Nufarm Coogee Pty Ltd

Project Definition Study

Upgrade 17,000 Tpa to 42,000 Tpa

Nufarm Coogee Pty Ltd

Chlor-alkali plant Kwinana

August 1996

Nufarm Coogee Pty Ltd
Kwinana Chlor-alkali Plant
Expansion to 42,000 tonne per annum

THE PURPOSE OF THIS DOCUMENT

Nufarm Coogee Pty Ltd is proposing to modify its existing chlor-alkali plant at Kwinana to permit an increase in production to 42,000 tonne per annum. A Project definition Document has been prepared by Nufarm Coogee Pty Ltd to refer the proposed expansion to the Environmental Protection Authority (EPA) to initiate the environmental approvals process. The document describes the proposal, identifies all environmental factors of relevance to the proposal and tabulates the environmental objectives and management strategies for each factor. The document will be available for comment from Monday 2 September to Friday 13 September 1996.

The document may be viewed at the following libraries:

Town of Kwinana Library
Pace Road
MEDINA WA 6167

Department of Environmental Protection (DEP) Library
Westralia Square
141 St Georges Terrace
PERTH WA 6000

A submission on the Project Definition Document enables the public to become involved at an early stage of the proposal. Comments from Government agencies and from the public will assist the EPA in preparing guidelines for the proposal.

Remember to include:

- your name;
- address;
- date, and
- whether you want your submission to be confidential.

Submissions should be addressed to:

Environmental Protection Authority
Westralia Square
141 St George's Terrace
PERTH WA 6000
Attention: Ms Xuan Nguyen

The closing date for submissions is Friday 13 September 1996

APPEALS

The Project Definition Document also contains information on the proposal to enable the public to appeal to the Minister for the Environment against the level of assessment set by the EPA for this proposal.

If you disagree with the level of assessment set by the EPA for this proposal, you may appeal to the Minister for the Environment outlining the environmental reasons for your concerns, and enclosing an appeal fee of $10.

It is important that you clearly indicate the reasons for your concern so that the grounds of your appeal can be properly considered by the Minister for the Environment.

Appeals should be addressed to:

Hon P Foss MLC
Minister for the Environment
12th Floor, Dumas House
2 Havelock Street
WEST PERTH WA 6005

Your appeal (with the $10 fee) must reach the Minister's office no later than 5.00 pm on Friday 13 September 1996.

Nufarm Coogee Pty Ltd

Chlor-alkali Plant, Kwinana

Upgrade 17,000 Tpa to 42,000 Tpa

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1. Introduction

1.1 The Proponent

Nufarm Coogee Pty Ltd is a Joint Venture company between Nufarm Ltd (80%), and Coogee Chemicals (20%) which owns and operates two chlor-alkali plants in Western Australia for the dedicated supply of chlorine feed stock to the titanium dioxide pigment industry.

1.2 Background and Purpose of This Project

Nufarm Coogee Pty Ltd is contracted to supply chlorine and caustic soda to the TIWEST Joint Venture, for the purpose of manufacture of titanium dioxide pigment at their Kwinana pigment plant.

All chlorine and caustic soda used by the TIWEST pigment plant since it commenced operation in 1991 has been supplied from a chlor-alkali plant located within the TIWEST Kwinana site, and built by Nufarm Coogee for that purpose.

TIWEST Joint Venture are now proposing to increase production capacity of their Kwinana pigment plant in three stages:

- from 80,000 Tpa to 120,000 Tpa during 1998
- from 120,000 Tpa to 165,000 Tpa by 2000
- final de-bottlenecking from 165,000 Tpa to 180,000 Tpa

In order to supply the additional chlorine required for the expansion of the TIWEST Pigment Plant, Nufarm Coogee will need to expand the production capacity of their existing Kwinana chlor-alkali plant from 17,000 Tpa to 42,000 Tpa.

This document has been prepared to refer the proposed expansion to the Environmental Protection Authority and initiate the environmental approvals process.

1.3 Alternatives to this Project

Chlorine is not available as a bulk merchant commodity in Western Australia. Growth in industrial consumption of chlorine can only be satisfied by increased local production capacity.

2. Project Description

2.1 Existing Arrangements

The Nufarm Coogee chlor-alkali plant at Kwinana is a purpose built facility dedicated to the supply of chlorine gas, by pipeline, into the TIWEST pigment process. The chlor-alkali plant is located in a separate fenced compound within the TIWEST pigment plant on land leased from TIWEST. This plant, built at a cost of $25 million, was commissioned in May 1991 and has a total workforce of 18 people.

The Kwinana chlor-alkali plant is licensed by the Department of Minerals and Energy under sections 45A & B of the Explosives and Dangerous Goods Act, which requires it to be operated in accordance with an approved Hazards Control Plan.

The plant manufactures chlorine and caustic soda by the electrolysis of purified brine solution in ion exchange membrane electrolysis cells. Membrane electrolysis is the cleanest and most energy efficient technology available for manufacture of chlorine. The process uses an electric current to decompose a purified salt solution simultaneously into the usable products chlorine, hydrogen, and caustic soda (see Figure 2, and Section 3.1).

Product chlorine is dried, then sent via a small intermediate buffer storage system into a fixed export pipeline into the TIWEST process. Chlorine is produced on demand, with production rate determined by customer requirements. Total inventory at any time is less than one day's production.

The existing chlor-alkali plant, with a nameplate capacity of 17,000 Tpa net chlorine output, was amply sized for TIWEST's initial production rate of 54,000 Tpa pigment, when it was commissioned in 1991. However, subsequent upgrades of the TIWEST pigment plant to 80,000 Tpa pigment have utilised all spare chlorine production capacity.

Additional chlorine required for the proposed expansion of the TIWEST pigment plant will require substantial capital investment to build a new stand alone chlorine production, processing, and export facility alongside the existing chlor-alkali plant. Incremental expansion of the existing plant is not possible, as it is a single stream process with all installed equipment systems operating at their design limit.

2.2. Description of Proposed Expansion

The proposed expansion will increase the installed capacity from 17,000 Tpa to 42,000 Tpa net chlorine output.

This will be achieved by constructing a second production train parallel to the existing plant, and capable of being operated as an independent stand-alone unit, with its own dedicated chlorine absorption and scrubbing system.

All new production will be processed through a new chlorine storage and export facility, which will be completely segregated from the existing system to minimise risks; and to permit plant construction, and future maintenance, to take place without major disruption to the TIWEST pigment process. The new storehouse will require, as a minimum, a working inventory of up to 50 Tonnes of liquid chlorine, in three 25 Tonne tanks. Total site inventory will therefore need to increased from the current limit of 50 Tonnes, to at least 100 Tonnes. The need for additional bulk liquid chlorine storage will be specifically addressed in the Quantitative Risk Assessment of the expanded plant.

The new chlorine storehouse will be located to provide the most direct routing of the new export pipeline into the pigment process.

All unit processes for the additional production will mimic that of the existing plant, and both units will be operated from a single common control room.

The design of the new facility incorporates the best of the proven safeguarding systems from Nufarm Coogee's two existing plants at Kemerton and Kwinana, together with some additional enhancements identified as a result of this operational experience.

New common systems for brine preparation and purification, caustic soda concentration, and plant utilities, will be built with sufficient capacity to service both production streams; with existing equipment being de-commissioned and dismantled after replacement.

A block diagram of the scope of the proposed expansion is attached as Figure 1.

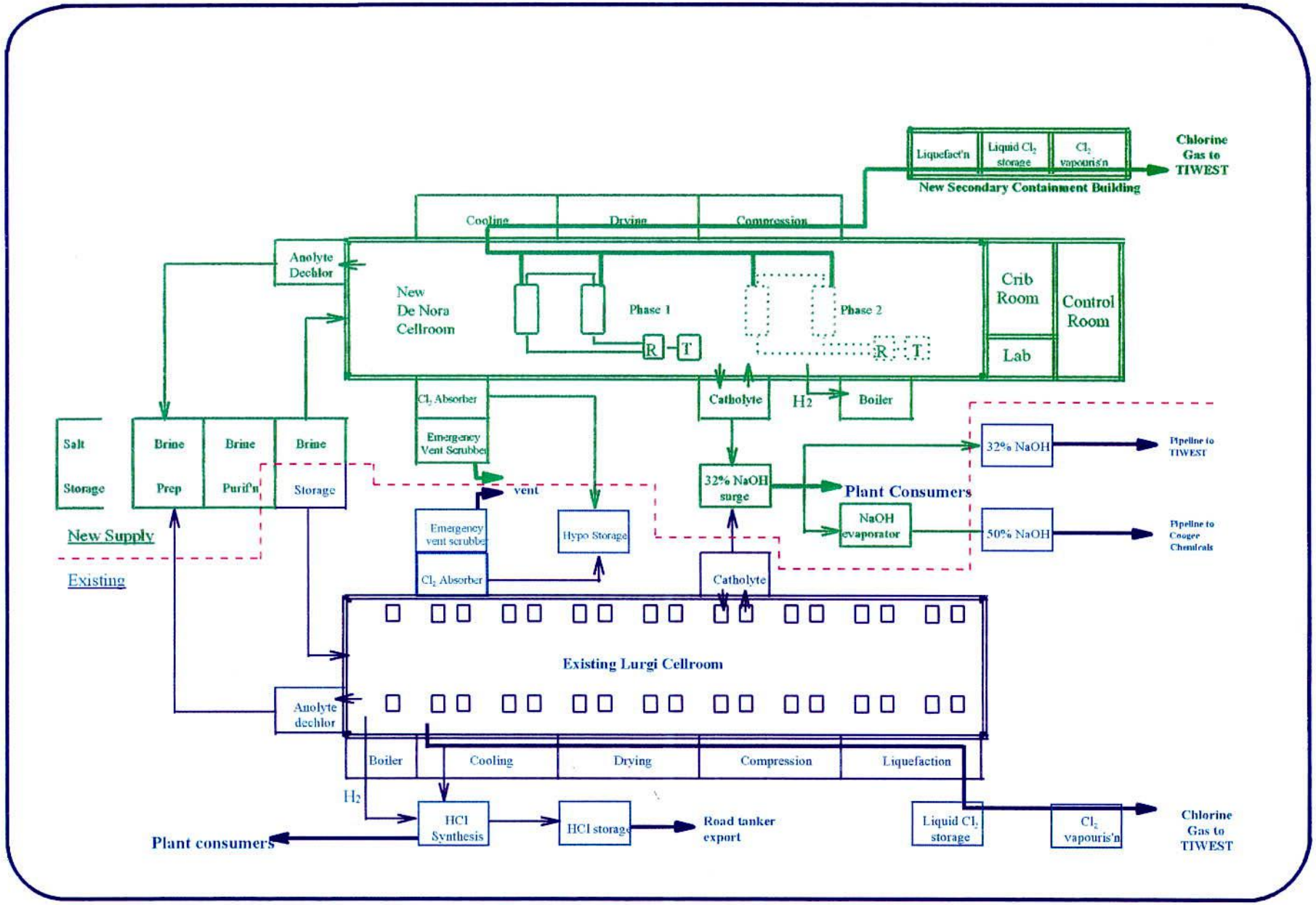

Figure 1: Schematic of Proposed Plant Expansion

2.3. Project Size: Installed Capacity and Expected Operating Rate.

The proposed chlor-alkali plant expansion will give a nameplate increase in net chlorine production capacity from 17,000 Tpa to 42,000 Tpa.

The new cell room is designed with two independent membrane electrolysis circuits, which will be installed sequentially to match the phased expansion of the TIWEST pigment plant.

Expected *average* chlor-alkali operating rate, and spare capacity, is shown in table 2.1 for different stages of the TIWEST expansion.

In practice, the day to day instantaneous operating rates must be varied up and down around the average to match the customer demand, since the chlor-alkali plant is close coupled to the pigment plant with minimal working inventory of bulk liquid chlorine.

Table 2.1: Chlor-alkali Plant Capacity and Operating rates

Pigment Production (kTpa)	**80**	**120**	**165**	**180**
Average Chlorine Export (kTpa)	16.9	27.4	37.6	41
Chlor-alkali Nameplate (kTpa chlorine output)	17	27.5	42	42
Instantaneous "Catch up" capacity	nil	+7%	+12%	+2%

2.4 Design Improvements Incorporated in Project

A number of enhancements will be incorporated into the design of the plant expansion. These have been identified as a result of operating experience gained by Nufarm Coogee at their two chlor-alkali plants at Kemerton and Kwinana. These changes will substantially constrain the incremental risk from the new facility, reduce energy consumption, and improve process management.

- All liquid chlorine systems (i.e. chlorine liquefaction, liquid chlorine storage, and chlorine vaporisation) for the new facility will be located inside a new secondary containment storehouse. This will facilitate rapid detection of any emissions, with automatic shutdown and isolation of this part of the process; and provide for containment and recovery to the chlorine absorption system.

- A new salt storage pad will be installed with improved joint design to minimise potential leaks, and it will also be furnished with a with leak detection and recovery system, with a secondary containment membrane underneath.

- The contaminated waste drainage system will be designed with surface collection drains only, for ease of inspection and maintenance.

- The new cell room will use a different, more modern design of membrane electrolyser with reduced power consumption, and fewer process connections.

- A new, replacement, two stage caustic evaporation unit will significantly reduce total plant thermal energy requirement. An additional package boiler utilising by-product hydrogen will make the operation almost self sufficient in steam.

3. Process Description.

3.1 Brine Electrolysis by Ion Exchange Membrane Process

The chemical process for the plant expansion will be identical to that of the existing plant. A block process schematic is shown in Figure 2.

The membrane electrolysers at the core of the process will be supplied by De Nora S.p.A. of Italy. This well proven equipment is used in over 33 plants world-wide, producing in excess of 1,000,000 Tpa of chlorine.

The electrolysers are fed with purified, near-saturated brine, and 31% caustic soda solution. An electric current is passed to decompose the salt and produce chlorine gas at the electrolyser anodes, and caustic soda and hydrogen at the cathodes. The two halves of the process are separated by an ion-exchange membrane which prevents re-mixing of the products and permits a 95% efficiency of power usage.

Depleted brine leaving the electrolysers is stripped free of dissolved chlorine and re-cycled through the brine preparation plant. A portion of the depleted brine is purged to waste to prevent sodium sulphate impurities, which enter with the raw salt, from accumulating in the recirculating brine loop and damaging the membranes.

Chlorine gas from the cells contains about 2% oxygen, and is saturated with water vapour. It is cooled, dried, compressed, and liquefied by chilling to below -34 C. The oxygen impurity in the chlorine is eliminated at the liquefaction step, and is passed to atmosphere via the chlorine absorption and scrubbing system.

Liquid chlorine is collected in small storage tanks, then forced by nitrogen pressure through a steam heated vaporiser into the export gas pipeline.

Caustic soda solution leaves the electrolysers at about 33% strength. Part of this is bled off and concentrated for sale, and the rest is diluted with water and recycled to the electrolysis cells.

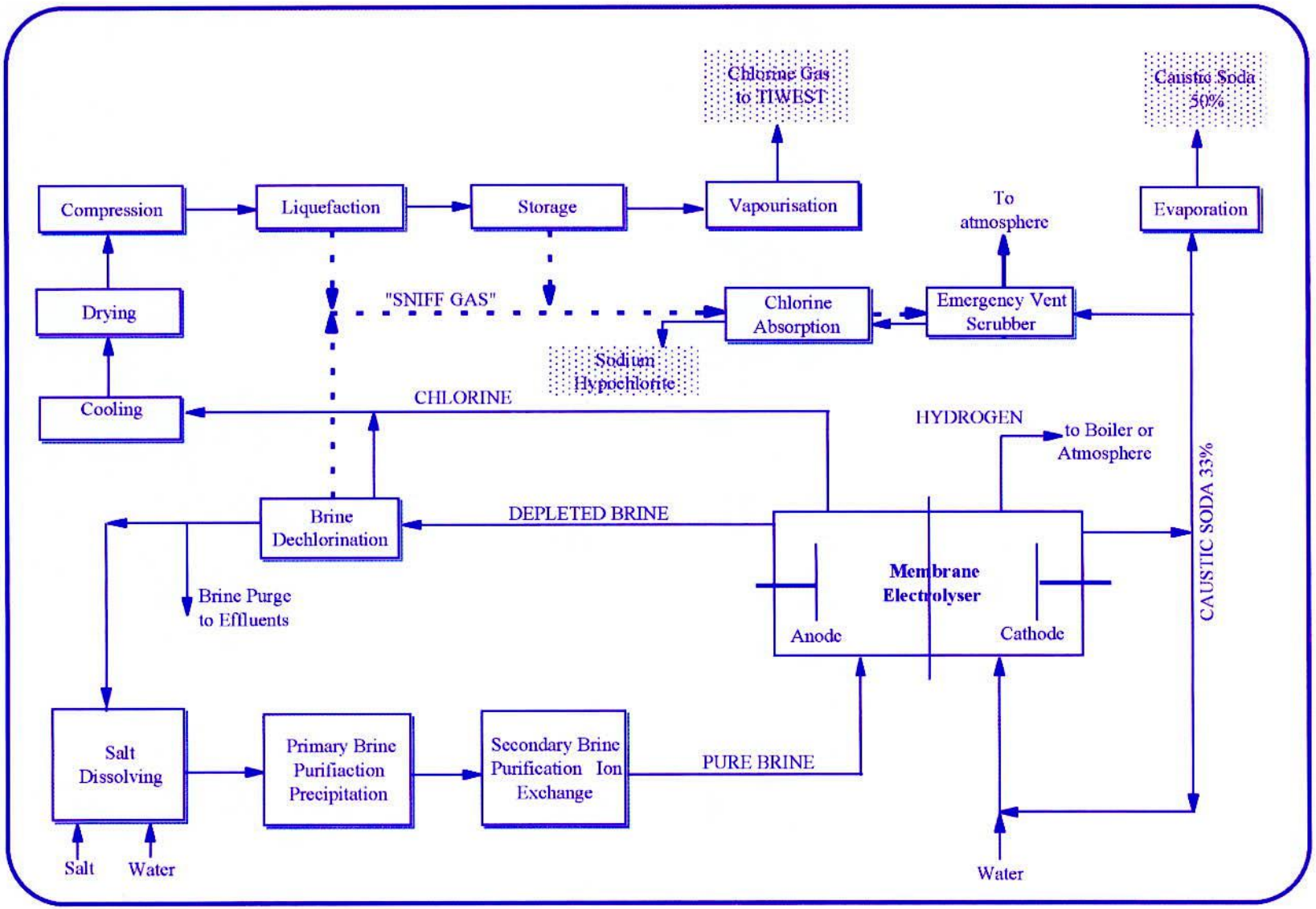

Figure 2. Chlor-alkali Process Schematic

3.2. Process Inputs.

	Existing	Proposed
	17,000 Tpa	**42,000 Tpa**
Raw Materials		
Salt: Naturally evaporated solar salt from Lake Deborah, trans-shipped from Koolyanobbing by rail to the new Westrail depot at Kwinana, then by road into the plant.	39,000 Tpa	84,000 Tpa
Water: Potable scheme water, supplied by the Water Corporation, via the TIWEST reticulation network.	180,000 Tpa	400,000 Tpa
Energy		
Electricity: Currently sourced from Western power grid. Future supplies expected to be supplied by co-generation project in conjunction with TIWEST expansion.	54,000,000 (kW.h pa)	129,000,000 (kWh pa)
Steam: An additional package boiler will be installed to burn the extra co-produced hydrogen. This, in conjunction with a new energy efficient caustic evaporator, will make the plant almost self sufficient in steam. Any shortfall will be purchased from TIWEST via the existing pipeline.	16,000 Tpa	6,000 Tpa
Ancillary Materials		
Nitrogen: Compressed dry nitrogen is used for process purging, brine dechlorination, and as an inert padding gas for chlorine export. Supplied via the TIWEST supply pipeline from the Air Liquide Kwinana air separation plant.	3,000 Tpa	6,000 Tpa
Sulphuric Acid: 98% sulphuric acid for chlorine drying is supplied by Coogee Chemicals, and is all re-exported, in diluted form, for use in copper sulphate manufacturing process.	400 Tpa	900 Tpa

3.3 Process Outputs

	Existing	Proposed
	17,000 Tpa	**42,000 Tpa**
Products		
Chlorine: All chlorine gas from the project will be supplied by dedicated pipeline to TIWEST for titanium dioxide pigment production.	17,000 Tpa	42,000 Tpa
50% caustic soda solution: Co-produced caustic soda will be sold locally for chemical manufacturing and mineral processing, taking the place of currently imported material. Caustic soda will be exported to Coogee Chemicals tank terminal by an underground pipeline.	38,300 Tpa	94,600 Tpa
Hydrogen: Will be used internally as boiler fuel. A small bleed of hydrogen is vented to atmosphere as part of the process safety pressure control system.	480 Tpa	1,200 Tpa
By-products		
Sodium hypochlorite solution 12.5%: produced when chlorine in waste gas streams is absorbed in caustic soda in the plant scrubbing system. This is sold for water and swimming pool chlorination. Surplus hypochlorite can be destroyed in the brine dechlorination system, with chlorine being liberated and re-cycled to the process.	2,500 Tpa	6,000 Tpa
Wastes		
Salt	6,000 Tpa	15,000 Tpa
Water	30,000 Tpa	75,000 Tpa
Oxygen	150 Tpa	380 Tpa
Nitrogen	3,000 Tpa	6,000 Tpa

4. Potential Environmental Impacts and Management

The existing chlor-alkali plant at Kwinana has been in operation for over 5 years, and no adverse environmental impacts have been identified. All known environmental factors associated with the existing operation, and the proposed expansion, are listed in the Table 4.1, below to identify areas where specific impact assessment of the proposed expansion may be required .

Nufarm Coogee believes that the overall off site environmental impact of the proposed expansion will be negligible, and that risk is the only significant factor which requires specific formal investigation. Risk evaluation is discussed further under item 4.2.

Table 4.1: Known Environmental Factors for Existing Chlor-alkali plant and Expected Impact of Proposed Expansion

Factor	Management Objective	Existing Environment 17,000 Tpa Production		Future Environment 42,000 Tpa Production		Additional Impact Assessment
		Existing Impact	Existing Management	Proposed Management	Predicted Outcome	
HAZARDS						
Risk	Maintain residual risk from plant operation below requirements of EPA Bulletin 611.	Quantitative Risk Analysis demonstrates existing plant design easily complies with Bulletin 611 requirements. See Figure 3 in Appendix. A copy of this report lodged with DME and DEP for reference.	Ongoing operational risk management through Total Hazards Control Plan, administered by DME.	Future additions will incorporate additional engineering risk mitigation measures. Expansion will be designed to comply with Bulletin 611. THCP will address ongoing risk management at expanded production levels.	Expanded plant will comply with guidelines, with only moderate increase on existing base case risk.	Quantitative Risk Assessment of Expanded Plant required to demonstrate that design complies with risk criteria. Update and review of THCP with DME
Storage and Handling of Dangerous Goods	Compliance with relevant statutory requirements and industry codes	Chemical bulk storage in approved, paved, and fully bunded tank farm. Liquid chlorine inventory in very high integrity, full containment storehouse.	Existing operation managed by licensing provisions of Dangerous Goods Act, and provisions of Total Hazards Control plan.	Additional liquid chlorine storage requirement with storage containment to world best practice, no changes to other inventories or operational procedures. Ongoing management via THCP.	No change to existing status.	Acceptability of additional chlorine storage will be addressed by Quantitative risk assessment; no other impacts foreseen.
POLLUTION PREVENTION - Air Quality						
Chlorine Emissions	To maintain chlorine emissions below existing, and future, industry and community standards	Waste process gas is vented to atmosphere via high integrity two stage caustic scrubber designed to control chlorine emissions below threshold of detection at all times. See performance data in Appendix .	Stack is continually monitored for chlorine and all detectable emissions reported. Ambient chlorine detectors are located in all areas of plant with potential for fugitive chlorine release.	The new chlorine process train will be fitted with its own stand alone scrubbing and monitoring system of the same proven design. Ambient monitoring network will be expanded to cover new process areas.	No change to existing status. Chlorine emissions will be controlled by well proven system to ensure ground level concentrations below expected ambient standards, and odour threshold.	No critical issues to be addressed. Effectiveness of existing design demonstrated by operational history spanning over 8 years at Kemerton plant and 5 years at Kwinana, with negligible chlorine emissions recorded. See Appendix .
Greenhouse Gases		The chlor-alkali process does not directly produce any greenhouse gases. Electricity used for chlorine production indirectly contributes to atmospheric CO2 from the remote power generation process.	Minimisation of specific energy consumption. Strong management incentive for this, as electricity is single largest cost of production.	Improved electrolysis technology to be employed for the proposed plant expansion will have a specific energy consumption about 5% lower than existing plant.	Overall reduction in specific energy consumption per tonne of product.	Not required. No direct impact from existing or future operation.
POLLUTION PREVENTION - Water Quality						
Plant Spillages	To contain and recover all chemical spillages	No history of unconfined spill or leakage over 5 years operation.	All storage and process areas are paved and bunded with provision for recovering all spillages into the plant effluent disposal system via pump pits and gravity collection drains.	No additional chemical storage is required for the expansion. All new process areas will be designed for spill containment, and with high integrity contaminated waste drains to effluent disposal system.	No change to existing status.	No critical issues to be addressed. No known impact from existing operation, no additional impact from proposed expansion.
Groundwater contamination	To ensure that the groundwater resource is not contaminated by operation of the plant	No known impact.	The plant is designed for containment of raw materials, products, and effluents; and a monitoring programme is in place to ensure no undetected leakage has occurred.	In the process of re-developing site utility areas some design enhancements will be incorporated to increase the security of the existing operation. Monitoring programme will be adjusted for the re-arranged site.	No known impact from existing operation, no additional impact foreseen.	Review design improvements, and sampling and monitoring regime.
POLLUTION PREVENTION - Waste Disposal						
Liquid Effluent Disposal	All liquid effluents are pumped to the TIWEST Pigment Plant for treatment and disposal in accordance with TIWEST license conditions.	Liquid effluents from the chlor-alkali plant consist of salt water, and naturally occurring inorganic impurities from the raw salt. Chlor-alkali effluents are pumped to the Pigment Plant and combined with the TIWEST effluents for treatment and disposal.	Effluent treatment and disposal under management control of TIWEST pigment Plant.	Effluent treatment and disposal under management control of TIWEST pigment Plant.	No anticipated changes. Chlor-alkali plant effluent volume will increase in proportion to chlorine production. Some scope for additional recycling of brine plant washings. There will be no change in effluent quality or disposal requirements.	No critical issues to be addressed. No additional impact from proposed expansion.
Sewerage Disposal.	To comply with statutory requirements	Existing septic tank system complies with statutory requirements..	Satisfactory trouble free operation for 5 years, no specific maintenance or management required.	Existing septic system will require replacement as part of proposed site re-arrangement.	New system will be designed to meet all statutory requirements.	No critical issues to be addressed. Existing system is satisfactory; no additional impact foreseen.
POLLUTION PREVENTION - Noise						

Table 4.1: Known Environmental Factors for Existing Chlor-alkali plant and Expected Impact of Proposed Expansion

Factor	Management Objective	Existing Environment 17,000 Tpa Production		Future Environment 42,000 Tpa Production		Additional Impact Assessment
		Existing Impact	Existing Management	Proposed Management	Predicted Outcome	
Noise	To comply with statutory requirements.	The existing chlor-alkali plant is a quiet industrial operation which complies with all occupational hygiene and ambient noise standards.	No specific monitoring or management requirements.	All additional equipment required for the plant expansion will be specified to maintain low levels of background noise.	No change to existing status.	No critical issues to be addressed. No impact from existing operation, no new impacts foreseen from proposed expansion.
DEMAND ON PUBLIC INFRASTRUCTURE						
Electric Power	To ensure a continuous and reliable supply of electric power	The chlor-alkali process is energy intensive. The existing plant uses approximately 3.15 MW.h per tonne of chlorine produced.	Electric power is currently purchased from TIWEST Pigment Plant and supplied from the Western Power grid.	The new electrolysis plant is expected to have a specific energy consumption 5% less than the existing plant. The total annual power requirement for the expanded plant will be approximately 129,000,000 kW.h .	It is expected that electric power for the expanded chlor-alkali plant will be drawn from a new cogeneration facility attached to the TIWEST Pigment Plant expansion.	No critical issues to be addressed.
Water	To minimise consumption of water.	The existing plant uses 180,000 tonnes of potable scheme water supplied by the Water Corporation via the TIWEST Pigment Plant reticulation system.	Waste water controlled by process brine purge, and regeneration of brine purification plant.	New brine plant design will permit recovery and recycle of some process washings, with modest reduction in specific water consumption.	Water usage will increase with production, but some savings expected Total requirement for the expanded plant will be approximately 400,000 tonnes per annum.	No critical issues to be addressed.
PUBLIC AMENITY AND AESTHETICS						
Road Traffic		The existing operation requires on average 12 truck movements a day for transport of raw materials and products.	No specific management requirement, as plant contribution to local traffic is negligible.	Installation of a transfer pipeline to Coogee Chemicals bulk storage terminal will eliminate the need for road transport of caustic soda product, with resultant average requirement for the expanded plant of 15 truck movements a day.	Net increase around 25% in truck movements for operation of expanded plant.	No critical issues to be addressed. Existing operation is only a minor contributor to local traffic movement. Impact of additional traffic considered insignificant.
Visual aesthetics.	To maintain visual aesthetics in character with an industrial area	The existing plant is a small compact operation, with high standards of housekeeping, and is totally contained within an industrial complex.	Landscape planting is used to soften the internal appearance of the site.	The proposed expansion will not change the visual aspect of the existing operation.	The site will be replanted in border areas after redevelopment.	No critical issues to be addressed. No additional impact foreseen from proposed expansion.
Odour	To ensure plant operation does not result in unacceptable odours	Refer chlorine emissions. No other materials used have any odour potential			No change from existing situation.	No issues to be addressed.

4.2. Risk Issues

The Kwinana chlor-alkali plant, as a designated "Major Hazards Site", is managed in accordance with an audited Total Hazards Control Plan administered by the Department of Minerals and Energy under sections 45A & B of the Explosives and Dangerous Goods Act.

A quantified risk assessment of the chlor-alkali plant conducted for Nufarm Coogee Pty Ltd by Mertz Australia Pty Ltd as part of the original project approval, confirmed that the plant, as constructed, complied with the existing Environmental Protection Authority guidelines for individual risk.

Nufarm Coogee recently commissioned VRJ Risk Engineers to update the base case QRA for the existing chlor-alkali plant. This study, which considered detailed site specific aspects of the chlor-alkali plant, in the light of 5 years operational experience, confirmed the risk from operation of the Kwinana chlor-alkali plant easily conforms to all current DEP criteria. Individual risk contours from this study are attached as Figure 3. Copies of this report have been supplied to DME and DEP for reference.

This study identified that substantial risk reduction could be obtained by secondary containment of all liquid chlorine systems, and this has been adopted a design principle for the proposed expansion.

VRJ Risk Engineers have commenced a preliminary QRA on the proposed design for the expanded chlor-alkali plant. It is expected that the incremental risk due to the expansion will be less than the base risk from the existing plant as a result of design improvements incorporated into the project, and that the combined risk of the expanded facility will be acceptable in accordance with current criteria.

5. References

Woodward Clyde. 1996. *Project Definition Document for TIWEST pigment Plant Expansion to 180,000 TPA*

Environmental Protection Authority. 1992. *Criteria for the Assessment of Risk from Industry*. Bulletin 611. Environmental Protection Authority, Perth, Western Australia.

VRJ Risk Engineers. 1996. *Nufarm Coogee Pty Ltd, Hazard and Risk Analysis, Kwinana Site*.

Chlorine Emissions from Absorption and Scrubbing System.

System description.

All parts of the process containing chlorine are hard piped to a two stage caustic soda absorption and scrubbing system designed to:

- strip all residual chlorine from process waste gas streams before discharge to atmosphere
- absorb full plant chlorine output under upset pressure relief conditions
- permit routine de-pressurisation and evaporative cooling of liquid chlorine storage tanks.
- Permit controlled de-pressurisation of other process systems for planned maintenance, or emergency leak mitigation
- Enable recovery of any chlorine leaks within the storehouse containment building.

Design

The two stage caustic scrubbing system is designed to maintain chlorine concentration in vent gas << 1 ppm under worst case conditions of process load. The theoretical design of the final stage packed column absorption tower provides 10 decades of attenuation. (The packed height of this column is 3.2 m, and design calculations show a 10 fold reduction in chlorine content for every 0.33 m of packed height.)

Normal process load during routine operation is approximately 1 tonne/day of chlorine, but it has a demonstrated absorption capacity of 2.3 tonne/hour with no detectable slippage of chlorine in vent gas.

Monitoring

The scrubber vent stack is continuously monitored for traces of chlorine in vent gas using an electrochemical sensor with a measurement range 0 - 100 ppm, an alarm threshold of 10 ppm, and a nominal measurement accuracy of +/- 10 %. The detector response is tested weekly, and is re-calibrated every 6 months, in accordance with test procedure SLP1016, attached.

All chlorine vent detector alarms are logged and reported. A total of 19 events have been recorded over the 5 year operational history of the Kwinana plant, as summarised below. All are attributable to malfunction or maintenance of the scrubber system, or measurement error from early model sensors. There has been no instance of chlorine detected in vent gas for the last 15 months.

Summary of Chlorine Vent Monitoring: May 1991 - August 1996

Kwinana Chlor-alkali Plant

Indicated Concentration of chlorine in vent (ppm)	Number of Events	Total Duration	Comment
10 - 20	12	approx 6 hours	suspect false positive reading from sensor drift due to moisture.
20 - 50	6	75 minutes	All events associated with fugitive gases entering system whilst scrubbers shut down for planned maintenance
>50	1	39 minutes	*Licence Exceedence*: Simultaneous plant trip and total scrubber system failure during plant commissioning period.

Consequence Modelling

Results of gas dispersion modelling of chlor-alkali vent discharge using AUSPLUME software are attached below. They show that the design, demonstrated performance, and monitoring, of the chlorine absorption and scrubbing system ensures that emissions from this source are totally controlled below any likely level of concern.

NUFARM COOGEE PTY LTD
Chlorine Gas Dispersion Study
Kwinana Chlor-Alkali Plant

August 1996

1.0 EXECUTIVE SUMMARY.

VRJ Risk Engineers Pty Ltd ("VRJ") have been commissioned by Nufarm Coogee to prepare a chlorine gas dispersion study of the proposed upgrade of the plant's Process Gas Scrubbing system of their Kwinana site.

The Gaussian plume dispersion model AUSPLUME has been used to calculate ground concentration levels (GLC) resulting from several combinations of emission concentrations. Each of these combinations was modelled using a representative year's weather data. The results from such modelling were then compared to a limiting ground level concentration for chlorine.

From our analysis we have concluded that the emission concentration shown in Table 1.0 will result in below the selected limit Cl_2 GLC at the plant boundary for the flow rate modelled.

Table 1.0: VRJ's Recommended Exit Concentrations

Stack Height (m)	Stack Diameter (cm)	Emission Concentration (ppm Cl_2)
18.5	20	0.1
18.5	20	1.0
18.5	20	10.0
18.5	20	100.0

2.0 INTRODUCTION

VRJ Risk Engineers Pty Ltd ("VRJ") have been commissioned by Nufarm Coogee to prepare a chlorine gas dispersion study of the proposed upgrade of the Plant's Process Gas Scrubbing system of their Kwinana site.

2.1 STUDY OBJECTIVES

The objective of this study is to determine:

- An acceptable ground level concentration for chlorine gas at the boundary of the Nufarm Kwinana site;

- Ground concentration levels resulting from emissions from the scrubber stack for various emission concentrations; and

- To present results so as an appropriate emission concentration can be determined.

2.2 APPROACH

In order to determine the ground concentration levels the steady state Gaussian plume dispersion model AUSPLUME has been used.

The Hope Valley Base Station meteorological data has been used. Such data covers the weather conditions over a one year period, 1980, within the Hope Valley region.

The results obtained from our dispersion modelling have been presented in the form of concentration contours. Such contours, plotted on a scaled site plan of the Kwinana plant enable the areas where the GLC, resulting from a stack emission, which will exceed the limiting GLC to be easily detected.

2.3 LIMITING GROUND LEVEL CONCENTRATION

The WA EPA currently have not set guidelines for the limiting ground-level concentration for chlorine, during previous conversations with them it was recommended that a value of the (occupational level) divided by 30 be used.

Considering that the release scenario is continuous, VRJ consider that the TLV (Threshold Limit Value) should be used for the occupational level for this scenario. For chlorine the TLV is 1ppm [1]. Hence the corresponding limiting ground level concentration is 0.033 ppm.

3.0 GAS RELEASE SCENARIOS

On the request of Nufarm Coogee, VRJ have investigated the effect of varying the emission concentrations from the stack. The following combinations stack emission concentrations were considered:

- 0.1 ppm
- 1.0 ppm
- 10.0 ppm; and
- 100 ppm

The emission temperature was taken to be 30°C, the stack height 18.5m and the stack diameter 200mm in all cases.

The results for these scenarios are presented in Section 4 of this report.

3.1 MODELLING PARAMETERS

3.1.1 Meteorological Data

The meteorological data used within the AUSPLUME modelling was obtained from the Hope Valley Base Station. Such data covers all possible weather conditions over a one year period (1980) for the Hope Valley region, catering for both onshore and off shore conditions.

3.1.2 Release Rates

VRJ have been supplied with the flow rate of the vent gas from the scrubber discharge vent as being 150 m^3/h which corresponds to an exit speed of 1.3 m/s.

Table 3.3 details the corresponding chlorine emission rates for the varying discharge concentrations of chlorine considered during VRJ's modelling and the corresponding operating conditions. Note all of these parameters were utilised within the AUSPLUME modelling.

Table 3.3: Stack Emission Rates

Operating Conditions	Emission Concentration (ppm Cl_2)	Emission Rate (g/s)
Normal Operation	0.1	1.22E-05
Undetected Slippage	1.0	1.22E-04
Alarm Activation Level	10.0	1.22E-03
Full Range of Detector	100.0	1.22E-02

3.1.3 Effect of Adjacent Buildings on dispersion profile

The effect of adjacent buildings upon the resultant gas dispersion profile is approximated with a function of the stack height and the dimensions of the nearby buildings. This effect can be characterised by the critical height (Hc) which is calculated as follows:

$$Hc = Hb + 1.5*\min (Hb, Wb) \quad [2]$$

where:

Hb is the height of the nearest, tallest building;
Wb is the minimum crosswind projected width of nearby buildings; and
min denotes the minimum of the two dimension Hb and Wb.

A building is considered to be "near" if it is separated from the stack by less than 5 times the lesser of Hb and Wb.

Wb is determined by examing all the crosswind projections of all nearby buildings, for all wind directions. The minimum projection is chosen. [2].

We were informed by Nufarm Coogee that there are no buildings within close proximity to the Scrubber discharge vent which would fall into the above category. Thus the effects of building wakes has not been taken into consideration within our Ausplume modelling.

3.1.4 Receptor Locations

AUSPLUME requires receptor locations to be specified in the form of a grid. It is at these points only that a GLC will be evaluated. It should be noted that, the 99 percentile concentration is only valid for the set of grid points specified.

The receptor locations chosen by VRJ were the same for each run and covered a wide area, outside of the plant boundary. The locations specified were at 20m intervals from 10m to 790m from the stack on bearings 15° apart.

Where the angle specified is of the following notation:

North 0°, East 90°, South 180° and West 270°.

4.0 RESULTS

4.1 Presentation of Results

For each of the release scenarios a 99 percentile concentration and its location has been calculated. Such a value denotes the ground level concentration of which 99% of the concentrations calculated will be at or below this level.

4.2 Results

On analysis of all of the stack configurations for 0.1ppm, 1.0 ppm, 10 ppm and 100ppm discharge concentrations of chlorine, VRJ are of the opinion that for such releases the resultant ground level concentration received will not exceed the GLC limiting value either inside nor outside the plant boundary. The maximum ground level concentrations and 99 percentile concentrations calculated are presented in Table 4.2 below.

Table 4.2: Maximum GLC Resulting From Different Stack Emission Concentrations

Stack Emission (ppm)	99 Percentile Concentration (ppm)	Radial Coordinates at Which Concentration Occurs (m, degrees)	Maximum Concentration (ppm)	Radial Coordinates at Which Concentration Occurs (m, degrees)
0.1	3.3E-6	50m, 270°	3.3E-6	70m, 255°
1.0	3.3E-5	50m, 270°	3.3E-5	70m, 255°
10.0	3.3E-4	50m, 270°	3.3E-4	70m, 255°
100.0	3.3E-3	50m, 270°	3.3E-3	70m, 255°

Note that as the concentration will not exceed 0.033 ppm, concentration contour plots have not been produced.

5.0 CONCLUSIONS

A GLC of 0.033 ppm for chlorine has been selected as an upper limit criteria at the site boundary. However, it is understood that the WA EPA currently have no set guidelines for the GLC for chlorine.. The GLC value utilised within this study was established after discussions with the WA EPA who recommended the a value of the (occupational level) divided by 30 be used.

The effect of varying stack emission concentration for the Nufarm Coogee Kwinana Plant Gas Scrubbing System stack has been investigated.

From our analysis we have concluded that the ground level concentration will not be exceeded for any of the release scenarios modelled within this report.

6.0 REFERENCES

1 United States Coast Guard, CHRIS Hazardous Chemical Data

2 Dr. Graeme Lorimer, The AUSPLUME Gaussian Plume dispersion model, Environment Protection Authority, Publication number 264.