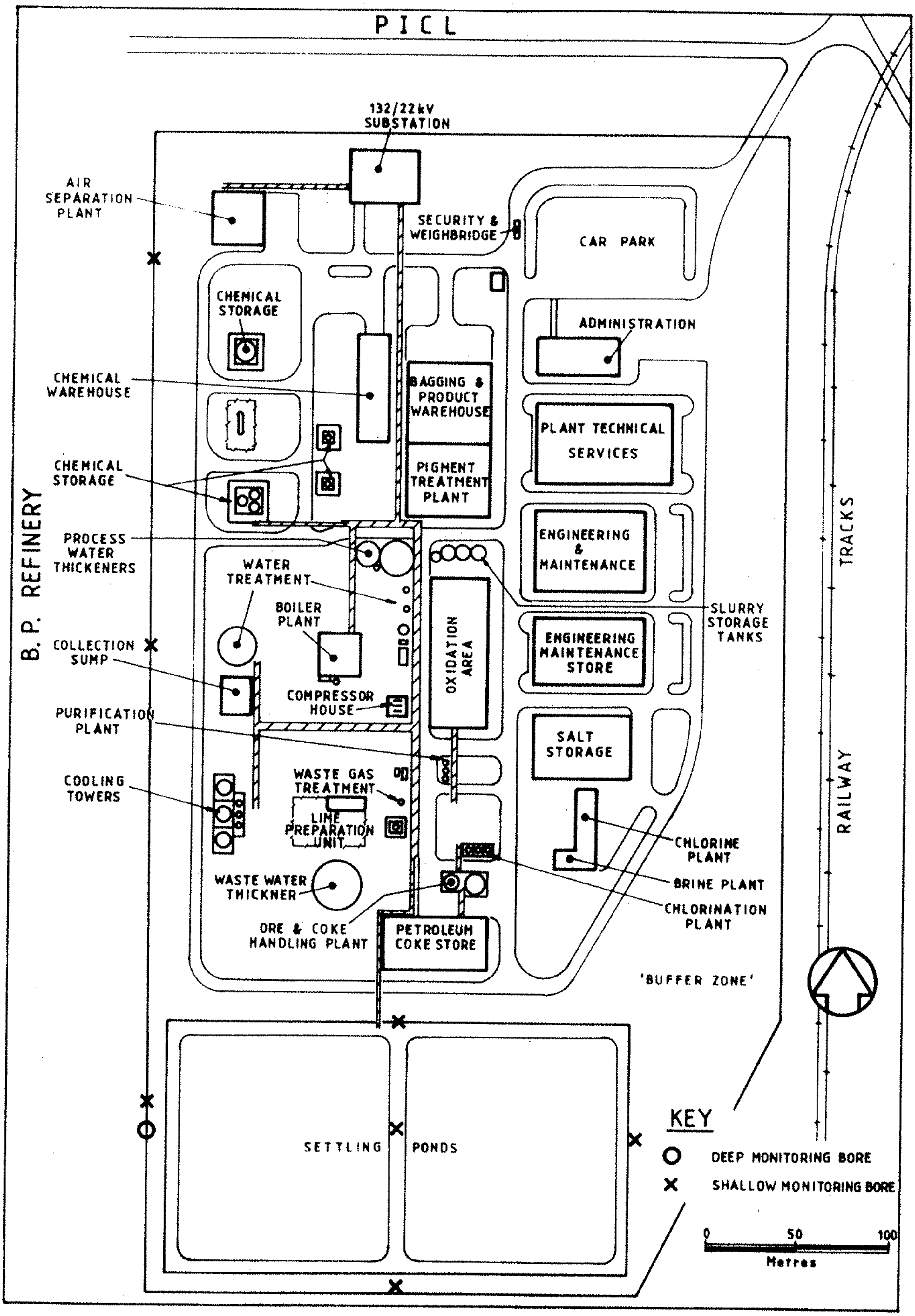
It is the aim of the proponent to minimise the use of water wherever possible. To this end, the cooling water system has been designed as a closed circuit and the process water will be recycled wherever possible.

The pigment plant requires 3000 Ml/yr (340 m^3/hr) of water, 132 m^3/hr of which will be treated for use as process water. The majority of the treated water will be used in the Chemical Treatment and Utilities Units. The untreated water will be used for cooling water and other plant water needs.

4.3 Ponds and Monitoring

M1, M2, M3, M4, M6, EPA33b, Hd

The current total planned capacity of the two settling ponds is approximately 120,000 m^3. At full production liquid effluent will be produced at a rate of 6,000 m^3/day. Only one pond will be used for daily operations whilst the other will be kept as a spare. The daily operational pond will continuously discharge into Cockburn Sound or Cape Peron Outfall (see Section 5.1 for more details). The pond discharge piping and pumping will be designed to handle the worst case 100 year rainfall.



PROPOSED PLANT LAYOUT
AND MONITORING BORE NETWORK

Figure 1

As stated in Section 6.3.4 of the ERMP, the settling ponds will be lined with high density poly-ethylene to prevent any leaching into the groundwater. As a precautionary measure, the groundwater will be monitored for leakage from the ponds by means of eight bores to be located around the site. The locations are shown on Figure 2. Seven of the bores will be shallow to monitor water quality at the surface of the water table. The remaining bore, located on the western side of the settling ponds, will monitor water quality at the base of the Safety Bay Sand Aquifer.

The following parameters will be monitored on a quarterly basis; chlorides (Cl), manganese (Mn), sodium (Na), sulphates (SO_4), total chromium (Cr), total dissolved solids (TDS), pH, specific conductivity and water level. The ground water sampling procedure and reporting programme will be detailed in the Environmental Management Plan (EMP) which will be submitted to the EPA prior to commissioning of the plant.

4.4 Atmospheric Emissions Control System

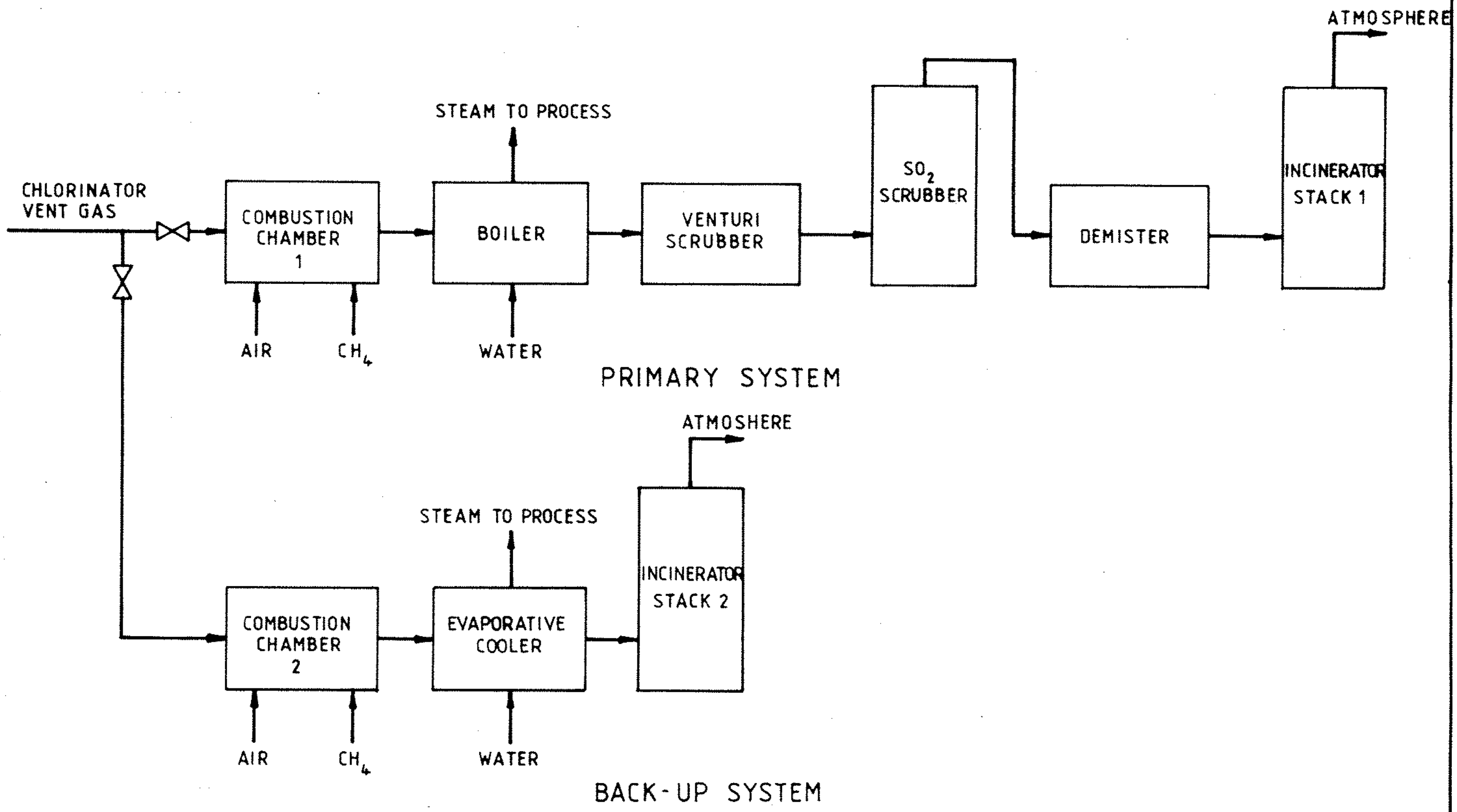
Further refinements have been made to the atmospheric emission control equipment since the ERMP. The chloinator vent gas, vented through Stack 202, will be cleaned by an incinerator system similar to that used at the Hamilton plant (see Figure 2).

The combustion chamber will convert the sulphurous compounds to sulphur dioxide (SO_2) and the carbon monoxide (CO) to carbon dioxide (CO_2) with an efficiency of 99.95%. The gas will then be cooled in a boiler before being scrubbed of SO_2 and vented to the atmosphere.

The incinerator on-line efficiency is 85% and the overall plant efficiency is 95%. The 10% of the time that the incinerator will be down while the plant is still operational the chlorinator vent gas will be directed to the back-up incinerator system (see Figure 2). This system will convert the sulphurous compounds to SO_2 and the CO to CO_2 as in the primary system. The gas will then be cooled in an evaporative cooler before being vented to atmosphere.

The results from the dispersion modelling of the emissions from both Incinerator Stack 1 and 2 can be found in Section 5.5 and Appendix 3 of this report.

Any chlorine gas that passes through the chlorinator unreacted will be directed to the main vent gas. This gas will be scrubbed with hydrochloric acid and then with lime. The later will remove the residual chlorine. This scrubber system will consist of two lines in parallel for both maintenance and emergency purposes. The system will operate with a scrubbing efficiency of 99.95%.



INCINERATOR SYSTEM FOR THE PIGMENT PLANT

FIGURE 2

All emergency emissions will be directed through one of two scrubbing systems prior to atmospheric discharge. Hence no emergency emissions will be directly vented to atmosphere. The source points of possible emergency emissions are listed in Tables 1 and 2. The emergency emissions listed in Table 1 are to be passed through the scrubbing system detailed in Figure 3 and those listed in Table 2 are to be passed through the scrubbing system detailed in Figure 4. "Vacuum pick-up points" will also be vented to the scrubber systems. These vacuum points are flexible hoses connected to the scrubber inlet piping system. Which are used in sampling $TiCl_4$ and chlorine or replacing valves, etc. The inlet piping system will provide sufficient draft for flow to the scrubber. The scrubbing systems will be operational during both normal and emergency plant conditions.

TABLE 1

VENT GAS STREAM LISTS FOR FIGURE 2

List A - Rupture Discs
- Treatment Reactor
- Crude $TiCl_4$ Storage Tank
- Crude $TiCl_4$ Surge Tank
- Pure $TiCl_4$ Storage Tank
- Accumulator

List B - Relief Valves
- Clorinator Inlet Pipe
- Clorinator Supply Inlet Pipe

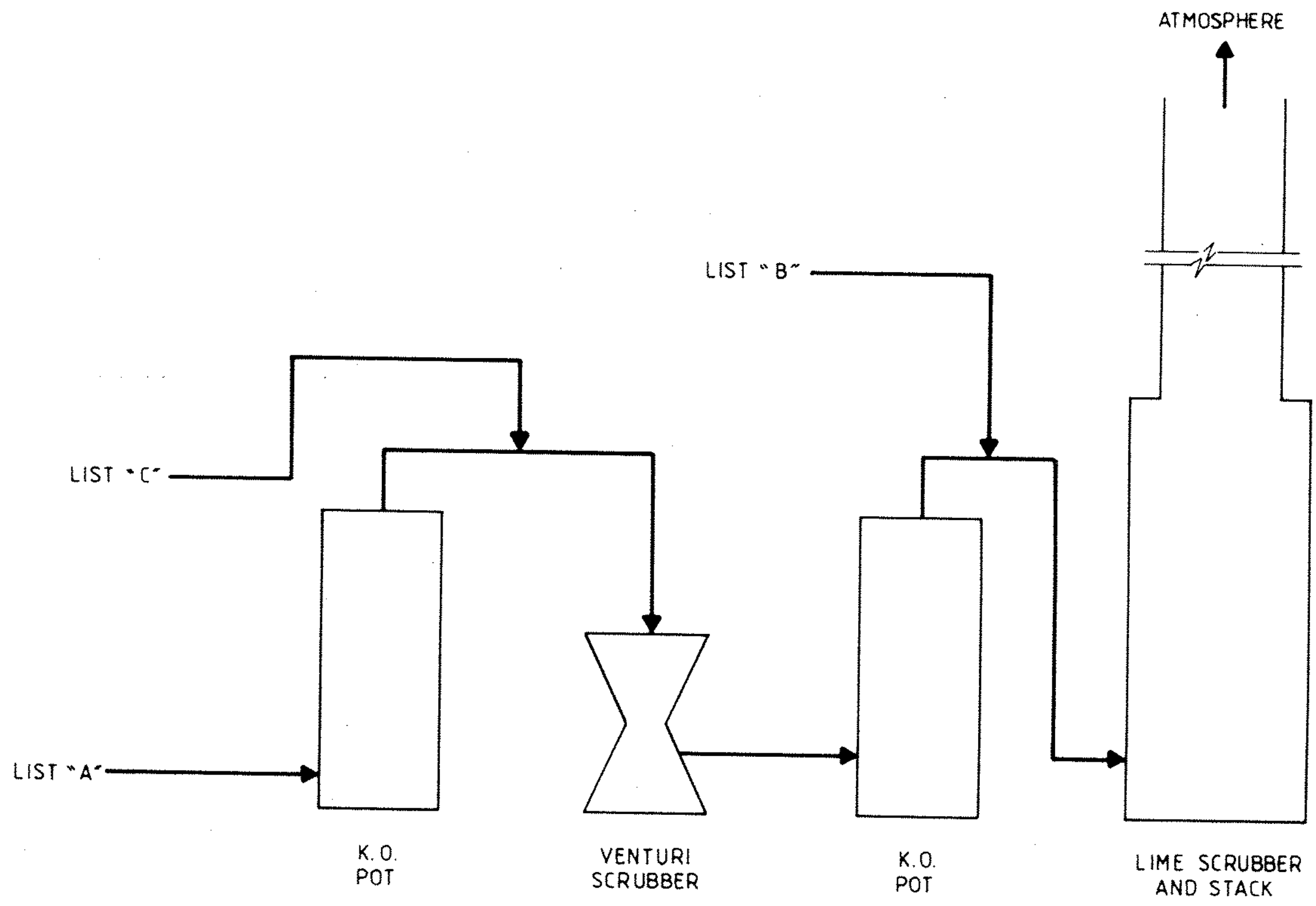
List C - Vents
- Clorinator Waste Solids Tank

TABLE 2

VENT GAS STREAM LISTS FOR FIGURE 3

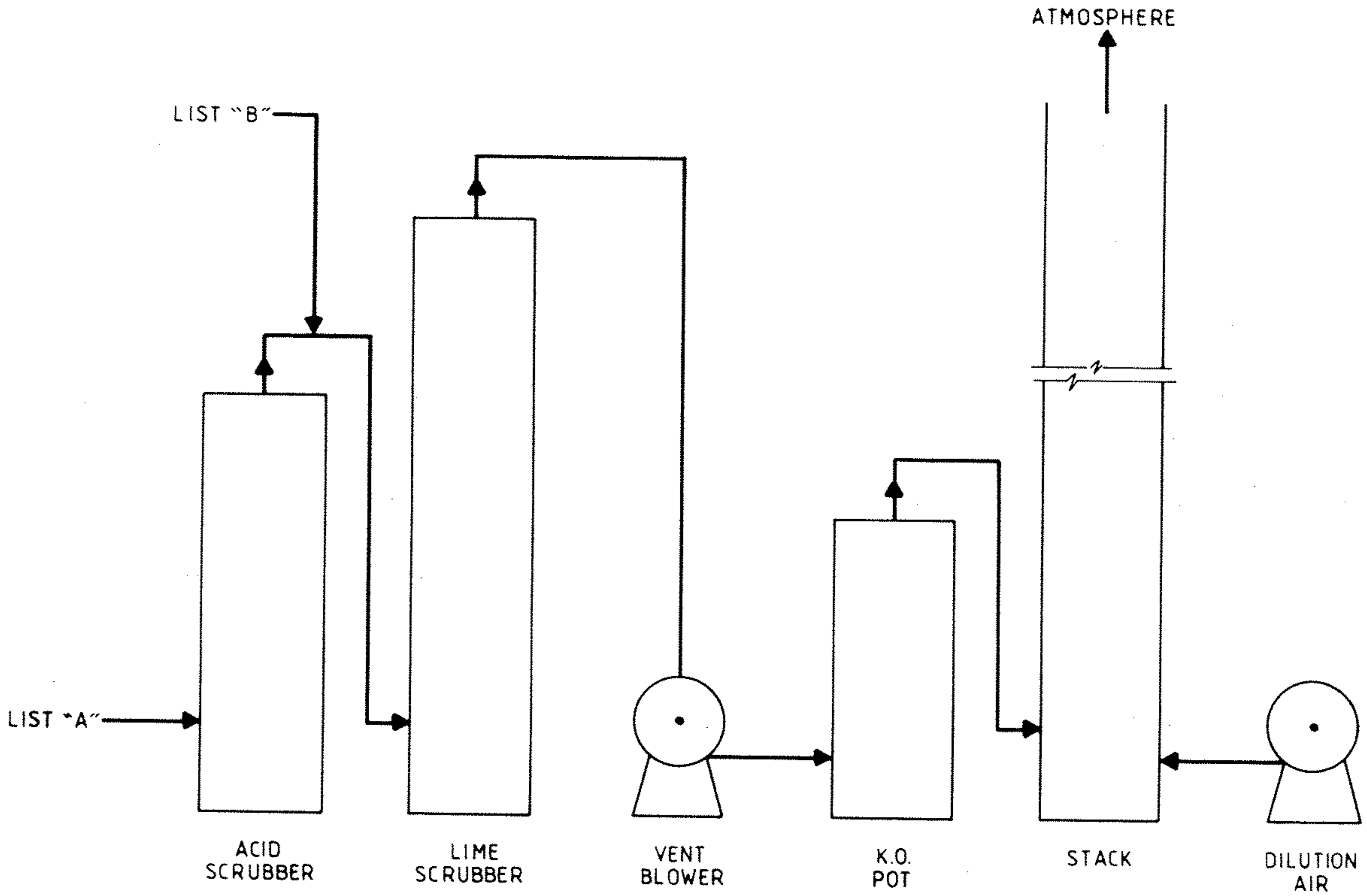
List A
- $TiCl_4$ Vaporiser Rupture Discs
- Aluminum Chloride/$TiCl_4$ Mix Tank Rupture Discs
- $TiCl_4$ Quench Tank Vents
- Vacuum Pick-up Points

List B
- Guard Filter Rupture Discs
- Process Vent Oxidation Lines
- Sand Separator Rupture Discs
- Pre-treatment Sump Scrubber Vents
- Demister Safety Valves
- Sulphuric Acid Scrubber Rupture Discs
- Vacuum Pick-up Points



SIMPLIFIED FLOW DIAGRAM
CHLORINATOR SUMP VENT GAS AND UTILITY SCRUBBER

FIGURE 3



SIMPLIFIED FLOW DIAGRAM
UTILITY SCRUBBING FOR UNITS 200 - 300

FIGURE 4

One boiler at the pigment plant will be equiped with a steam turbine driven boiler feed water pump and a steam turbine boiler draft fan. This boiler will remian operational during a power failure. In addition, there is a steam driven emergency generator which provides control power to the emergency boiler and other emergency power services.

In the case of a power failure, the emergency scrubbing system will remain operational. Energy for the scrubber system liquid cirrculation pumps and exhaust blowers will be supplied by steam turbine 'back-up' drivers which will automatically activate in a power failure. The steam for the turbine 'back-up' drives will be provided by the emergency boiler that was previously described. This type of emergency system has proven to be effective at the pigment plant in Hamilton.

There are three types of events which would require emergency scrubbing of $TiCl_4$ or chlorine: plant shutdown, relief valve failure, and busting of a rupture disc.

Power failure, or any other causes for immediate shutdown of the plant, will cause the oxidiser units (No 2 on list B Table 2) to vent to the scrubber system for Units 200 - 300 (Figure 4). As this is a control function and part of the control system logic it would not involve bursting of rupture discs nor operation of safety valves.

Emergency venting will be required in the event of a rupture disc bursting or the operating of a safety valve. Such incidences usually would be caused by failure of control equipment ie. pressure controllers. In this case the $TiCl_4$ or chlorine will be released to a relief line which is be connected to the appropriate scrubbing system.

4.5 Phosgene

M17

During normal chlorination operations there will be no production of phosgene (carbonyl chloride) for the following reasons:

(1) Phosgene is formed only when chlorine "slip" (unreacted chlorine passing through the fluid bed is termed as slip) occurs and carbon is present and the temperature is under 500°C.

(2) Phosgene disassociates 100% to chlorine and carbon monoxide at 800°C.

(3) Normal operating temperatures of the fluid bed is above 980°C.

In the unlikely event that the fluid bed is operated under severely poor conditions then chlorine slip can occur and phosgene can be formed.

In such a case, instrumentation and operator tests will confirm that this condition exists and chlorination will be shut down.

If the chlorinator was not shut down the phosgene would be effectively scrubbed out of the vent gas stream by hydrolysis, using a lime scrubbing system.

4.6 Process Chemicals

EPA75, M25, M26e

Material Safety sheets for sodium aluminate, sodium silicate, sulphuric acid, aluminum chloride, lime, hydrogen chloride, caustic soda, calgon, and dutrex treating oil are provided in Appendix 1.

Details of the process chemicals used in the plant have been given in Section 4.2.2 of the ERMP. However, further details of their uses in the plant are as follows:

- **Sodium Aluminate** will be used in the finishing section to precipitate alumina onto the TiO_2 particles.

- **Sodium Silicate** will be used in the finishing section to precipitate silica onto the TiO_2 particles.

- **Sulphuric Acid** will be used in the chemical treatment section of the finishing section for the adjustment of pH. It will also be used in the oxidation section for scrubbing of the chlorine gas. In the chlorine plant it will be used to dry the chlorine gas released from the electrolysis cells.

- **Aluminum Chloride** will be used in the oxidation section as a treatment chemical for the raw TiO_2 produced there.

- **Lime** will be used in the chlorination section for alkaline scrubbing of the vent gases. It will also be used in waste water treatment section for pH adjustment.

- **Calgon** will be used as a wetting agent in the oxidation section to disperse the TiO_2 particles to form a water based slurry.

- **Hydrochloric Acid** is a by-product from the chlorine plant and it will be used as a scrubbing agent in the atmospheric emissions control systems.

A total of 3,000tpa of sulphuric acid will be required for production, not 1,000tpa as stated in Section 4.2.2(5) of the ERMP.

Chemicals to be used in the treatment of the salt in the chlorine plant are sodium carbonate, caustic soda, and hydrochloric acid. The last two will be produced as a by-product of the process. Sodium carbonate, a non hazardous material, will be trucked onto site as described in Section 4.2.2 of the ERMP.

The list of hazardous materials stored on the site is given in page 25 of the ERMP, Volume 2. Further details of their storage and the associated risks are provided below.

Chlorine will be stored in refrigerated tanks in a completely enclosed system which will be vented to a caustic scrubber. This corresponds to current international state of the art safety design. Even in the unlikely event of a large leak, no chlorine will be released to the atmosphere. The caustic scrubber is duplicated with a fully redundant unit in series, so that the chance of a chlorine escape through the scrubber is negligible.

Three pure $TiCl_4$ storage tanks in Unit 200 will be adjacent to each other in a bunded area. This bunded area will be 100%, this will include allowances for footing etc. It will also be lined with HDPE sheets. Design of the bunded area will provide for collection of liquid in a small sump with provision to pump collected water or spill residue to the neutralisation system and $TiCl_4$ to process.

Hydrogen chloride fumes generated in any theoretical spill would not extend to residential areas as shown in the Preliminary Risk Analysis Study.

The emergency procedures to be used are outlined in Appendix 4 of the ERMP, Volume 2. Detailed emergency procedures and spill clean up procedures will be developed by the proponent as part of the HAZOP study.

The other chemicals involved are sulphuric acid, 33% caustic soda and 25% hydrochloric acid. The storage areas for these chemicals will be bunded to contain any spills. The quantities stored are small and there is no off-site risk from these chemicals. The plant personnel will be fully trained in spill clean up procedures.

The only other hazardous substance is liquid petroleum gas (LPG). The storage is only 20 tonnes, which is quite small compared to storage of LPG in neighbouring installations. The LPG tank will be fitted with a water spray deluge system and normally operated emergency isolation valves, so that any leak would be dispersed and the tank kept cool. The design will conform to the most up to date standards for LPG storage.

A comprehensive risk analysis of the proposed plant is included in the ERMP as Volume 2. The analysis concluded that "the TiO_2 pigment plant would not pose an undue risk to the residential areas in and around Kwinana either on its own or in a cumulative sense".

The level of risk has been shown to be less than the EPA Guidelines for acceptability.

4.7 Plant Enclosure

EPA33a, M7

Each of the three operating areas, or units, of the plant are described and requirements for enclosing the process in a building are discussed below.

The chlorination process unit (Unit 200) consists basically of steel vessels, piping, etc., for $TiCl_4$ handling and FRP vessels, piping for vent gas scrubbing and handling . All of this equipment is of durable construction and is not affected by rain water or other weather conditions. The process, except for downstream vent gas scrubbing, operates under positive pressure and this eliminates the possibility of water in-leakage.

From a process and safety viewpoint there is no reason to enclose this area in a building.

The oxidation unit (Unit 300) can be separated into three distinct types of operation and equipment, from the viewpoint of enclosure or the need for enclosure.

The upstream process equipment, for heating and vaporisation of $TiCl_4$ is of steel or glass-lined steel and operates under positive pressure. This equipment is unaffected by weather conditions. One small area is for handling of aluminium chloride and this is normally protected against contact with water.

The process area of $TiCl_4$ gas preheating, oxygen preheating and subsequent oxidation operation consists of furnaces and oxidisers which require rather precise temperature and pressure control plus protection from weather elements. As a result this area will be enclosed in a substantial building which is ventilated.

The downstream process area, although partially constructed of more sophisticated alloys, is operated under positive pressure and very precise temperature and pressure control is not necessary. Any leaks would be external and because of positive pressure there is no risk of water in-leakage. Process vessels are pressure protected and venting, either controlled or through rupture discs, is to a gas scrubber system. There are no $TiCl_4$ liquid nor gas streams in this area. No benefits to the community can be achieved by enclosing the outside areas of Units 200 and 300.

The finishing area (Unit 400) is enclosed in a ventilated building, with the exception of some storage tanks and vessels which do not require weather protection. This area includes wet milling, treatment, filtration, drying etc., and water or dust entering the process stream would be detrimental to the process or to the product quality. There are no process streams of $TiCl_4$ nor chlorine in the finishing areas and operator safety is not affected by the option of enclosure versus non-enclosure. Any dust leaks would normally be contained the building and would not pose a problem to the community.

4.8 Chlorine Plant

M8, M9, M11, M13, M22, M24, AND M29.

The chlorine plant will be of similar design to the existing SCM plant and the proposed PICL plant. Information from these two plants has provided practical emissions data. This information has been used to assess the impact of the plant for the ERMP, taking into consideration the specific site.

State of the art membrane technology will be used for gaseous separation in the electrolysis cells. The gaseous chlorine coming off the cells will then be liquified for two reasons: to increase the purity of the chlorine gas by reducing the oxygen content; and to provide flexibility in pigment plant chlorine feed rate.

It is necessary for the chlorine plant to operate continuously to prevent membrane deterioration. The pigment plant however requires feed chlorine only on an as required basis. Chlorine storage is therefore needed to provide a surge capacity between the chlorine and pigment plants.

There will be three chlorine storage tanks each having a capacity of 25 tonnes of chlorine. However, at no time will more than 50 tonnes of chlorine be stored. The extra 25 tonnes of storage space is intended to provide backup if one of the other tanks is taken out of service. It is necessary to have some chlorine in all three tanks so that the third can be used as an immediate substitute. The hazards associated with chlorine tank leaks will be reduced due to lower volumes of chlorine in the individual tanks as a consequence.

The specific design standards for the chlorine tanks will be determined at the detailed design stage and will be submitted to the appropriate government agencies for checking and approval.

The bunding around the chlorine tanks will be sufficient to hold 25 tonnes of chlorine or the contents of one full tank.

In the event of a power failure the emergency scrubbing system will collect and scrub the fumes being produced in the chlorine plant. This emergency equipment will be steam driven. The steam will be produced by a boiler. The emergency boiler has a steam driven boiler feed water pump and a steam turbine driven draft fan. The power for the boiler instrumentation will be supplied by an emergency generator.

5. PLANT EMISSIONS AND IMPACT

5.1 Liquid Waste

EPA43, EPA61, M5, M26a, M26b, M28, HC2, Ha, Hd

Liquid effluent from the pigment plant itself makes up 94% of the total liquid waste. The composition is detailed in the ERMP. The pH will be within the range of 6.5 to 8.5 as required in Water Quality Criteria for Marine and Estuarine Waters of Western Australia, Schedule 3.

The chlorine plant effluent makes up the remaining 6% of the total liquid effluent and will have the following composition:

Sodium chloride	<150g/l
Sodium chlorate	<3g/l
Sodium sulphate	<5g/l
pH	>7
Solids ($CaCO_3$ and $Mg(OH)_2$)	<4%
Temperature	<50°C

These two liquid waste streams will be combined, producing 3000 megalitres of process plant effluent per annum.

The pH and temperature of the pigment and chlorine plant waste water streams are essentially the same. The heavy metals in the pigment plant effluent are not present in the chlorine plant effluent and thus are diluted by the chlorine plant waste water. There are three ions, sodium (Na), chlorides (Cl), and sulphates (SO_4), present in both the pigment and chlorine plant liquid effluent The resulting concentration of these ions from combining the two effluent streams is as follows:

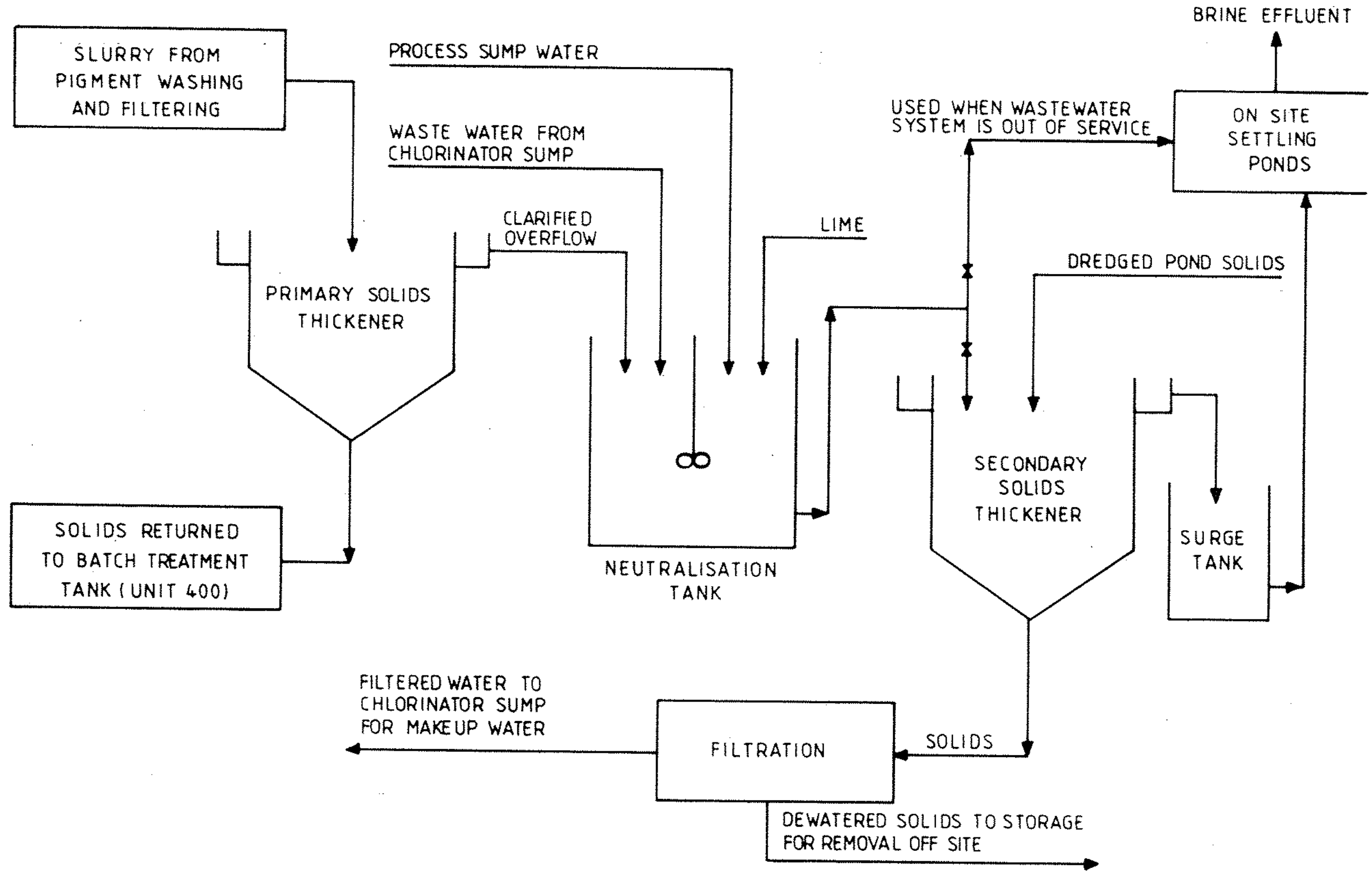
Na	<5,500 ppm
Cl	<11,600 ppm
SO_4	<490 ppm

The concentration of these ions is still below values typical for seawater (see Table 5.4 in the ERMP).

The wastewater treatment system for the pigment plant has been revised as follows. Figure 5, the revised ERMP Figure 4.10, is a flowsheet detailing the updated wastewater treatment system.

Process wastewater will be pumped to a neutralisation tank for pH adjustment and then to a solids thickener. It may be necessary to add flocculant to aid in settling in the solids thickener. A research project is currently being conducted to study settling rates. The results of this study will be used in the final design of the wastewater treatment system.

The overflow from the solids thickener will be pumped to one of two on-site settling ponds. The settling ponds will be used to settle out any solids that are not removed in the solids thickener. The discharge from the operating pond will overflow to either Cockburn Sound or Cape Peron Outfall. The second pond will be kept as a spare pond or backup pond.



REVISED WASTEWATER SCHEME FOR THE PIGMENT PLANT

FIGURE 5

The underflow from the solids thickener will go to a filtration step for solids dewatering. The water removed from the solids will be pumped to the Unit 200 chlorinator sump for make up water. The dewatered solids will be collected and trucked to the Muchea site. At the Muchea site, the pigment plant waste solids will be combined with the synthetic rutile waste solids and trucked to the mine site for landfilling.

When the wastewater system is out of service for maintenance, the neutralised wastewater will be pumped directly to the operating pond to settle the solids. The water will discharge from the pond as in normal operation. At some point in time when the operating pond begins to fill with solids, the second pond will be put into service. A floating dredge will be used to remove the solids from the operating pond. The dredged solids will be pumped back to the solids thickener and be removed in the normal operating procedure.

The majority of the piping will pass over concrete pads or hardstanding which will be required to have kerbed areas with sumps. In the event of a spill the liquid will be collected in the sump and pumped to the plant neutralisation system. Any contaminated rainwater will be pumped through a separate neutralisation system and then be pumped to the settling pond. Areas of the plant where contamination of the rainwater runoff is not possible will be allowed to drain off the plant site through surface ditches.

Should an accident occur involving spillage outside the controlled drainage areas, reclamation will be made by either spear or sump dewatering depending on the nature and volume of the material released.

The issuing of a licence to discharge treated process plant effluent into Cockburn Sound is conditional upon the discharges meeting water quality criteria specified by the EPA. Examples of such criteria are given in the publication "Water Quality Criteria for Marine and Estuarine Waters of WA" under Schedule 3. The treated effluent will comply with these particular criteria. A preliminary water quality assessment concluded that a diffusor could be designed for the plant effluent such that the EPA thermal water quality standard will be met. This report can be found in Appendix 2.

As discussed in the ERMP (Section 4.5.6) the residual radioactivity in the treated effluent is of the same order as that occurring naturally in Perth groundwater and commensurate with drinking water standards. The mixing interface between the groundwater and the waters of Cockburn Sound also will not be affected by the discharge as it too contains a similar order of naturally occurring radioactivity.

The impact on naturally occurring radiation levels in Cockburn Sound as a result of the discharge of treated effluent will therefore be negligible.

If the State Government directs that the liquid effluent be discharged via the Cape Peron outfall, it is reasonable to assume that the level of environmental assessment required by the EPA would be related to the quality and quantity of the effluent being discharged. Again the quality of the plant effluent water is such that it will meet the discharge conditions currently applied to the Cape Peron outfall by EPA.

The Cooljarloo Joint Venture plans to utilise a septic tank system with a dispersion field. The requirements for this system will be supplied by the Town of Kwinana for approval.

5.2 Solids

M27, HCl

The process produces an estimated 20,000 tonnes (previously 30,600 tonnes) of solid waste corresponding to a production level of 54,000tpa of final product. Table 4.2 in the ERMP is revised as follows:

TABLE 4.2 (Revised)
OUTPUTS-PRODUCTION PROCESS PLANT (54,000tpa)

Description	Quantity
Final Product	54,000tpa
Hydrochloric Acid (for sale)	5,000tpa
Solid Effluents -	
. coke/ore blend	8,000tpa
. metal hydroxides	5,400tpa
. calcium sulphites/carbonates	6,000tpa
. inert and plant trash	600tpa
Liquid Effluents (unchanged)	
. brine solution	2,200 megalitres per annum
. washdown, waste filtrate	Refer Section 4.6.4

The quality of the solid wastes, as determined by leachate tests on the Hamilton Plant solid wastes, is given in Table 4.4 in the ERMP. Soluble salts and in particular chlorides contained within the wastes have not been reported in the tests.

Calculations for a worst case leachate test were done to assess the impact of chlorides leaching out of the solid waste. The leachate test is based on a 20:1 dilution of the leachate and worst case conditions assume 100% leaching of chlorides out of the solids. The pigment plant waste contains 0.1% w/w chloride which would result in a chloride concentration of 50 ppm in the leachate. Testing of the groundwater at the mine site found chloride levels of 290-300mg/l whereas the acceptable chloride level for drinking water in the US is 250ppm (Safe Drinking Act 1974).

The solid waste will be stored at the pigment plant on concrete aprons. For transportation the solid waste will be dewatered to the extent necessary to prevent liquid loss during transport but not to the extent that dust will occur.

A WA hauling contractor will be utilised to transport the solids to the Muchea site. Here the solids will be transferred to outbound wet concentrate road trains for transport to the Cooljarloo mine site.

The proponent is committed to achieving a very high standard of rehabilitation of the Cooljarloo mine site. This commitment is outlined in the Cooljarloo Mineral Sands Project ERMP and details of the rehabilitation plan will be outlined in the mine site EMP and will include details for the disposal of the pigment plant solid waste product.

Equipment used in the transport of solid wastes will be designed and operated to prevent leakage onto roads and to prevent dust or airborne losses. The equipment needs are currently under study and will be completed during the detailed design of the synthetic rutile and pigment plants.

5.3 RADIATION

EPA42, EPA59, M31, Hb, Hc, He

Radiation levels in the solid waste are reviewed below.

On the basis of experience at the Hamilton Plant, virtually all the radioactivity in the synthetic rutile feedstock will end up in the solid waste. Thus feedstock with 15ppm uranium and 100ppm thorium would result, after processing, in solid wastes having levels of some 45ppm and 300ppm respectively, based on a 3:1 feedstock to waste generation weight ratio. (The value of <9ppm for thorium in solid wastes reported in Section 4.6.5 of the ERMP is incorrect.)

The absorbed dose rate from the stored waste at the plant would be of the order of 1uGy/hr so an employee working in the immediate vicinity for as much as 1,000 hours per annum would receive an effective dose equivalent of 1mSv in one year. This compares to a dose limit of 5mSv/annum for a non-designated employee and 1mSv/annum for a member of the public given in the Code of Practice.

The solid wastes will be routinely transported to the Cooljarloo mine site for burial. The thorium content of the orebody averages 300ppm. Thus, by returning the wastes to selected excavated orebody zones the naturally occurring levels of radiation in these backfilled zones will be unaffected. The gross radioactivity of the original orebody will be substantially reduced because of the removal of monazite in the mining and treatment process. A cover of 2m of soil over the backfilled area will bring surface levels of radiation within the original background levels prior to mining.

Regular checking and reporting to the appropriate authority will be carried out to ensure that the above-mentioned uranium and thorium levels in the feedstock, solid wastes, liquid wastes and product are met and maintained. Details of this monitoring programme will be provided in the EMP.

Decontamination of any process plant equipment with enhanced radioactivity is discussed in Section 7.10 of the ERMP. Radiation surveys of the KMCC Hamilton Pigment Plant have demonstrated that build-up only occurs in the brick lining of chlorinators and chlorinator outlet piping.

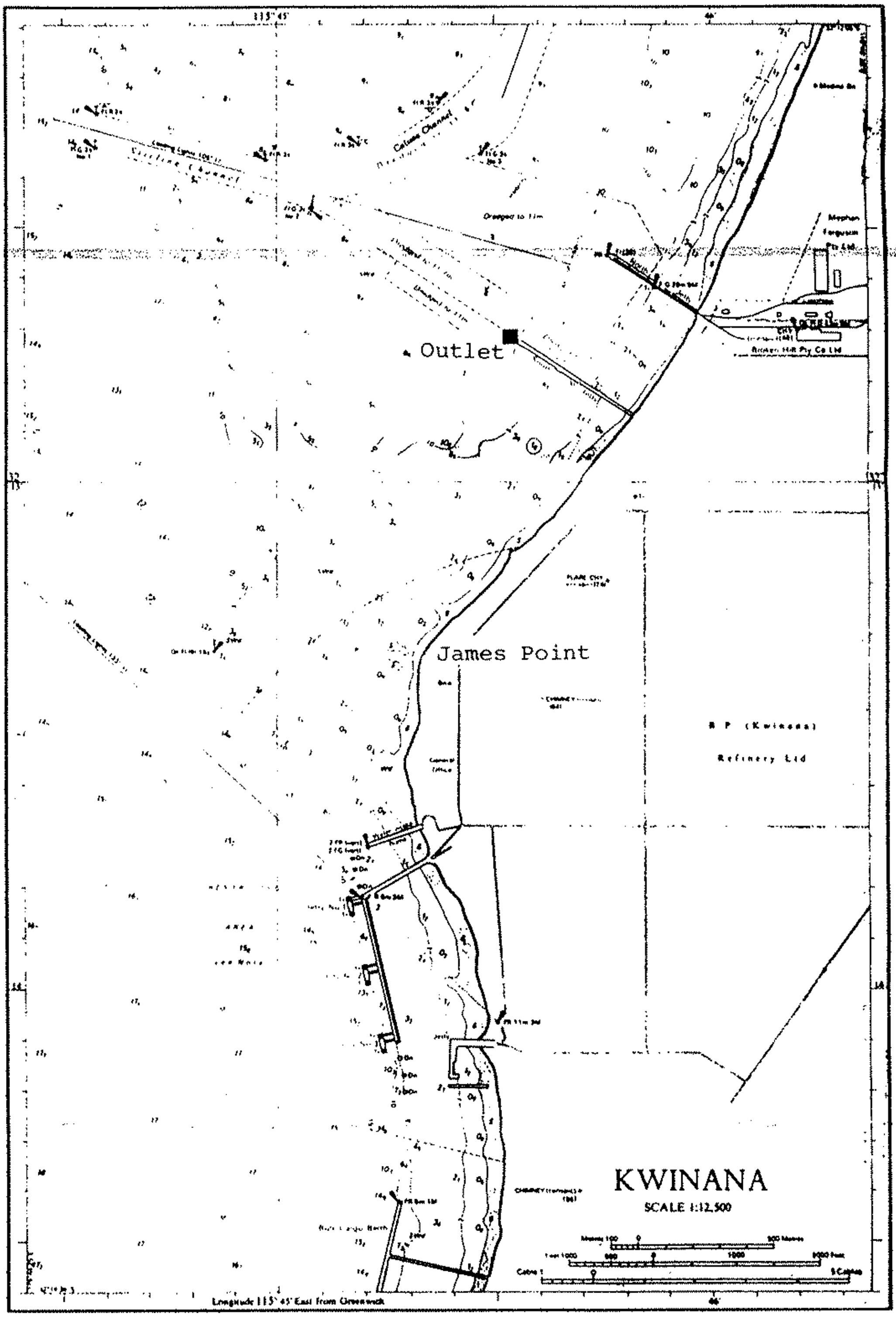


Figure 1.1 Location diagram.

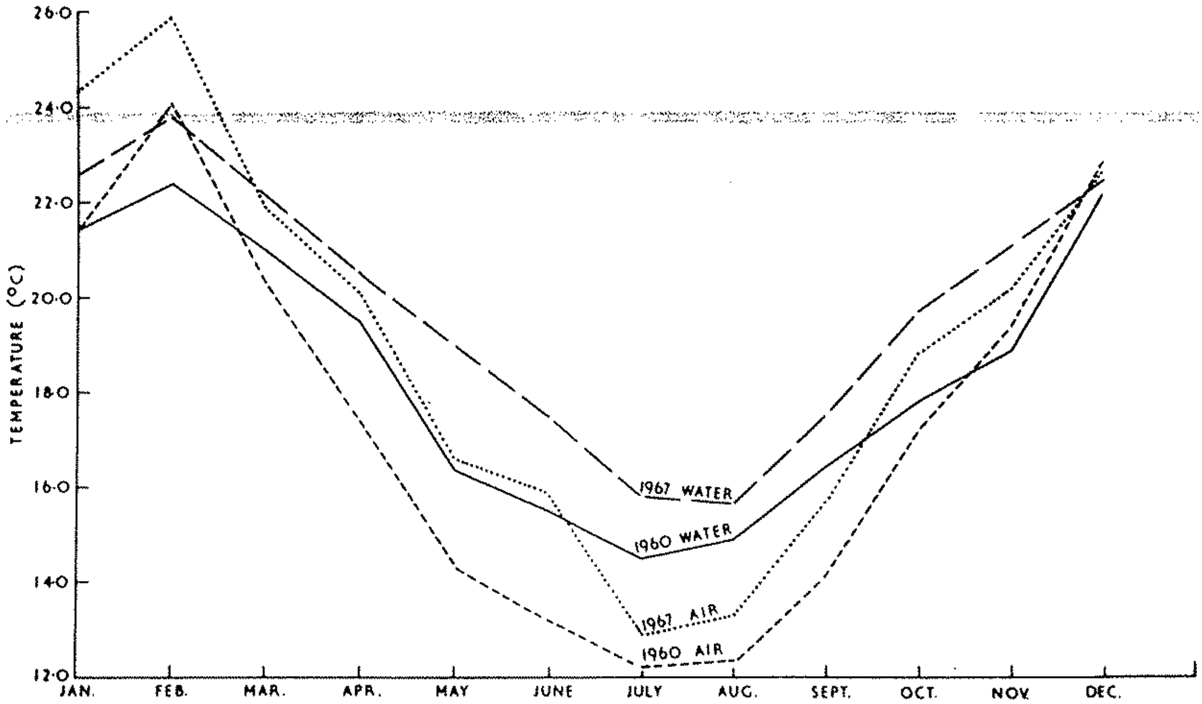
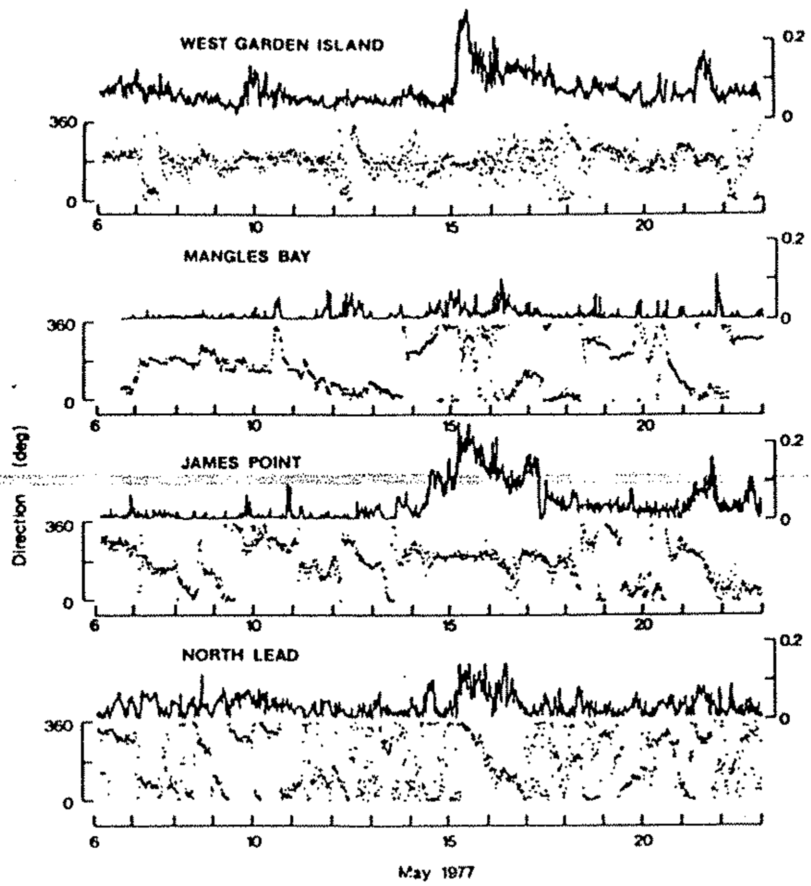
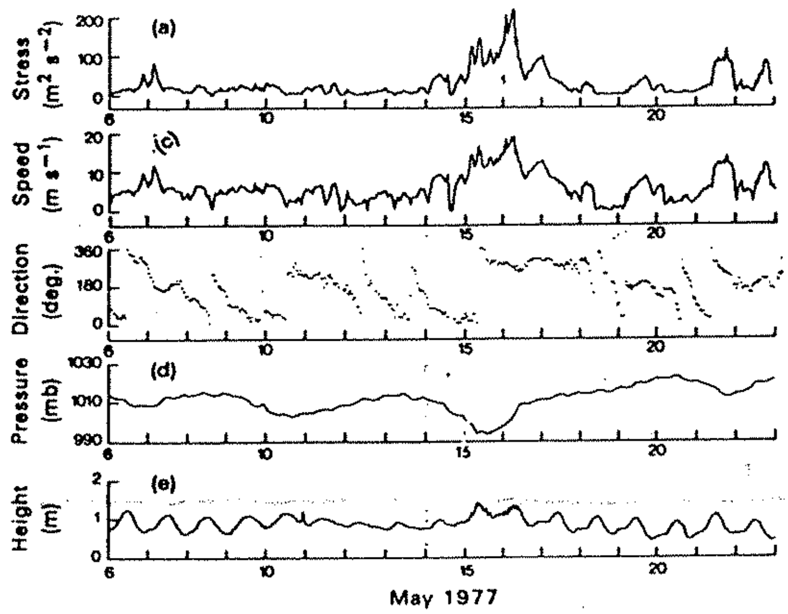


Figure 1.—Monthly mean surface water temperatures in the Forebay, BP's (Kwinana) refinery, Cockburn Sound, (mean of daily minimum and maximum) and monthly mean air temperaure at Perth, Western Australia during 1960 and 1967.

Figure 2.1 Mean monthly air and sea water temperatures representing Cockburn Sound area (from Hodgkin and Phillips, 1969).

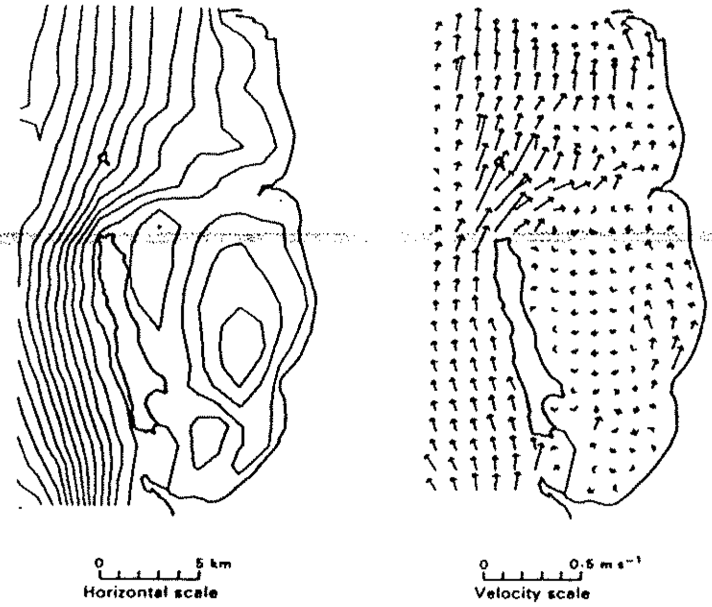


Example of the current records, 6–22 May 1977.

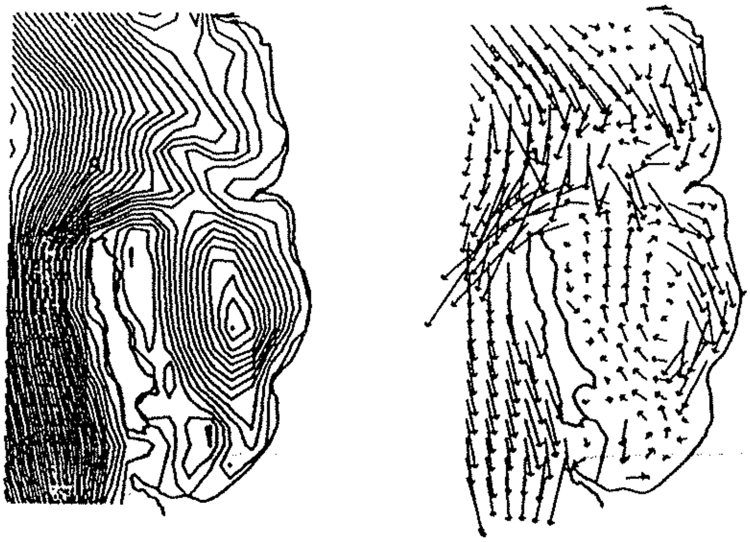


Tide height at Fremantle (collected by FPA, *e*), barometric pressure (recorded in Perth by Bureau of Meteorology, *d*), wind speed (*b*) and direction (*c*) (collected by FPA), and wind stress (represented by the square of the 10-m wind speed, *a*), 6–22 May 1977.

Figure 2.2 Examples of wind driven current meter records in Cockburn Sound (from Steedman and Craig, 1983). The James Point record is closest to the Alcoa Kwinana plant site.



(a) Numerical simulation of circulation under sea breeze conditions: 1800 hours January 28, 1975.



(b) Numerical simulation of circulation under winter storm conditions: 0000 hours May 28, 1975.

Figure 2.3 Example of calculated circulation patterns in Cockburn Sound (from Steedman and Craig, 1983). Streamline spacing is 500 m^3 s^{-1}.

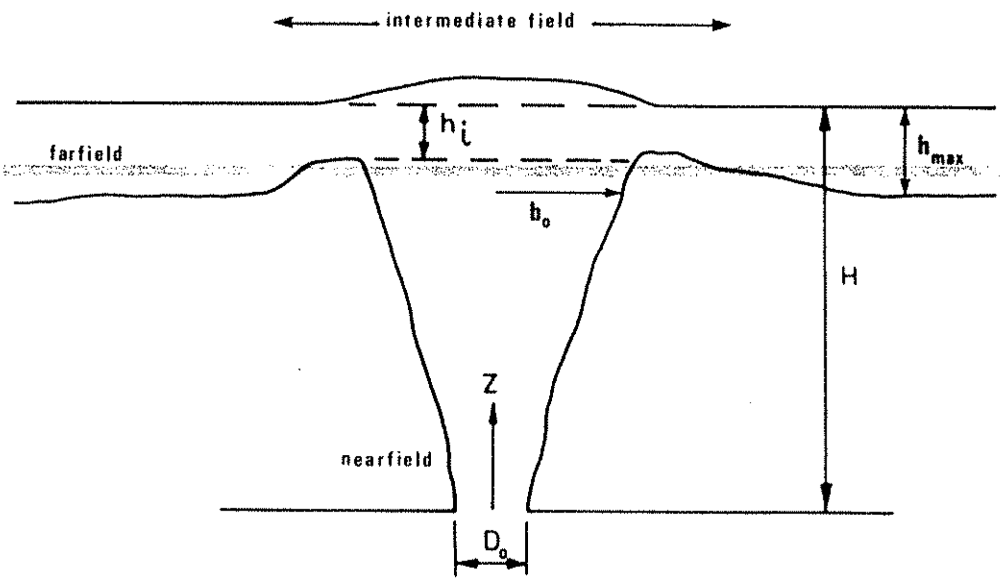


Figure 3.1 Vertical round jet in deep water, showing impingement zone.

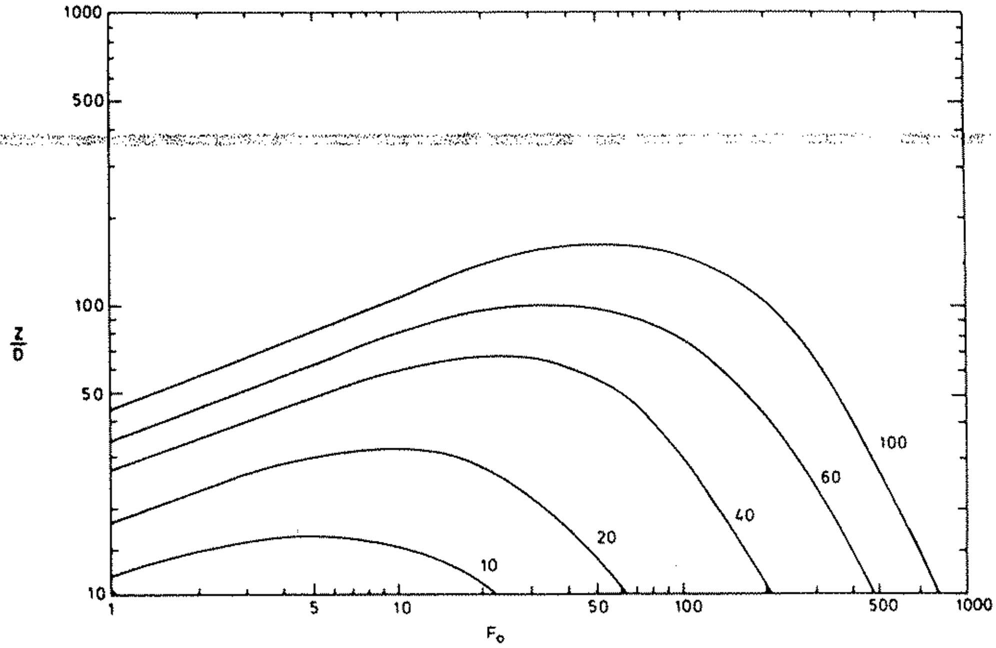
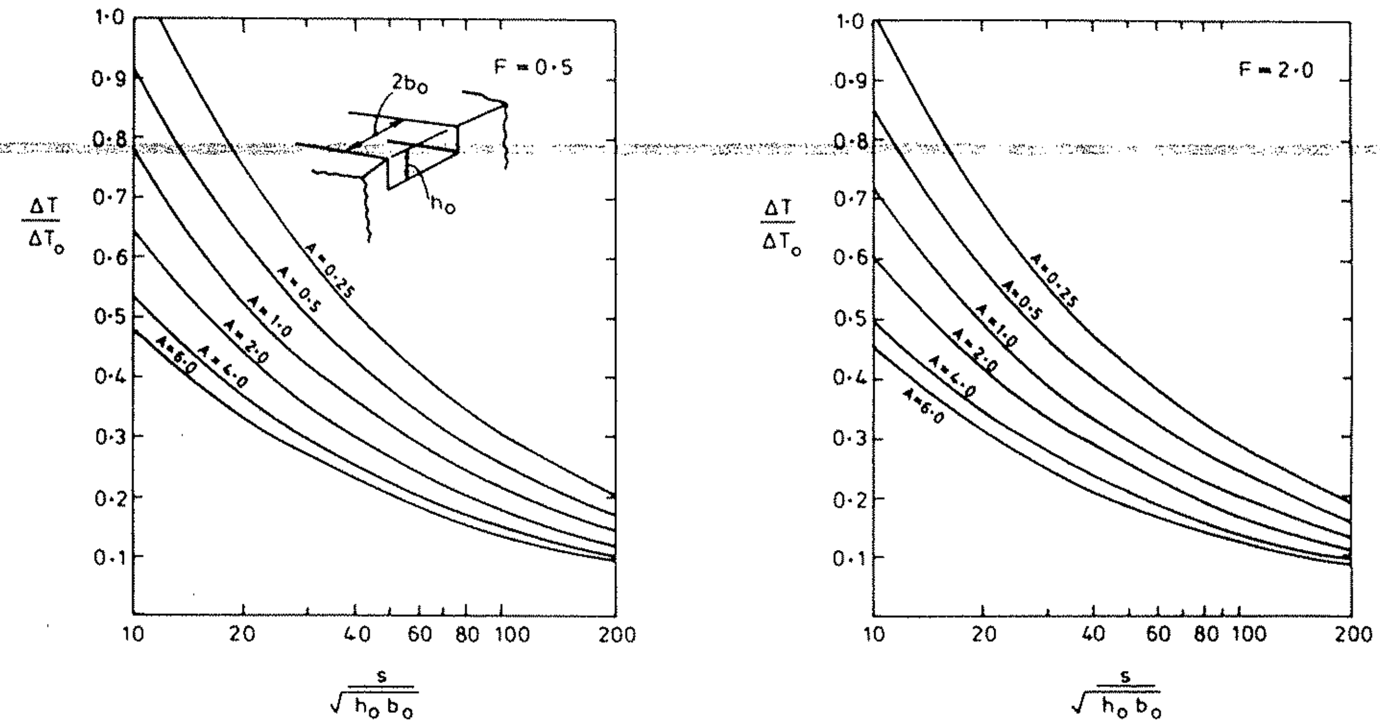


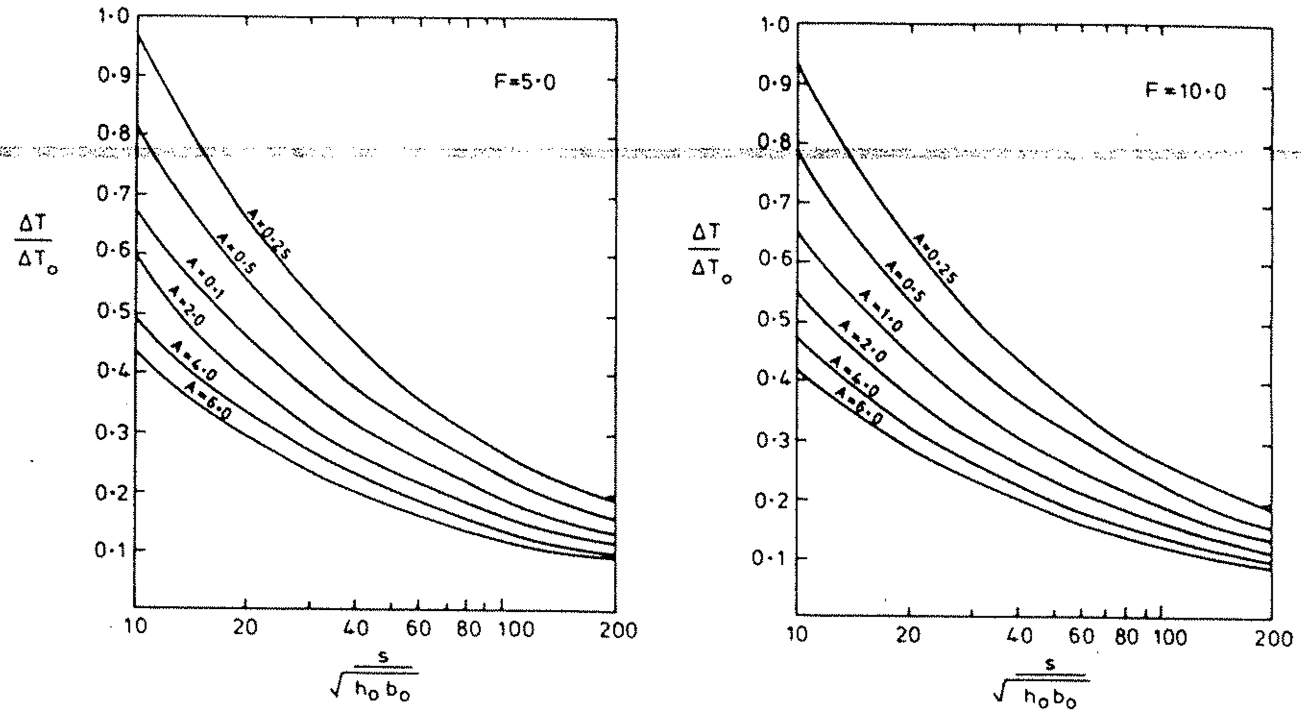
Figure 3.2 Centre-line dilutions, $10 < S_c < 100$, for submerged round horizontal jets as a function of Z/D_o and F_o.



(a) F = 0.5

(b) F = 2.0

Figure 3.3 Surface discharge into deep water - centre line temperature decay in stagnant ambient conditions, for various Froude numbers, F.



(c) F = 5.0

(d) F = 10.0

Figure 3.3 Surface discharge into deep water - centre-line temperature decay in stagnant ambient conditions, for various Froude numbers, F.