# *INTEGRATED METHANOL and AMMONIA PRODUCTION*

*FOR*

# *EGYPTIAN PETROCHEMICALS HOLDING COMPANY*

*(TDA Appropriation No. 114/51001 and Grant No. GH04119314)*

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# EXECUTIVE SUMMARY

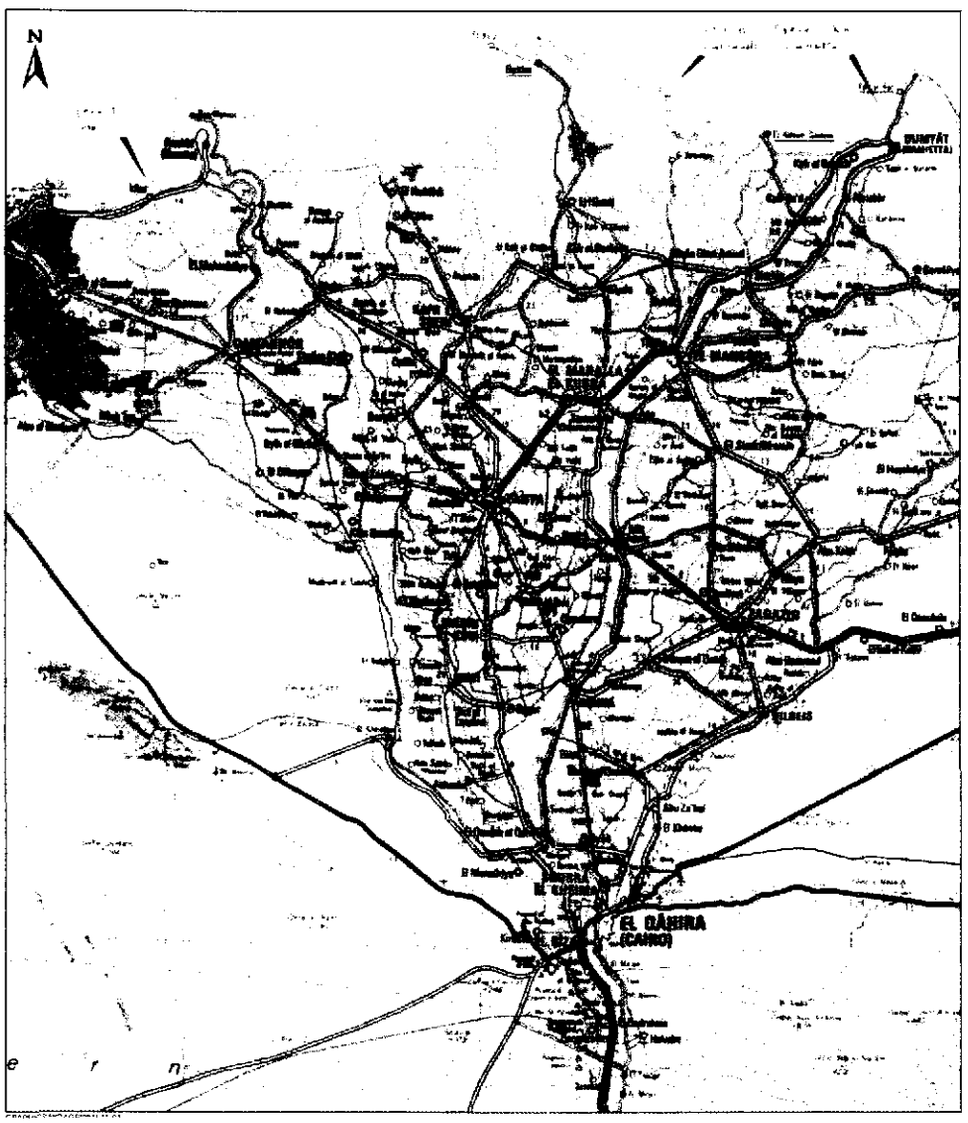
## Introduction

This Feasibility Study has been prepared for Egyptian Petrochemical Holding Company (ECHEM) by Granherne Inc.

## Purpose

This purpose of this Study is to evaluate the feasibility of constructing integrated methanol and ammonia production units on one grass root site on the Egyptian Mediterranean coast, between Alexandria and Damietta. Four possible sites were evaluated.

**General Location of the Four Possible Sites**



The criteria provided by ECHEM for the layout of these facilities are as follows:

- The development will be undertaken on one common site.
- The integrated methanol/ammonia process will have shared utilities and offsites
- Most of the product will be exported, with an assumed 15% sold on the local market.
- The products exported will share a common dedicated export marine terminal.

The methanol plant will produce methanol product as well as supplying hydrogen feed to the ammonia plant. Plant capacities are to be as follows:

- Methanol – 3,000 MTPD
- Ammonia – 1,200 MTPD

There will be three plant expansion phases, each with the same production capacity. Allowance will be made in developing the selected site for the second and third phase expansions. Phasing is planned as follows:

Each EPC phase for the methanol/ammonia units is considered to be 33 months from award of the EPC contract to production for each phase.

It is assumed that the Phase 1 EPC contracts will be awarded in the 1Q06, with initial production from each project phase scheduled for mid-2008, 2011 and 2014

**TASK A - MARKETING**

Markets and pricing for ammonia and methanol were examined by CMAI

Key to the success of the ECHEM nitrogen products/methanol project will be a feedstock cost position to compete favorably against other new projects with such an advantage. Higher hydrocarbon values in the developed regions of the world will preclude new capacity for these products being built in these areas. Remote, cost advantaged gas locations will compete for the new capacities to supply the international markets. These large plants will need to rationalize higher cost capacity as well as capture normal market growth as economics dictate the construction of very large facilities (compared to total market size) to reduce fixed costs. This is frequently achieved through long-term gas supply agreements with fixed or margin sharing type price terms. With a supply commitment to provide uninterrupted supply of gas from the Egyptian government, the ECHEM project can be perceived as lower risk than more remote projects tied to other gas sources.

Strong offtake agreements and or involvement with international marketers are also of great benefit in achieving rapid penetration into the global marketplace. Agrium and Methanex both bring international marketing experience and logistics to this project.

The ultimate cost analysis of the project must be performed on a delivered-to-customer basis. The physical location of the project in Egypt allows for relatively easy and cost efficient transportation to markets in Asia and Europe in particular for methanol. Western Europe and even the Americas are natural candidates for nitrogen products. Combined with growing domestic demand and the possibility to rationalize older, smaller domestic nitrogen capacity, world class operations in Egypt would appear to have good transport logistics.

Due to continued growth in the end markets for these products, consumer products or fuels in the case of methanol and fertilizer applications for nitrogen will continue to demand these products over time. The current phasing out of MTBE in the U.S. gasoline market not withstanding, the demand for methanol is subject to little pressure from competing products and should continue to grow in line with GDP growth. Likewise, with its demand strongly tied to food production in the world, ammonia/urea demand is forecast to grow around the world, thus requiring new capacity on a regular basis.

A market summary for each product is outlined below.

## A.1 METHANOL

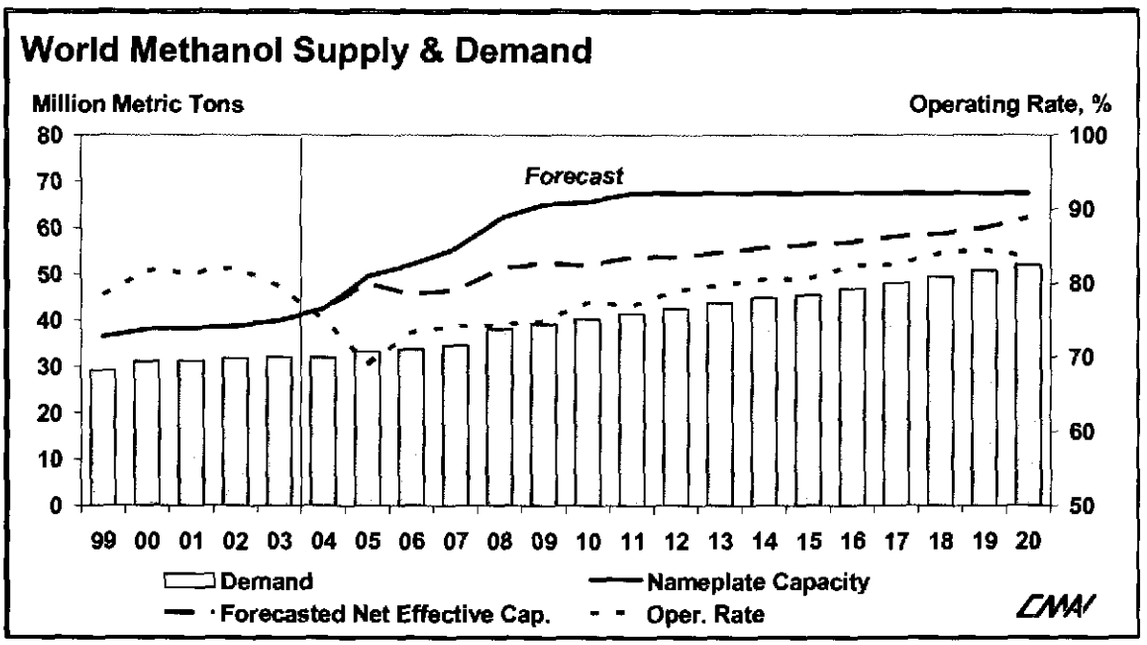
World methanol demand in 2004 is estimated to be 32.0 million metric tons, which if holds true, will be the first time since the 1990-1991 timeframe the industry has experienced a year-over-year decline. (2003 demand has been estimated at a slightly higher 32.1 million metric tons.) While growth was observed in most other derivatives, the loss of about 1.3 million metric tons of methanol consumption into MTBE/TAME could not be overcome.

Industry capacity totaled 42.6 million metric tons, an increase of about 2.6 million metric tons from 2003. This is a major change in assumptions from just one year ago. It includes the addition of almost 3.5 million metric tons of existing methanol capacity in China. We now believe as much as 6.5 million metric tons of methanol capacity exists in 2004, with planned construction propelling capacity to over 9.0 million metric tons in a few short years.

The regional charts contained in the marketing report pull all of the above information together in one meaningful picture. The actual and projected demand is shown as vertical bars above the respective years.

The methanol industry is undergoing a change from production in the consuming regions to production (much larger scale) in more remote locations. As a result, plants are being built far in excess of demand, thus rationalizing the older units. CMAI shows its best opinion on the

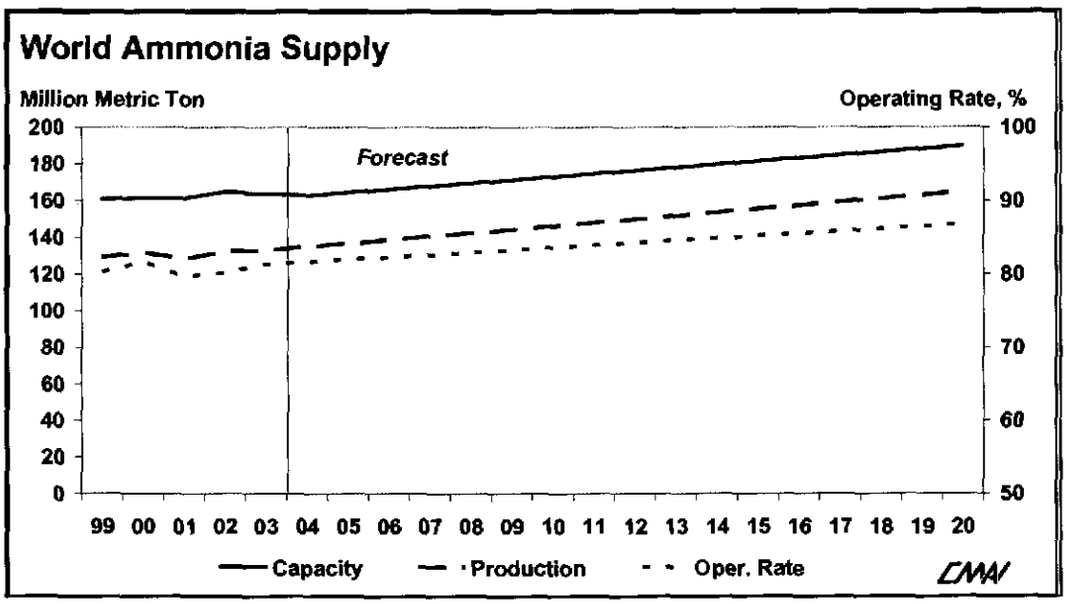
actual or "net effective" capacity that will be in place with the dotted lines on each graph. Operating rates are based on this net effective capacity.




The methanol industry has been very much driven by supply limitations for two years now, and may actually see little change into early 2005. Overall growth for the industry will be less than it has been historically as MTBE demand peaked and will continue to erode over time. For the near term forecast, the addition of over 20.0 million metric tons of capacity is huge, and rationalization of high cost producers will have to occur, willingly or unwillingly.

## A.2 AMMONIA

In 2003, world ammonia capacity stood at about 161 million tons per year, and produced 133 million tons at an 83 percent operating rate. World urea capacity was about 133 million tons per year (excluding capacity in integrated nitrogen solutions plants), and produced 112 million tons at an 84 percent operating rate. About 13 percent of the total ammonia output (17 million tons) was traded internationally, compared to the 25 percent (28 million tons) of total urea output that was traded.




In 2020, the total world capacity of ammonia is forecast as being 192 million tons and 183 million tons for urea. Outputs will be 162 million tons for ammonia and 153 million tons for urea at 84-85 percent operating rates for each. International trade will approximate 19-20 million tons for ammonia (12 percent of output), and 45-46 million tons for urea (30 percent of output).

World nitrogen consumption, as measured by world ammonia production (i.e., supply equals use), has slowed down since the end of the 1990s. After the full decline of usage in Central Europe and the FSU (per the collapse of the USSR system), the world market experienced growth of 23 million tons of $NH_3$ output, which represented a 21 percent increase from 1993-2000. From 2000 – 2003, though, the increase was only 1.2 million tons.

In forecasting to 2020, it is estimated that the world nitrogen market will increase by another 27 million tons $NH_3$, reaching 160 million tons in 2020 (vs. 133 million tons in 2003). This increase is equivalent to 30-32 million tons of ammonia capacity, on an 85-90 percent operating rate basis. The amount of new-plant capacity increase forecast herein is actually about 42 million tons, with the additional volume required to offset assumed closures in (unprotected) high-cost production regions.

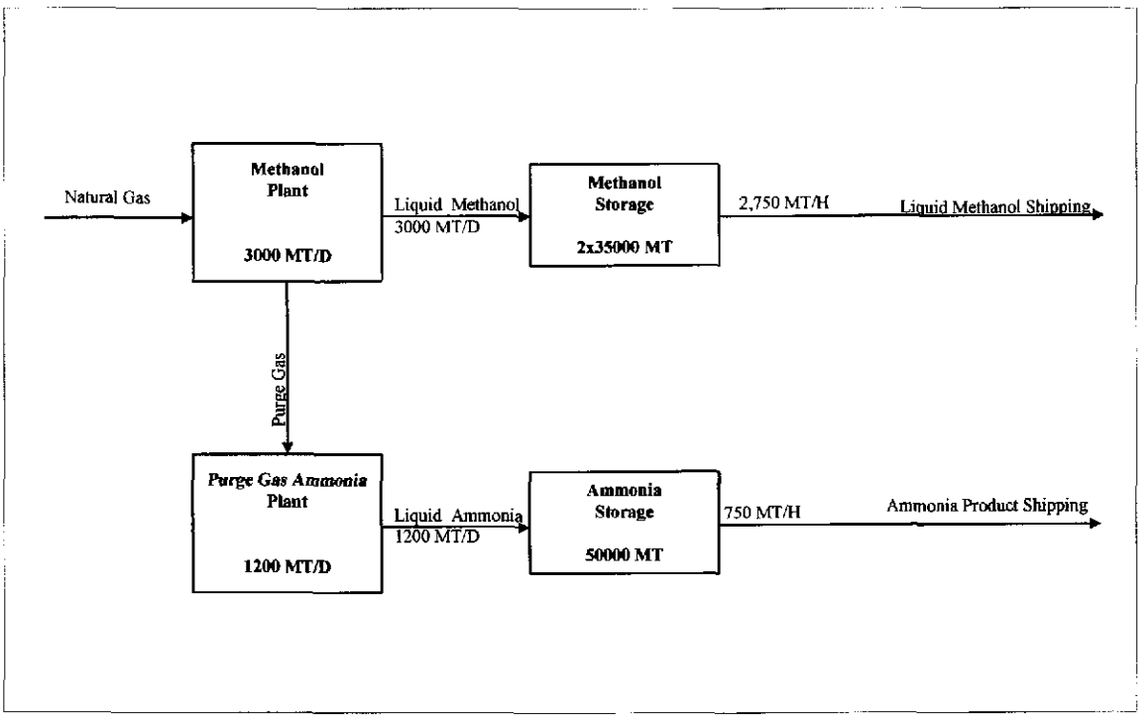
## TASK B - TECHNOLOGY SELECTION

A study was prepared to evaluate cooling options for the process units. Fresh water was found to be the optimum. However the quantities required were not available at any of the sites. Consequently sea water cooling towers were selected as the basis for the study design.

## B.1 APPLICABLE TECHNOLOGIES

The integrated methanol/ammonia plant schematic is shown in the figure below.

**Integrated Methanol/Ammonia Production Units**




The applicable technologies and their ranking are as follows.

### B.1.1 Methanol

There are several major process licensors of methanol technology. Based upon the number of large size plants built worldwide since 1965 and the market share of these technologies, the four major technologies considered are:

- Johnson Matthey (JM)
- Lurgi Mega Methanol
- Haldor Topsoe
- Mitsubishi Gas Chemical Company

The Kepner-Tregoe ranking analysis of these process licensors showed that there was little to differentiate the technologies. For the purpose of this study we selected the process offered by the newly found group "One Synergy" (Johnson Matthey Catalysts/Davy Process

Technology/Aker Kvaerner).

### B.1.2 Ammonia

There are three major process licensors of ammonia technology, based on the number of large size plants built worldwide since 1965 and the market share of these technologies. The three technologies recommended for considerations are:

- KBR
- Haldor Topsoe
- Uhde

All three licensors have solid experience in conventional ammonia production using natural gas as a feedstock. However, KBR has considerably more experience in supplying technology for ammonia production plants where the prime feedstock is hydrogen from a methanol production plant. The Kepner-Trego system of evaluating and ranking these technologies shows that this experience places the KBR ammonia technology process as an acceptable option.

## TASK C -SITE EVALUATION

### C.1 SITE DESCRIPTIONS

Four possible sites were evaluated for ECHEM:

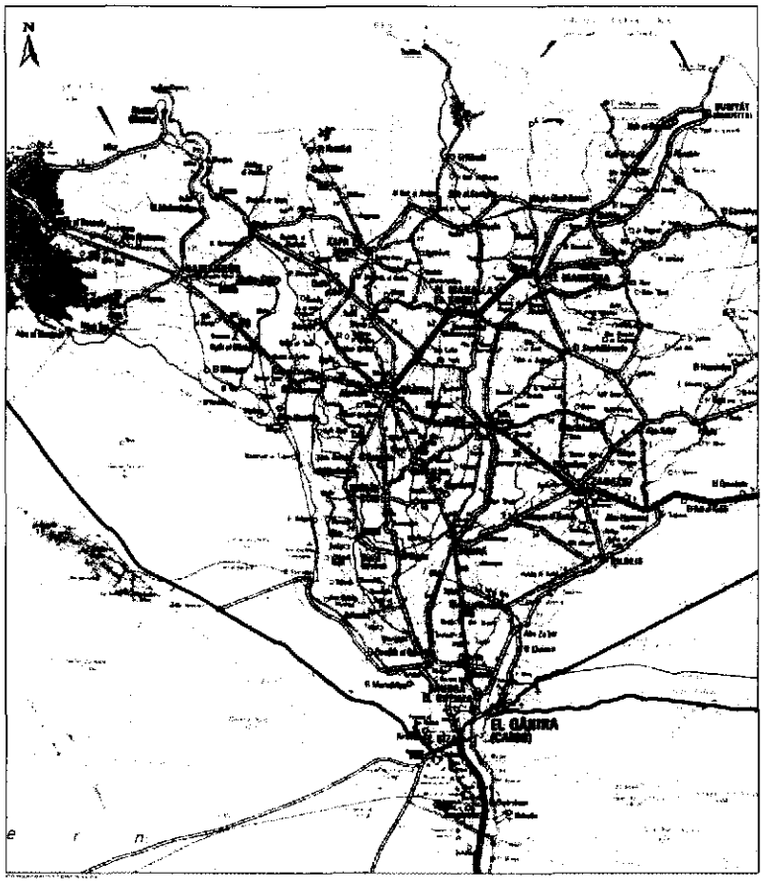
- Option 1 (Idku) - A strip of land bordering the Mediterranean, adjacent to the British Gas ELNG project currently being constructed in the vicinity of Idku Town. Located on the coastline in Abu-Qir Bay approximately 9 km. west of the Rosetta Nile branch outlet, 200 km west of Port Said and 45 km east of Alexandria. This site has some local existing industrial infrastructure developed during the ELNG construction.
- Option 2 (Gamasah) - Another strip of land on the main Inter-coastal Highway paralleling the Mediterranean Sea. This plot is in a rural area with no existing infrastructure and is situated on the coastline approximately 75 km west of Port Said.
- Option 3 (Damietta Echem) –This site is situated along the Damietta Port Barge Navigation Canal, just outside the eastern port boundary. It is located on the coastline approximately 1km east of the port at Damietta.
- Option 4 (Damietta Port Industrial Zone) – The site is located in the Damietta Free Trade Industrial Zone, an area developed around the Damietta Port and is under the jurisdiction of the Damietta Port Authority (DPA). The plot fronts part of the Damietta

Port basin. Damietta Port is on the outskirts of Damietta Town and is 50 km west of Port Said. The proposed site is south of the Union Fenosa/SEGAS LNG Site and borders the DPA Container Terminal.

**Approximate Distances between Proposed Sites**

| Site | GPS Coordinates | Idku Site | Gamasah Site | Damietta Sites (2) |
|---|---|---|---|---|
| **Idku Site** | N 31° 22'<br>E 30° 03' | 0 | 120 km | 155 km |
| **Gamasah Site** | N 31° 29'<br>E 31° 24' | 120 km | 0 | 35 km |
| **Damietta Sites** | N 31° 27'<br>E 31° 45' | 155 km | 35 km | 0 |

The locations of the four sites are shown on the following map.



Site selection criteria were developed to rate each site. The criteria focused on the differentiators that would add cost to develop each site. Such differentiator criteria included:

- The major cost of developing a dedicated marine export facility.
- Environmental considerations.
- Site preparation costs
- Location of cooling water, fresh and sea water.
- Location of natural gas pipelines.
- Site access and construction issues.
- Land rental costs.
- Damietta Port Site (Option 4) was chosen as the development site for this study.

## C.2 MARINE TERMINAL

As the majority of the products produced will be exported, the location of the site to an existing marine export terminal, or to an area where a new export marine terminal could be constructed at minimal cost, was the major cost impact. Echem had advised that all sites, irrespective of location, would be considered as Free Industrial Zone developments and will be subject to the same benefits and controls.

Damietta Port offered the most cost effective location to construct the process plants and to export the products. This Study is based upon a dedicated terminal being constructed within Damietta Port.

## C.3 PRELIMINARY ENVIRONMENTAL ASSESSMENT

The terms of reference for the environmental assessment were developed during discussions between Granherne and Komex.

Information regarding the surrounding geology and soils was determined from borehole samples collected from four boreholes drilled (Samsung-Arab contractors) at the Damietta Port east dock area.

The area proposed for development was surveyed to check for the presence of any important (National and International) wildlife species and to evaluate the likely effects of the proposed activities on them. Effects on local employment, the local economy and cultural aspects were also taken into account.

In terms of positive economic impact and employment, the project will enable Egypt to annually export approximately 400,000 metric tonnes of Ammonia and 1,005,000 metric tons of methanol, generate foreign income and provide a great number of jobs both during the

construction and operation phases. The socio-economic benefits of the project are thus largely positive. The PEA identifies other possible impacts on local biology, soil, air, and water quality.

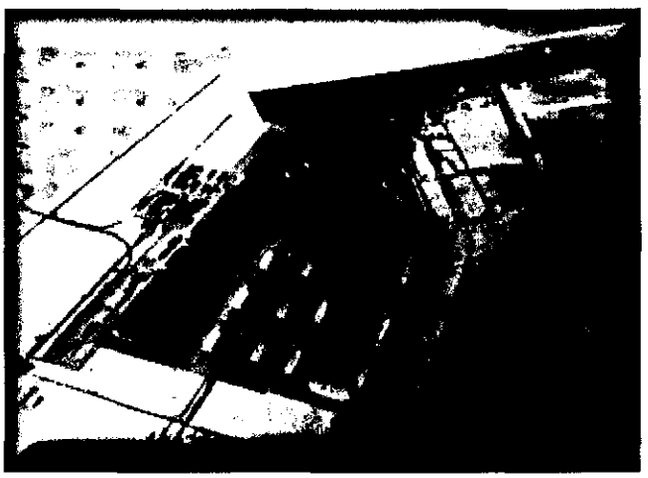
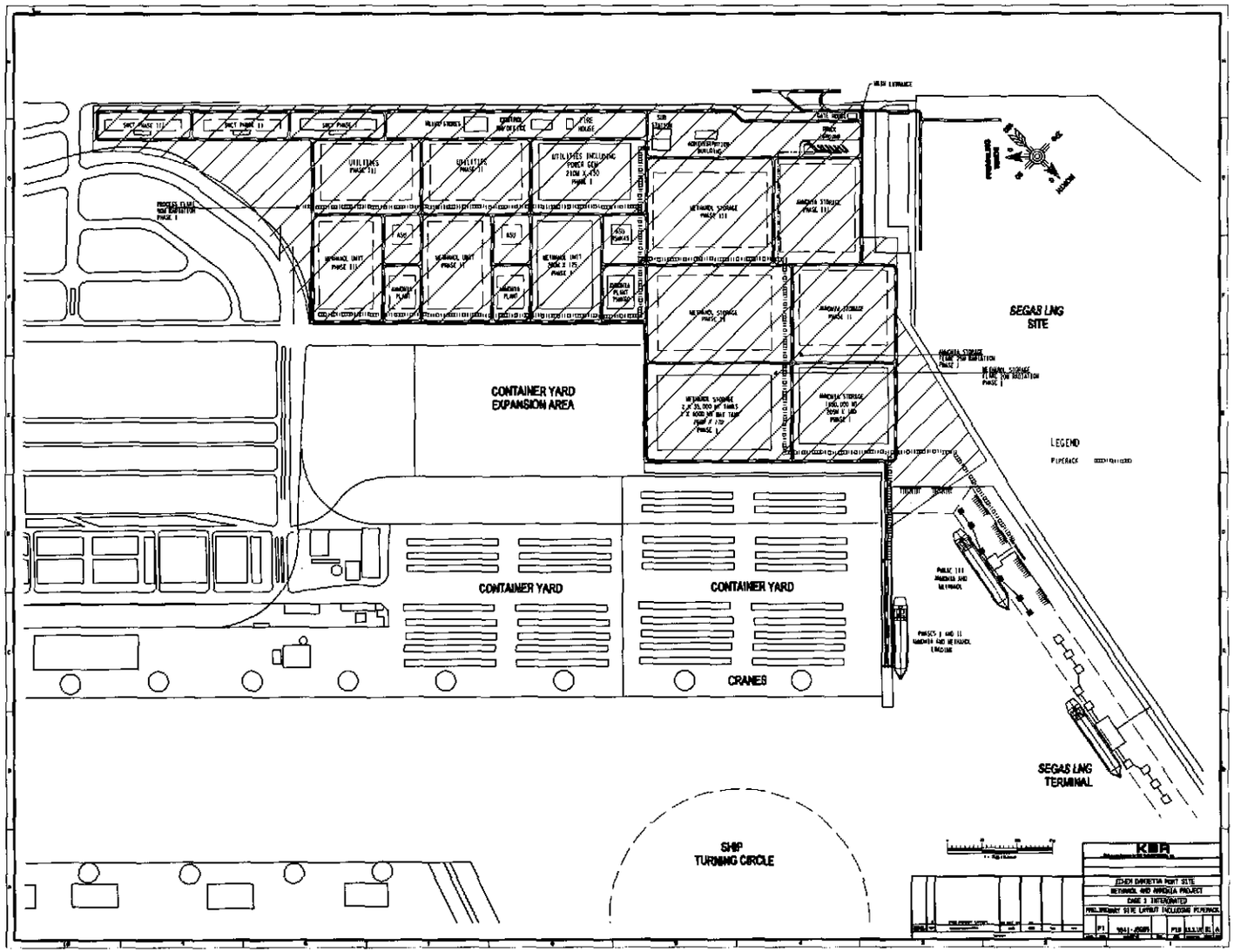


**Figure 1 - Damietta Port Site**

Based on this PEA, the assessment team concludes that the proposed methanol and ammonia/urea production complex is environmentally feasible, and a full EIA should be conducted at the FEED stage with a comprehensive baseline assessment and detailed environmental management plan (EMP).

## PRELIMINARY SITE LAYOUT – THREE PHASE EXPANSION - DAMIETTA PORT



## TASK D – COST ESTIMATES

### D.1 CAPEX COSTS

Separate cost estimates were prepared for the Phase I installations only. The design and cost estimates for the methanol and ammonia production units included the utilities and offsites associated with those process units. Costs for common shared facilities, such as the marine terminal and sea water intake basin, were divided equally between the methanol and ammonia/urea cost estimates. Costs for specific hardware installed within the marine terminal were allocated directly to the process utilities estimate.

The methodology used to develop the cost estimates was based upon factored budget quotations received for principal equipment. This was possible where preliminary engineering data was available to seek such quotations. However, process licensors were reluctant to provide the level of engineering detail required to prepare such budgetary enquiries. In such cases, preliminary major equipment costs were factored from cost data on similar projects.

In the case of cost estimates for methanol technology, the Process Licensors refused to provide technical information on the process or equipment to enable Granherne to prepare equipment load sheets. Consequently, budget phone estimates could not be obtained for methanol plant equipment. In the absence of any other cost data, Granherne used the Echem cost data for a 3,000 mtpd conventional methanol plant and stripped out the identified utility and offsites costs. Although not providing firm cost data, One Synergy (incorporating Johnson Matthey (JM), Davy Process Technology (DPT) and Aker Kvaerner (AK)) did comment that the estimate was of the correct order of magnitude and provided commodity percentage breakdown of the total TIC. Where one figure percentage of the commodity provided applied to both the ISBL and OSBL, Graherne estimated the split to obtain ISBL costs.

Phase I cost estimates have been prepared as follows:

- Methanol Total Installed Cost (TIC) for:
    - 3,000 MTPD One Synergy Conventional Methanol Process Unit
    - 2 x 35,000 MT methanol storage tanks
    - Two Methanol Liquid Loading Arms
- Ammonia Total Installed Cost (TIC) for:
    - 1,200 MTPD KBR Ammonia production Synthesis Loop with Air Separation Unit (ASU) and Nitrogen Wash Unit.
    - 50,000 MT ammonia storage tank

  - One Ammonia Liquid Loading Arm

- Utilities, Offsites and Marine Terminal (Costs shared between Process Facilities)
  - Site preparation
  - Roads, Drainage, etc.
  - Common Utilities and Power Generation for the Methanol and Ammonia Process Units
  - Common Administration Building, Electrical Substation, Workshops, Warehouse and Control Room
  - Dredged marine harbor for 2 berths (only one berth to be completed for Phases I and II)
  - Common Sea Water Pump Basin with sea water supply and reject lines

Separate costs for the Front End Engineering Design (FEED), Detailed Design and Procurement, and Construction/Startup have been prepared.

A likely currency split scenario of the TIC costs has been developed, split between local and foreign currencies. The split of currencies is partly based upon the likelihood of sources of financing and the associated limitations in the flexibility of use of such funding.

The following table summarizes the estimated costs for each process unit.

## Summary Cost Estimate – TIC Integrated Units

| USD x 1000 | | | | | |
|---|---|---|---|---|---|
| | 3,000 MTPD Methanol Production Unit | 1,200 MTPD Ammonia Production Unit | Shared Utilities and Offsites | Marine Facilities (Dedicated Ship Loading Berth and Sea Water Intake Basin | TOTAL Case 1 |
| **Home Office Services** | 25,136 | 14,223 | 18,798 | 1,792 | **59,949** |
| **Equipment, Catalyst & License Fees** | 92,093 | 49,943 | 72,620 | 2,512 | **217,168** |
| **Bulk Materials** | 38,410 | 8,331 | 41,754 | 3,488 | **91,983** |
| **Material Related Costs** | 24,769 | 14,812 | 20,958 | 1,064 | **61,603** |
| **Construction Sub-Contracts** | 2,103 | 3,062 | 44,846 | 45,830 | **95,841** |
| **Construction Services** | 39,659 | 22,757 | 47,680 | 6,008 | **116,104** |
| **Operations & Start Up** | 7,009 | 6,182 | 7,976 | 1,962 | **23,129** |
| **Escalation 04Q2004 to 01Q2006 + 33 months** | 28,790 | 14,401 | 33,838 | 8,934 | **85,963** |
| **TOTAL PROJECT COST** | **257,969** | **133,711** | **288,470** | **71,590** | **751,740** |

| U.S. Export Potential – Ammonia & 50% offsites, utilities, marine - USD thousands | | | | | | | |
|---|---|---|---|---|---|---|---|
| Commodity | Total | US Export Portion | Estimated Local Content | Estimated Foreign Content | Estimated US Competitive-ness | Estimated High US Content | Estimated Realistic US Content |
| Total Installed Cost | 313,741 | 142,752 | 78,435 | 92,554 | | | |
| Procurement: | | | | | | | |
| Equipment | 87,509 | 47,124 | | 40,385 | B | 38,641 | 32,044 |
| Bulk Matls. | 30,952 | 8,097 | 9,518 | 13,337 | B | 6,640 | 5,506 |
| Subcontracts | 48,400 | 11,713 | 34,606 | 2,081 | | 9,370 | 8,023 |
| Services: | | | | | | | |
| Engineering | 24,518 | 19,614 | | 4,904 | A | 17,221 | 13,730 |
| Constn. Mgt. | 9,763 | 5,858 | 1,953 | 1,953 | A | 5,009 | 3,983 |
| Construction | 25,460 | | 25,460 | | B | | |
| Start-up | 11,151 | 10,192 | 535 | 424 | A | 8,154 | 8,154 |
| *TOTAL* | ***237,753*** | ***102,598*** | ***72,071*** | ***63,084*** | | ***85,035*** | ***71,440*** |

| U.S. Export Potential – Methanol Production & 50% offsites, utilities, marine - USD thousands | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Commodity** | **Total** | **US Export Portion** | **Estimated Local Content** | **Estimated Foreign Content** | **Est. US Competitive-ness** | **Estimated High US Comp.** | **Estimated Realistic US Comp** |
| **Total Installed Cost** | **437,999** | **192,720** | **127,458** | **117,822** | | | |
| **Procurement:** | | | | | | | |
| **Equipment** | **129,659** | **75,202** | | **54,457** | **B** | **61,666** | **51,138** |
| **Bulk Matls.** | **61,031** | **20,140** | **7,324** | **33,567** | **B** | **16,515** | **13,695** |
| **Subcontracts** | **47,441** | **35,154** | **5,930** | **6,357** | | **28,123** | **24,080** |
| **Services:** | | | | | | | |
| **Engineering** | **35,431** | **28,345** | | **7,086** | **A** | **24,887** | **19,841** |
| **Constn. Mgt.** | **14,309** | **8,586** | **2,862** | **2,862** | **A** | **7,341** | **5,838** |
| **Construction** | **37,311** | | **37,311** | | **B** | | |
| **Start-up** | **11,978** | **8,265** | **1,473** | **2,240** | **A** | **6,612** | **6,612** |
| *TOTAL* | ***337,161*** | ***175,692*** | ***54,900*** | ***106,569*** | | ***145,143*** | ***121,205*** |

| Overall Export Summary<br><br>Methanol | | Overall Export Summary<br><br>Ammonia |
|---|---|---|
| US Manufacturing. Exports | $95,342,450 | $55,240,640 |
| Labor Portion | $66,739,715 | $38,654,448 |
| Average Loaded Labor | $26/hr | $26/hr |
| Person Hours | 2,566,912 | 1,486,710 |
| Manufacturing Person Years | 1,426 | 826 |
| | | |
| Technical Service Exports | | |
| Engineering | $44,472,148 | $35,093,852 |
| Environmental | $723,124 | $570,632 |
| [illegible] | [illegible] | [illegible] |
| TOTAL EXPORTS | $140,537,723 | $90,885,123 |
| | | |
| Person Hours Services | | |
| Engineering | 592,962 | 467,918 |
| Environmental | 8,035 | 6,340 |
| TOTAL TECHNICAL PERSON HOURS | 600,997 | 474,258 |
| SERVICE PERSON YEARS | 334 | 263 |
| | | |
| TOTAL PERSON YEARS | 1,760 | 1,089 |

## D.2 OPEX COSTS

The Cost of Production for each product has been calculated using the cost of natural gas (as advised by ECHEM) and a number of other assumptions.

A preliminary plant operation staffing table has been prepared. ECHEM may wish to modify this staffing scheme based upon their final staffing plan.

### D.2.1 OPEX Costs – Methanol

**Methanol Plant Production Cost Estimate**
**Nameplate Capacity: 3,000 MT of Methanol**

| Item | | | Methanol Plant | |
|---|---|---|---|---|
| | Units | US $ Cost/Unit | Usage/MT | $/MT |
| Natural Gas (Note 1) | MMBtu(HHV) | 1.00 | 43.6 | 43.58 |
| Purge Gas Export to NH3 Unit | MMBtu(HHV) | 1.00 | 14.2 | (14.16) |
| Waste Gas Import from NH3 Unit | MMBtu(HHV) | 1.00 | 4.2 | 4.22 |
| Electricity (Note 2) | kWh | 0.013 | 40 | 0.52 |
| Sea Water Circulation | M3 | 0.02 | 144 | 2.88 |
| Fresh Water Circulation | M3 | 0.01 | 81 | 0.81 |
| Steam Export,MP | MT | 4.00 | - | - |
| Demin Water Makeup | M3 (Note 3) | 1.3 | 1.1 | 1.43 |
| Catalyst& Chemicals | | | | 2.27 |
| **Feed & Utility costs** | | | | **41.54** |
| Operating Labor | | | | 1.54 |
| Maintenance - Parts & Labor | 1.5% of TIC | | | 7.00 |
| Taxes & Ins | 0.5% of TIC | | | 2.33 |
| Direct OH | 45% of Operating Labor | | | 0.69 |
| General Plant OH | 30% of Direct Fixed Cost | | | 3.47 |
| **Total Fixed Cost** | | | | **15.04** |
| **Total Production Cost** | | | | **56.58** |

**Notes:**
1) Natural Gas consumption for Methanol ISBL and Package Boilers
2) Electrical cost is for self generated power and includes fuel + maintenance
3) Demin.Water makeup is from Desalination Plant

## D.2.2 OPEX Costs – Ammonia

**Ammonia Plant Production Cost Estimate**
**Nameplate Capacity: 1,200 MT of Ammonia**

| Item | | | Ammonia Plant | |
|---|---|---|---|---|
| | Units | US $ Cost/Unit | Usage/MT | $/MT |
| Purge Gas From Methanol Plant | MMBtu(HHV) | 1.00 | 35.4 | 35.41 |
| Waste Gas Export to Methanol Plant | MMBtu(HHV) | 1.00 | 10.5 | (10.55) |
| Electricity (Note 1) | kWh | 0.013 | 467 | 6.07 |
| Sea Water Circulation | M3 | 0.02 | 130 | 2.60 |
| Fresh Water Circulation | M3 | 0.01 | 81 | 0.81 |
| Steam Export,MP | MT | 4.00 | - | - |
| BFW Makeup | M3 | 1.3 | 0.34 | 0.44 |
| Catalyst& Chemicals | | | | 1.50 |
| **Feed & Utility costs** | | | | **36.28** |
| Operating Labor | | | | 1.89 |
| Maintenance - Parts & Labor | 1.5% of TIC | | | 11.37 |
| Taxes & Ins | 0.5% of TIC | | | 3.79 |
| Direct OH | 45% of Ops Cost | | | 0.85 |
| General Plant OH | 30% of Direct Fixed Cost | | | 5.37 |
| **Total Fixed Cost** | | | | **23.27** |
| **Total Production Cost** | | | | **59.55** |

**Notes:**
1) Electrical cost is for self generated power and includes fuel + maintenance

## D.3 OWNER'S CAPITALIZED COSTS

The following is the estimated Owner's Capitalized Costs:

| US Dollars, million | | |
|---|---|---|
| **ITEM** | ***Ammonia*** | ***Methanol*** |
| **Catalyst and Chemicals (Initial Fill)** | **Included in TIC CAPEX** | **Included in TIC CAPEX** |
| **Annual Land Rental** | **$2,971,309/2 =** | **$2,971,309/2 =** |
| **$2.80/m2 x 1,061,182** | **$1.48** | **$1.48** |
| **Project Development** | **7.5** | **7.5** |
| **Project Management Team** | **5** | **5** |
| **License Fee** | **Included in TIC CAPEX** | **Included in TIC CAPEX** |
| **Customs Clearance** | **$0.2** | **$0.2** |
| **Community Relations** | **$0.25** | **$0.25** |
| **Safety Incentive** | **$0.1** | **$0.2** |
| **Independent Engineer & Qrtly reviews** | **$1.25** | **$1.25** |
| **Plant and Cairo set up costs** | **$5** | **$5** |
| **TOTAL** | **$20.78** | **$20.88** |

## TASK E - FINANCIAL ANALYSIS

The following text box outlines our understanding of the ECHEM's objectives.

***Priorities for Project Financing and Implementation***

- To obtain financing at the lowest possible combined cost on an all-in cost basis;
- To reduce the amount of capital required from Echem and/or the level of contingent risk to be assumed by Echem; and
- To obtain financing as quickly as possible and under a structure that will facilitate rapid implementation of the project.

The limited recourse approach would entail the creation of a special purpose vehicle (SPV) to own and operate the Project. The recommended financial strategy would include the following types of capital:

- Limited recourse senior debt for petrochemical projects can typically provide for up to 75 percent of a project's total cost, including capitalized soft costs such as transaction fees and interest during construction. Loan tenors are typically long-term and tied to a combination of risk factors, including (i) the duration and sensitivity of project's offtake and supply contracts, (ii) the general appetite of the capital markets for country-specific risk, and (iii) other risk factors.

- Based upon a total Phase I project cost of approximately USD 1,098 million, the estimated Phase I requirement for equity and/or equity-like capital (such as subordinated debt) is in the range of USD 439 million. Some of this requirement is expected to be met by equity contributions from ECHEM, while the remainder is being sought from third parties. Equity requirements for Phases II and III should be less of an issue, as they could potentially be funded from cash from earnings retained within the SPV.

- Local and international commercial lenders should be the primary target for senior debt financing. Based upon their financial resources and experience in underwriting major syndicated project finance loans, the Lead Arranger will most likely be an international commercial bank based outside of Egypt. Local commercial lenders could also play an important role as they could assist the Lead Arranger in assessing country risk and related tax and regulatory issues, and could potentially provide an EGP-denominated working capital loan to the SPV if necessary and appropriate. ECHEM should begin the

selection of a Lead Arranger by issuing a Request for Proposals once the scope and cost of the project has been finalized (or nearly finalized).

A possible Financing Plan is outlined below.

| *Type* | *Amount – US$ million* |
|---|---|
| Senior Debt – Syndicated Commercial Bank Loan | $629 |
| Equity – Strategic Investors/ECHEM | $419 |
| TOTAL | $1,048 |

**Case 1 – Integrated Methanol Ammonia Plant**

Project costs for the integrated methanol ammonia plant are expected to total $1.048 billion. Using a leverage of 60%, the project is expected to be financed by $629 million of debt and $419 million of equity. The loan will be drawn over a period of 30 months and have a repayment term of 10 years. During the grace period, no principal will be paid but interest payments will be serviced through the proceeds of the debt and equity contributions. Due to the competitive lending environment in the Egyptian petrochemical market and high liquidity in the Egyptian lending sector in general, interest rates for the project are estimated at 6%.

As a result of the project's competitive lending parameters and strong profitability, the project is expected to have acceptable minimum and average debt service coverage ratios (DSCR) of 1.08 and 1.34, respectively. Because operating cash flow at the beginning of the repayment lower due to the initial working capital requirements, the DSCR is lowest during this period. Once operating cash flow begins to accumulate and working capital investments level out, DSCR is expected to consistently increase until subsequent phases are implemented and additional capital investments become necessary.

While debt service to lenders will be fixed, dividends to equity investors will fluctuate depending on project performance. As long as the project maintains a minimum cash balance of $1 million, Echem will be able to pay out up to 100% of its net income to equity investors. As a result, equity investors can expect an internal rate of return (IRR) of 11.5%. A positive net present value (NPV) of $254 million (discounted at 808%) strongly recommends accepting the project.

Financial models are included in Appendix 4 of this Report.

**Task F – RISK ASSESSMENT AND MITIGATION**

The following tables summarize the assessed risks and proposed mitigation strategies.

# Risk Assessment - Ammonia for Trade/Export

| Risk Elements | Characterization | Probability of Occurrence | Comment | Suggestions for Mitigation Strategy |
|---|---|---|---|---|
| ***Market Variables*** | -- Regional Market Stagnation | Medium to High | North Africa has growth potential, but other Mediterranean, European and Atlantic markets don't. | Produce all/mostly upgraded nitrogen products. |
| ***Competition*** | – New, low-cost capacity in the Caribbean, West Asia, upgrade-expansion of FSU export supply | Medium to High | *FSU shippers out of the Black Sea are expected to* vigorously protect their key markets | Involvement of an existing strong and established marketer will be critical, as will the cost of feedstock gas. *Long term formula sales contracts may* be required to assure steady volume operation. |
| ***Feedstock Supply*** | -- Possibility of supply interruption | Unknown | Unpredictable situation | Supply guarantees from Egyptian government |
| | – Feedstock quality | Unknown | Gas "richness" affects yields | Guaranteed specifications |
| ***Margin and Price*** | – Revenue - influence of hydrocarbon prices on residual capacity/production in major European and American markets, and their support of nitrogen/ammonia prices. | Medium to High | Should continue until such a time as market conditions enable buyers to negotiate prices absent the cost structure of a shrinking supply of high-cost production | |
| | -- Margins - a function of revenues and costs | | Margins, and the sharing thereof, will depend on (in addition to revenue) actual price/price formulae for gas, taxes, infrastructure costs (by plant investors), etc. | |
| ***Technology*** | -- Production interruption due to technological issues | Low | Tried and true - many licensors | Use of experienced contractors & technology |
| ***Political Issues*** | Tensions as an outcome of Mideast politics | Low | | Company is Government controlled |
| ***Interest rate and foreign exchange*** | Acquiring US dollar-denominated debt while sourcing equipment from Europe should the dollar depreciate further against the euro payments to suppliers will be more expensive | Med | | Debt financing denominated in two currencies (*USD and* EUR) in a ratio matched to the Project costs |

# Risk Assessment - Methanol

| Risk Elements | Characterization | Probability of Occurrence | Comment | Suggestions for Mitigation Strategy |
|---|---|---|---|---|
| ***Market Variables*** | – Methanol demand changes significantly | Low | Methanol is already a mature product. New potential exists for fuel cell applications, but not for several years in CMAI's opinion | Diversity of marketing |
| ***Competition*** | – Abundance of new, low cost capacity continues to be built | High | Relatively low capital cost and modest gas reserve requirements (vs. LNG) make methanol an attractive investment | Very little that Echem can do, but Methanex plays a very large role by being involved in the sales and marketing of new ventures |
| | – Continued rationalization of industry | High | Methanex controls a very large percentage of the international trade in methanol already and has shown themselves effective at actively rationalizing the industry | Investment in non-Egyptian gas reserves to limit competition |
| ***Feedstock Supply*** | -- Possibility of supply interruption | Unknown | Unpredictable situation | Supply guarantees from Egyptian government |
| | -- Feedstock quality | Unknown | Gas "richness" affects yields | Guaranteed specifications |
| ***Margin and Price*** | -- Global supply and demand balances tip towards oversupply, squeezing margins | High | CMAI forecasts excess supply during study period. Global margins don't make sense as each producer has distinct cost structures primarily influenced by gas price | Margin sharing formula (Methanex/Echem) based on methanol market prices |
| | -- Higher cost producers are all rationalized away, resulting in global price drop as incremental supplier has lower cost | High | Price is set by the incremental producer's costs; these are dropping as high cost producers are rationalized | Gas pricing formula based on methanol market prices |
| ***Technology*** | -- Production interruption due to technological issues | Low | Tried and true - many licensors | Use of experienced contractors & technology |
| ***Political Issues*** | Tensions as an outcome of Mideast politics | Low | | Company is Government controlled |
| ***Interest rate and foreign exchange*** | Acquiring US dollar-denominated debt while sourcing equipment from Europe should the dollar depreciate further against the euro payments to suppliers will be more expensive | Med | | Debt financing denominated in two currencies (USD and EUR) in a ratio matched to the Project costs |

## Task G - PROJECT FINANCING AND IMPLEMENTATION

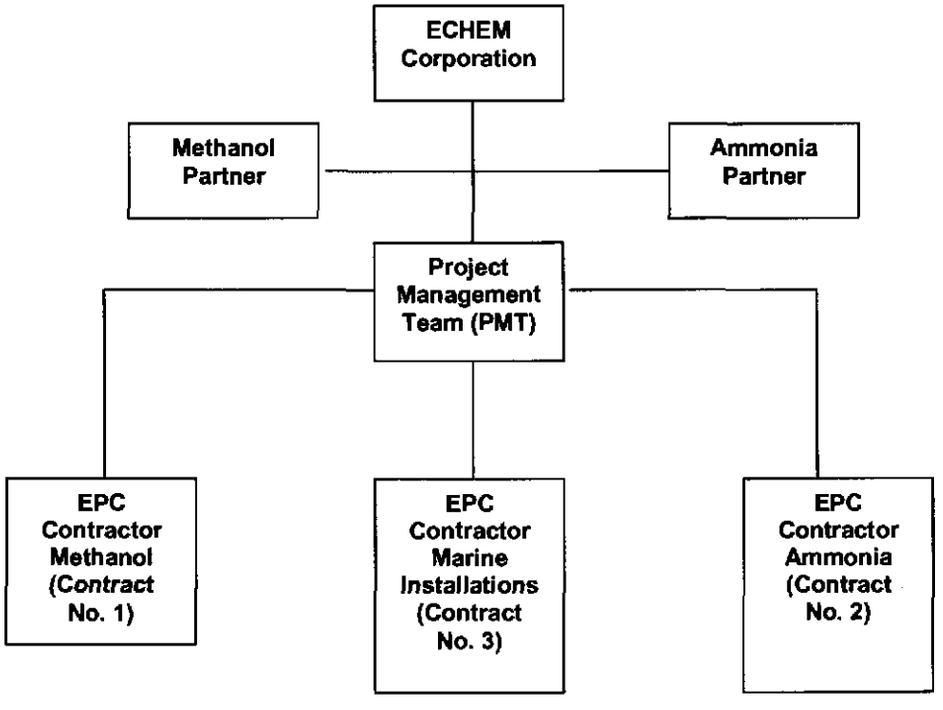
### G.1 PROJECT IMPLEMENTATION

Suggested priorities that will ensure a successful Project are listed below.

***Priorities for Project Financing and Implementation***

- To obtain financing at the lowest possible combined cost on an all-in cost basis;
- To reduce the amount of capital required from Echem and/or the level of contingent risk to be assumed by Echem; and
- To obtain financing as quickly as possible and under a structure that will facilitate rapid implementation of the project.

It is proposed that a contract will be awarded to establish an integrated Project Management Team (PMT) that will oversee and manage all work on the site. The contracting strategy is proposed as shown below.




Such a contracting structure will require separate EPC contracts to be awarded for the methanol production facilities and a second EPC contract for the ammonia production facilities. A third contract would be awarded for the design and construction of the dedicated marine loading

terminal and sea water intake structure. The costs for the marine and civil engineering works for the marine terminal and sea water intake basin (with pumps and screens) would be equally apportioned between the methanol and ammonia groups.

## G.2 FINANCING PLAN

Based upon ECHEM's specific objectives regarding financing and implementation (see text box above), a limited recourse project financing approach will be most appropriate for the project. A limited recourse approach would entail the creation of a special purpose vehicle ("SPV") to own and operate the project assets. Under such a structure, the SPV would serve as the borrower for long-term debt financing, and lenders would rely primarily on the project's assets and cash flows for repayment and collateral. Some supplemental credit support would typically be required from the project's key stakeholders, including the owner(s) of the SPV and the EPC contractor, during the start-up phase.

A limited recourse approach would entail the creation of a special purpose vehicle ("SPV") to own and operate the project assets. Under such a structure, the SPV would serve as the borrower for long-term debt financing, and lenders would rely primarily on the project's assets and cash flows for repayment and collateral. Some supplemental credit support would typically be required from the project's key stakeholders, including the owner(s) of the SPV and the EPC contractor, during the start-up phase.

**Acknowledgements**

In preparing this study, Granherne wish to acknowledge the participation of the following companies that were subcontractors to Granherne or associated in the preparation of this document.

| COMPANY | LOCATION | PARTICIPATION |
|---|---|---|
| KBR | Houston, USA | Providing technology and specialized engineering services |
| KOMEX | Cairo, Egypt | An internationally recognized environmental engineering company subcontracted to Granherne |
| DELPHOS International | Washington DC USA | Providing Financial and Financing Consulting Services subcontracted to Granherne |
| Chemical Marketing Associates Inc. (CMAI) | Houston USA | Providing Marketing Consultancy Services subcontracted to Granherne |
| Engineering Company for Marine Affairs (ECMA) | Cairo, Egypt | Providing Marine Engineering Services subcontracted to Granherne |
| Aker-Kvaerner US Inc. | Houston, USA | Providing cost information on methanol process units |
| Davy Process Technology | London, UK | Providing process information on the methanol LCM and LPM processes |
| Halcrow Group Ltd | London, UK | A subcontractor to Agrium Inc. providing Marine Consultancy |

# TASK A MARKET ASSESSMENT

The following section has been prepared by Chemical Marketing Associates Inc. (CMAI) and reviews the production and market conditions and forecast for ammonia and methanol. The format of this report follows the USTDA Terms of Reference. The report is based on data available in December 2004.

## Tasks A.1 – A.3

This Report covers Tasks A.1 through A.3 of the USTDA Terms of Reference. It assesses the ammonia and methanol consumption for the past five (5) years and forecasts the probable regional consumption for the next fifteen (15) years.

This section identifies producers, capacities and where possible, the planned future production for each region. Overall supply, demand and balances have been prepared forecasting the probable status for the next fifteen (15) years by each region.

## A.1.1 World – Methanol and Ammonia

### A.1.1.1 World Methanol

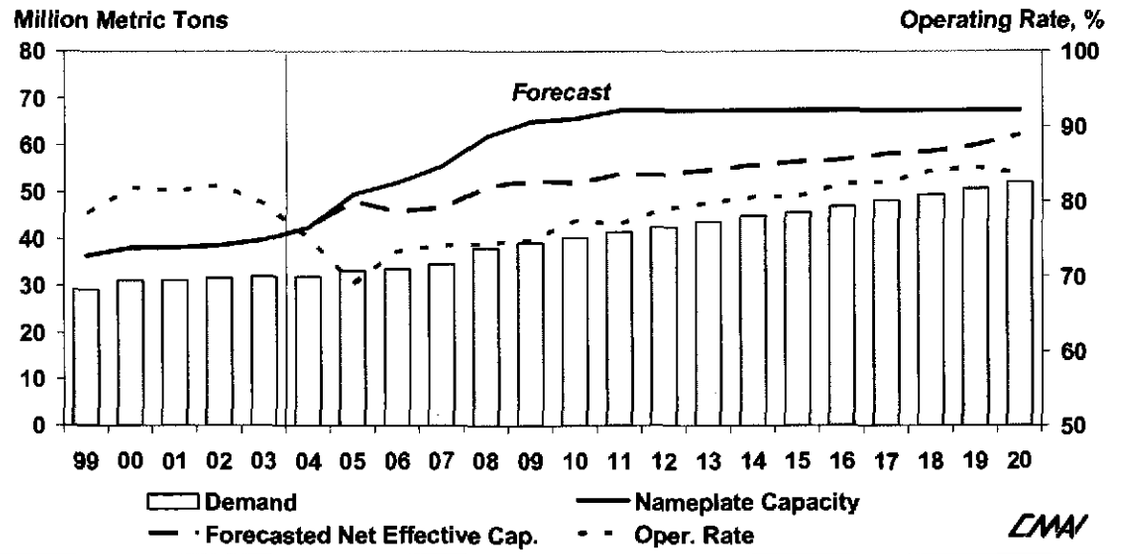
World methanol demand in 2004 is estimated to be 32.0 million metric tons, which if holds true, will be the first time since the 1990-1991 timeframe the industry has experienced a year-over-year decline. (2003 demand has been estimated at a slightly higher 32.1 million metric tons.) While growth was observed in most other derivatives, the loss of about 1.3 million metric tons of methanol consumption into MTBE/TAME could not be overcome.

Industry capacity totaled 42.6 million metric tons, an increase of about 2.6 million metric tons from 2003. This is a major change in assumptions from just one year ago. It includes the addition of almost 3.5 million metric tons of existing methanol capacity in China. We now believe as much as 6.5 million metric tons of methanol capacity exists in 2004, with planned construction propelling capacity to over 9.0 million metric tons in a few short years.

The regional charts that follow pull all of the above information together in one meaningful picture. The actual and projected demand is shown as vertical bars above the respective years.

The methanol industry is undergoing a change from production in the consuming regions to production (much larger scale) in more remote locations. As a result, plants are being built far in excess of demand, thus rationalizing the older units. CMAI shows its best opinion on the actual or "net effective" capacity that will be in place with the dotted lines on each graph. Operating rates are based on this net effective capacity.

## World Methanol Supply & Demand




## Major World Methanol Expansions (2004 - 2010)

| Company | Location | Capacity (KTA) | Start Date |
|---|---|---|---|
| Methanex | Pta. Arenas, TF - Chile | 840 | 2005 |
| Methanex - Atlas | Point Lisas - Trinidad | 1,750 | 2004 |
| MHTL - M5 | Point Lisas - Trinidad | 1,900 | 2005 |
| Azot Togliatti | Togliatti, Sam. - Russia | 450 | 2005 |
| NPC-Iran | Bandar Assaluyeh - Iran | 1650 / 600 | 2005 & 2010 |
| NPC-Iran | Bandar Imam - Iran | 1,000 | 2004 |
| NPC-Iran | Kharg Island - Iran | 660 | 2008 |
| Oman Oil | Sohar - Oman | 1,000 | 2007 |
| QAFAC | Mesaieed - Qatar | 2,175 | 2009 |
| Ar Razi | Al Jubail - Saudi Arabia | 1,750 | 2008 |
| IMC | Al Jubail - Saudi Arabia | 1,000 | 2005 |
| Tasnee Petrochemical | Al Jubail - Saudi Arabia | 1,750 | 2007 |
| Viva Methanol | Lagos - Nigeria | 2,500 | 2008 |
| CNOOC | Hainan, Hainan - China | 600 | 2006 |
| Henan Coal Chem Zone | Henan - China | 800 | 2006 |
| Lutianhua Group | Luzhou, Sichuan - China | 355 | 2005 & 2006 |
| Shenmu Shaanxi | Shaanxi - China | 600 | 2005 |
| Methanol Australia | Tassie Shoal - Australia | 1,750 | 2008 |

Due to their vast reserves of natural gas, South America and the Middle East are the largest producing regions in the World, representing approximately 44 percent of total methanol production in 2004. While North America was the third largest producing region, natural gas costs are the highest in the world and rationalization is occurring at a rapid pace.

The largest producer/marketers in the world currently are Methanex, SABIC (Ar-Razi) and MHTL (Methanol Holdings Trinidad Limited), combined, representing almost 30 percent of the capacity around the world. The other 70 percent of capacity is owned by smaller players, including governments and small producing companies.

Several expansions of more than 300,000 metric tons per year have been announced to come online between 2004 – 2010. In addition to the capacities shown in the table above, another 2.5 million tons is anticipated to come online in China alone in this time period.

**2004 Methanol Market Share**

| | Operating Capacity (-000-) Metric Tons / Year | Share of World Nameplate | Capacity as % of World Demand |
|---|---|---|---|
| MHTL | 2,100 | 4.9% | 7% |
| Ar-Razi | 3,100 | 7.3% | 10% |
| Methanex | 7,341 | 17.3% | 23% |
| Others | 30,011 | 70.5% | 94% |
| **TOTAL** | **42,552** | 100.0% | 133% |

Global methanol demand continues to be dominated by: Formaldehyde production for phenol/urea formaldehyde resins into wood panel adhesives and glues, engineering plastics, insulation and agricultural products; MTBE as a gasoline additive to replace lead and as an oxygenate to help reduce emissions; Acetic acid as a basic component of PET plastic, used to package beverages and household products, used in making polyester fiber for clothing and carpets, and a precursor in the manufacture of water-based paints and adhesives.

International trade of methanol is a very large part of this industry, growing from 8.0 million metric tons in 1990, to almost 17.5 million metric tons in 2004, and is expected to exceed 39.0 million metric tons by 2009. Today trade represents more than 50 percent of worldwide demand.

South America and the Middle East export most of the world's trade in methanol, almost 70 percent of the industry in 2004. The largest methanol importing regions are North America, Northeast Asia and West Europe, as these regions have much more methanol consuming capability than local production capacity.

Methanol is an extremely efficient way to transport, and thus monetize, natural gas. Since the early 1990s, countries in the Middle East, South America and other remote countries, sitting on huge reserves of stranded natural gas, have chosen ammonia, methanol or LNG as avenues to generate cash. These areas, and Australia in the future, will continue to add world-leading low-cost methanol capacity and target high-cost production in North America, West Europe and Northeast Asia. These exporting "mega-centers" will continue to dominate methanol supply.

When global methanol capacity utilization rates are at a level of 85 percent or above, the methanol market is generally considered to be "strong" with higher prices and good cash margins, even for the high-cost producers. When methanol capacity utilization rates fall to the 75 percent range, the market is generally considered to be "weak" with market prices very near the cost of production for the incremental producers.

Most petrochemical industries add capacity during periods of high profitability, causing the market to be subsequently over-supplied with relatively low profitability for the 3-5 years following the peak in margins. During the over-supplied period, industries usually avoid capacity additions, causing the market to be subsequently under-supplied for 3-5 years following the trough in margins. These cycles continue to perpetuate themselves with 5-7 years between peaks. The addition of more than 20 million metric tons of capacity will clearly put a lot of pressure on existing production capacity.

Methanol is not like most petrochemicals. Because lesser developed economies happen to have large reserves of natural gas, for over 10 years now most capacity expansions have been driven by the desire to monetize these assets (not demand driven). The result is the rationalization of higher natural gas-cost facilities in North America, Europe and other parts of the world. This industry tends to experience 3-year cycles between peaks, not 5-7 year cycles for other petrochemicals.

Global methanol capacity utilization rates have risen to near 85 percent in 2002-2003 due to a rash of operating problems. While the large Atlas and Iran facilities (2.7 million metric tons) began operations in mid-2004, this new capacity served to offset lost New Zealand capacity and the shutdown of both the Lyondell and Beaumont Methanol Company-BMC (and Air Products in late 2003) units, netting little new production.

The methanol industry has been very much driven by supply limitations for two years now, and may actually see little change into early 2005. Overall growth for the industry will be less than it has been historically as MTBE demand peaked and will continue to erode over time. For the near term forecast, the addition of over 20.0 million metric tons of capacity is huge, and rationalization of high cost producers will have to occur, willingly, or unwillingly.

### A.1.1.2 World Ammonia

This section of the report reviews recent supply, demand, trade and economic activity in the global ammonia industry, as well as projected trends out to 2020. These projections reflect a scenario considered reasonable based on knowledge/information available today. However, the future is always full of changes and surprises – mostly unpredictable – and the outlook presented herein must be considered with this in mind.

In 2003, world ammonia capacity stood at about 161 million tons per year, and produced 133 million tons at an 83 percent operating rate. World urea capacity was about 133 million tons per year (excluding capacity in integrated nitrogen solutions plants), and produced 112 million tons at an 84 percent operating rate. About 13 percent of the total ammonia output (17 million tons) was traded internationally, compared to the 25 percent (28 million tons) of total urea output that was traded.

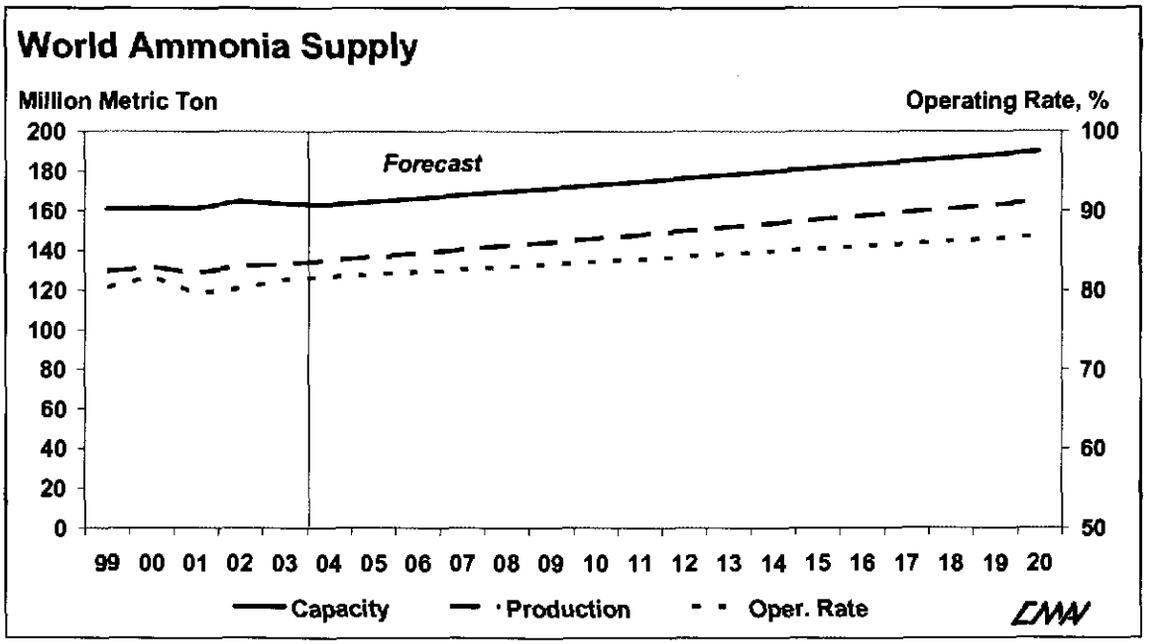
In 2020, we forecast total world capacity at 192 million tons for ammonia. Outputs will be 162 million tons for ammonia at 84-85 percent operating rates for each. International trade will approximate 19-20 million tons for ammonia (12 percent of output).

The growth portion of ammonia import trade (3.8 million tons total) will primarily occur in Latin America, Africa, and Asia. This increase will be offset by import declines in the United States and Europe (1.6 million tons total) resulting from:

- Closures of chemical plants using imported ammonia feedstock (both regions),
- Declining use of ammonia as a direct –application fertilizer (United States).

Period growth in urea import trade (17.1 million tons total) will occur in just about all regions and countries, but the biggest increase will be in the Americas – 8.5 million tons in the United States, 4.7 million tons in Latin America. Growth in the U.S. will continue to be driven by replacement, i.e., replacement of other nitrogen products in the fertilizer market plus replacement of domestic production. Growth in Latin America will be driven by agriculture and growing nitrogen demand, e.g., especially Brazil.

World nitrogen consumption, as measured by world ammonia production (i.e., supply equals use), has slowed down since the end of the 1990s. After the full decline of usage in Central Europe and the FSU (per the collapse of the USSR system), the world market experienced growth of 23 million tons of $NH_3$ output, which represented a 21 percent increase from 1993-2000. From 2000 – 2003, though, the increase was only 1.2 million tons. Recent and future trends are reflected in the following regional patterns.




For the future period covered in this report (to 2020), we estimate the world nitrogen market will increase by another 27 million tons NH3, reaching 160 million tons in 2020 (vs. 133 million tons in 2003). This increase is equivalent to 30-32 million tons of ammonia capacity, on an 85-90 percent operating rate basis. The amount of new-plant capacity increase forecast herein is actually about 42 million tons, with the additional volume required to offset assumed closures in (unprotected) high-cost production regions.

Fertilizers account for at least 85 percent of world nitrogen consumption (and growing), and urea is the dominant product in this market sector. In 2003, nearly 50 percent of 133 million tons of world total ammonia production was used to produce 112 million tons of urea product (excluding urea in nitrogen solutions). In 2020, we estimate 55 percent of 160 million tons of world total ammonia production will be used to produce 150 million tons of urea product.

The 37.5 million ton increase forecast for urea usage/output is equivalent to 82 percent of the period increase for total ammonia/nitrogen growth. This high percentage is driven by the following factors:

- Urea will continue as the dominant straight nitrogen growth product in Asian and Latin American fertilizer markets,
- Urea will continue as both a growth and replacement product in northern hemisphere markets, e.g., North America and Europe. This is particularly true in the United States where, in a fairly flat fertilizer market, urea continues to grow as a replacement for direct-application (DA) ammonia and ammonium nitrate (AN) as rising "risk costs" of

distribution and handling for the latter products are driving dealers towards "safer" materials.

The focus of future supply and future trade patterns will continue to change as a result of energy economics. The sharply higher cost of liquid and gaseous feedstock for ammonia production since 1999 is rapidly changing the face of international nitrogen. Capacities/production have already shrunk to a significant degree in countries where feedstock prices are high, unpredictable, and Nitrogen producers unprotected, e.g., the United States, Mexico, parts of Europe, Japan, Korea. As a corollary, all new world nitrogen capacity (ex-China) is being installed in countries/regions where feedstock costs are both "low" (reasonable) and predictable. These patterns will continue – total ammonia capacity growth of 40 million tons between 2004-2020 will include 71 percent for market growth and 29 percent as replacement for expected additional capacity closures (e.g., United States, Europe, Japan, Korea).

International trading patterns for ammonia and urea are strongly determined by shipping costs. This is especially true for ammonia where, because of the absence of backhaul opportunities, freight costs are highly correlated to mileage. Thus, most Caribbean ammonia stays in the Americas (98 percent total, 88 percent to the U.S.), most West Asian ammonia goes to India, most FSU ammonia goes to Europe, North Africa, West Asia (the FSU product to the U.S. Gulf Coast is an exception – this business was developed in the 1970s, and remains as one of the Former Soviet Union's (FSU's) largest markets at 37 percent of total exports).

Mileage is also a factor in defining urea trading patterns, but with more exceptions that are/will be significant for (any) new Caribbean production. One factor is the existence of cost-reducing backhaul opportunities sometimes available on certain routes. For example, freight costs preclude much, if any, shipments of West Asian ammonia to the U.S. Gulf. However, the volume of grain (wheat, corn) shipped from the Gulf to Islamic markets in North Africa and the Arab Gulf present dry bulk backhaul opportunities from time to time that cut urea shipping costs. This, coupled with U.S. tariffs on FSU urea plus the absence of more urea capacity in the Caribbean (so far), has allowed West Asia to become the largest offshore supplier of urea to the U.S. (the U.S. market took 30 percent of West Asian urea exports in 2003).

Of similar significance is the position of FSU urea in the Latin American market. Prior to the late 1990s, only 15-17 percent of its urea was from the FSU. Its largest market by far was China – about 70 percent of China's urea imports came from the FSU, and this trade accounted for about 70 percent of total FSU urea exports. Then, in mid-1997, China withdrew from the world market (became self-sufficient), and the FSU turned to Latin America. Thus, Latin America's share of FSU exports quickly rose from only 7 percent in 1995-96 to 45 percent in 1998 and further to 58 percent in 2003. Since the FSU exports the bulk of its urea (77 percent of production in 2003), deliveries to Latin America in 2003 were equivalent to nearly 45 percent of total FSU urea production (or about 13 percent of total FSU ammonia production). From

another perspective, 73 percent of Latin America's import urea supply over the past three years has come from the FSU. (Of the largest single import market, Brazil, the FSU supplies the following shares – 85 percent for urea, 30 percent for dry phosphates, 35 percent for potash.) These statistics imply that FSU shippers are unlikely to be displaced in Latin America. The forecasts in this report assume that West Asian urea shipments to the Americas will get even larger, growth in Caribbean capacity notwithstanding, but that FSU shipments will not. The projected growth in American urea imports is about double the projected growth in Caribbean urea capacity, which translates to continued increases in supply from West Asia. Actually, much of the latter will occur from new West Asian capacity already underway, i.e., during 2004-2007, before new Caribbean capacity is operational.

The top global suppliers of Ammonia are listed below, shown with the location of their principal markets.

## Ammonia World Top Suppliers

| Company | Location | Principle Markets |
|---|---|---|
| Agrium | Canada | U.S. (rail) |
| CFL | Canada | U.S. (rail) |
| Agrium | United States | Pacific Rim |
| Carib. N/Koch | Trinidad | USGC, USEC, Caribbean & Atlantic Rim |
| MissChem | Trinidad | USGC, USEC, Caribbean & Atlantic Rim |
| PCS | Trinidad | USGC, USEC, Caribbean & Atlantic Rim |
| Yara | Trinidad | USGC, USEC, Caribbean & Atlantic Rim |
| Fertinitro | Venezuela | USGC, USEC, Caribbean & Atlantic Rim |
| Yara | Germany | Europe |
| Yara | Netherlands | Europe |
| Yuzhnyy (OPZ) | Ukraine | USGC, NW Europe, Mediterranean & Asia |
| Gorlorvka | Ukraine | USGC, NW Europe, Mediterranean & Asia |
| Togliatti | Russia | USGC, NW Europe, Mediterranean & Asia |
| Asmidal | Algeria | Europe-Mediterranean |
| QAFCO | Bangladesh | Asia-Pacific/Indian Rim |
| SABIC | Saudi Arabia | Asia-Pacific/Indian Rim |
| Kaltim | Indonesia | Asia-Pacific/Indian Rim |
| Petronas | Malaysia | Asia-Pacific/Indian Rim |

# Ammonia In Progress and Speculative Production Increases

| (-000-) Metric Tons | In Progress | Speculative |
|---|---|---|
| **North America** | **0** | **0** |
| **South America** | **1,260** | **1,300** |
| Brazil | | 800 |
| Peru | | 500 |
| Trinidad | 1,260 | |
| **West Europe** | **0** | **0** |
| **Central Europe** | **0** | **0** |
| **Former Soviet Union** | **200** | **500** |
| Lithuania | | 500 |
| Uzbekistan | 200 | |
| **Africa** | **1,750** | **1,720** |
| Algeria | 550 | 960 |
| Egypt | 1,200 | 760 |
| **Middle East** | **4,570** | **2,690** |
| Abu Dhabi | | 450 |
| Iran | 1,750 | 1,350 |
| Oman | 1,820 | |
| Saudi Arabia | 1,000 | |
| Syria | | 660 |
| UAE | | 230 |
| **Indian Subcontinent** | **0** | **5,195** |
| Bangladesh | | 1,275 |
| India | | 2,750 |
| Pakistan | | 1,170 |
| **Northeast Asia** | **0** | **0** |
| **Southeast Asia** | **760** | **5,005** |
| Australia | 760 | 2,205 |
| Burnei | | 700 |
| Indonesia | | 730 |
| Myanmar | | 215 |
| Vietnam | | 1,155 |
| **World** | **8,540** | **16,410** |

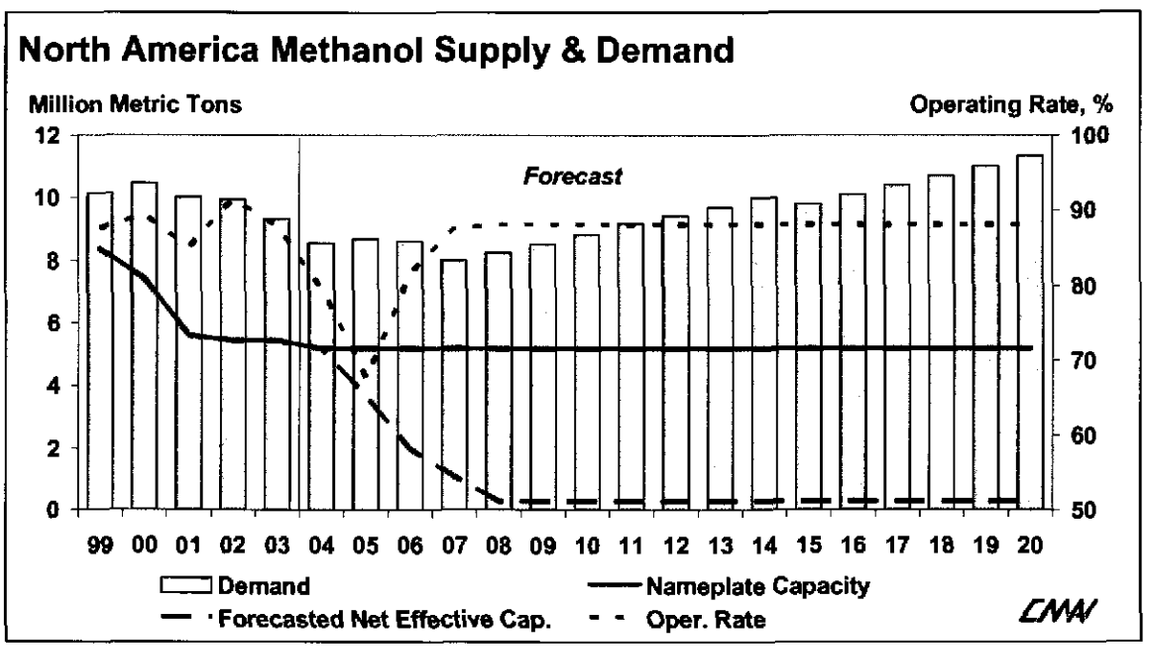
## A.1.2 North American Methanol and Ammonia

### A.1.2.1 North American Methanol

Methanol production in North America has steadily decreased as new world scale capacity has come online in other areas of the world. In 2004, production is estimated at about 4.1 million metric tons, an aggregate decrease of about 10 percent per year since 1999. The United States and Canada represent over 95 percent of this region's production.

MTBE and formaldehyde demand account for more than 55 percent of the region's methanol consumption, but like other regions, will move in different directions, as formaldehyde will follow GDP growth whereas over time, MTBE demand will be largely eliminated by the U.S. phase down programs.

North America is the second largest importer of methanol in the world (led by the United States), with imports expected to total over 5.1 million metric tons in 2004.




Although North America has a diverse derivative slate, with most growing at GDP rates or better, the loss of MTBE will continue to lead an overall decline in demand through 2007, at which time methanol demand is forecast to return to positive growth.

North America is the second largest methanol consuming region in the world (8.6 million metric tons), accounting for 27 percent of global demand. Through 2004, the region ranks third in total production, behind South America and the Middle East. North American production in 2004 is

expected to be 4.1 million metric tons, or 13 percent of global supply, declining to less than 300,000 metric tons by 2009.

The United States is currently the largest single consuming country in the world, alone accounting for 7.3 million metric tons of methanol (23 percent of global consumption). In 2000, the U.S. relinquished its position as the largest producer in the world. Methanol consumption peaked in 2002, the last year of nationwide MTBE requirements under the Clean Air Act Amendments of 1990. With the phase out and ban of MTBE use in California, along with other states following the California lead, methanol demand will decline significantly through the next five years. Unfortunately, it is unlikely that any current or potential outlet will provide significant requirements for methanol to replace lost MTBE demand for another 10-15 years.

Feedstock natural gas represents a very large portion of the production cost of methanol. In the last two years, natural gas costs in the United States have touched the $10.00 per MMBtu level twice, with the typical monthly price above $6.00 per MMBtu for much of 2004. The outlook for consumption of natural gas is rather strong for the next five-year period. Since residential, commercial and other such uses represent a very large outlet for gas, and can/will pay higher prices as compared to a feedstock for methanol, U.S. methanol production has become the "high-cost" incremental producer, and will continue to be under fire, cost wise, for the foreseeable future. Canadian methanol production is no exception. Already significant capacity has been rationalized at the expense of low-cost production from South America and the Middle East. Between the loss of MTBE and lower natural-gas-cost based methanol capacity starting up over the next few years, the remaining capacity in North America will be forced to rationalize.

The Lyondell (Channelview, TX) facility was idled in September 2004 once the new Atlas facility (Trinidad) was well established. The Beaumont Methanol Company facility was shutdown shortly thereafter, on December 1. Celanese has secured methanol from the M5000 Trinidadian unit (MHTL) that is slated to startup mid-2005 to replace domestic capacity.

Methanol demand in North America is estimated at 8.6 million metric tons for 2004, forecast to decline to about 8.0 million metric tons in 2007 before returning to a slow but steady GDP related growth rate.

Given the current and forecast global methanol conditions, methanol production in North America is forecast to continue to decline through the next few years, with the largest year-over-year decrease already recorded, from 2000 to 2001. Enron, Borden, Sterling/BP and Medicine Hat have all rationalized production capacity over the last few years, at the hand of lower cost production from South America, the Middle East and other countries. At the present time there are two projects underway to add methanol capacity in Trinidad. The Atlas unit (1.75 million metric tons), with startup in mid-2004, is the sixth methanol unit in this complex. MHTL (Methanol Holdings Trinidad Limited) has announced plans to construct a new 1.9 million metric

ton unit in Trinidad, the seventh unit (fifth under the MHTL umbrella) with start-up targeted for the first half of 2005. Methanex has also announced plans to construct a fourth methanol unit at their Chile complex, with startup scheduled for early 2005, having a nameplate capacity of 840,000 metric tons. Based on these expansions, the Lyondell and BMC facilities have shut down, Celanese will idle capacity in mid-2005, and Kitimat will likely idle in the 2005/2006 timeframe.

Methanol production in North America is forecast to decrease from today's level of 4.1 million metric tons, to about 250,000 metric tons by 2009, at which time North America will represent almost nothing of global production.

Conversely, imports into North America will grow from today's level of 5.1 million metric tons to almost 8.3 million metric tons by 2009.

Methanol demand in North America for 2004 will no longer be dominated by the production of MTBE (24 percent of demand), a position MTBE has held since 1992. Formaldehyde now represents the largest single derivative (30 percent of demand) followed by acetic acid (13 percent of demand). Overall, North American demand is expected to decline at an annual rate of about 0.1 percent over the next five-year period. This compares to a negative 3.3 percent rate for the previous five years, which was negatively impacted by the drop in overall demand in 2002 and 2003. CMAI's forecast may now be somewhat pessimistic, as the phase-out of MTBE could stall from current expectations; yet this forecast presents our best understanding regarding MTBE legislation.

North America is the second largest importer of methanol in the world, just behind Northeast Asia. The region relinquished being a larger producer than importer in 2001 because of the reduced methanol production in Canada and the U.S. The U.S. is currently the largest single importing country in the world, and is forecast to maintain this position throughout the next five years at least.

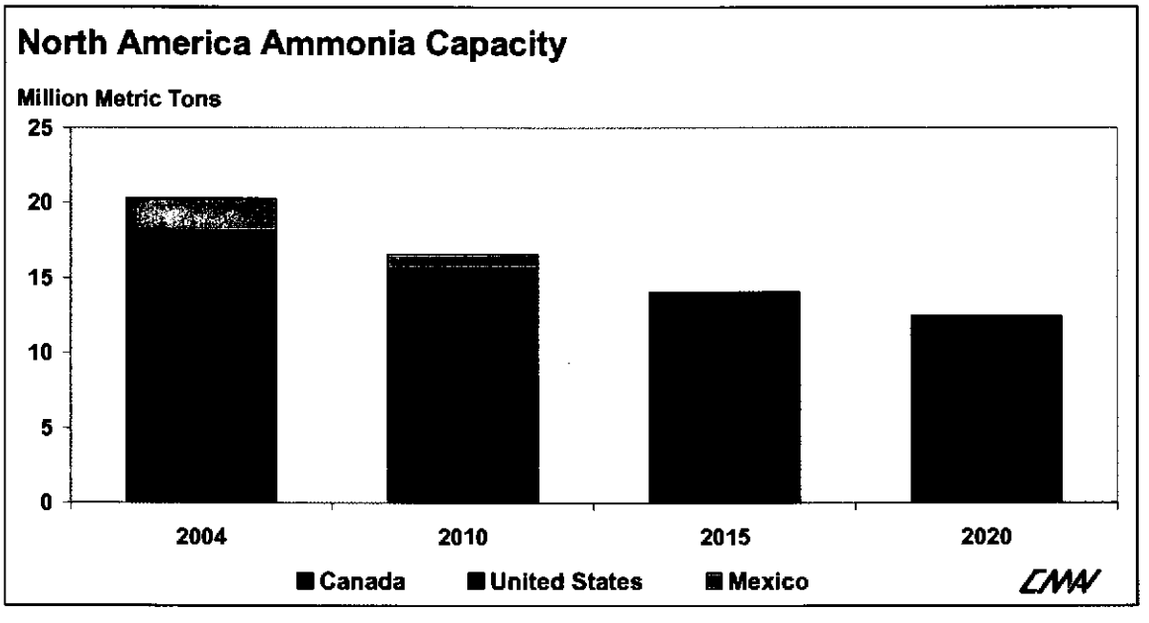
There will likely continue to be some exports of very small quantities from North America to more out-of-the-way locations and countries in South America. This is due to the small quantities involved that have historically been better served by exports from the U.S., in combination with other petrochemicals rather than diverting large dedicated tankers.

Based on the new production planned in South America and the Middle East countries, and the phase out of MTBE demand in the U.S., it is clear that shutdown decisions will have to be made in some of the "high-cost" methanol production locations around the world. North America and Europe are the most logical targets for much of this new production. Lyondell and BMC have rationalized in late 2004, while Celanese locations and Kitimat appear poised for rationalization beginning mid 2005-2006 timeframe.

To date, North American production and production costs have dictated the "floor" price for methanol. While not always influencing actual market prices, North American (namely United States) producers have been the high cost incremental production, which shuts down in a long market as prices are driven below U.S. cash cost levels, and restarts once prices move above cash costs. Within the next few years, it is likely most of the capacity remaining in the U.S. will rationalize, thus removing them from the role of setting the "floor" price for methanol. The question then is, "Who will be the next high-cost producer, and dictate the floor price of methanol?" South America will likely be the low-cost supplier to North America and Europe, and the Middle East/Australian capacity will clearly be the low-cost supplier to Asia. The Middle East may inherit the role of incremental supplier to North America, and industry pricing may be based on the cost of production, plus delivery from these remote areas.

### A.1.2.2 North American Ammonia

Six customs district destinations in five states (eight ports) account for about 99 percent U.S. vessel imports of ammonia. The individual ports are defined by the existence of dock-tank infrastructure that can receive vessel ammonia – no others exist in the United States except at Stockton and Sacramento in California (on the Sacramento River), both of which are primarily supplied from Canada.




***Savannah, Georgia***. Only storage owned by PCS, who controls all supply and ships most/all product to North Carolina and Florida (some to Augusta) for captive feedstock use (ammonium phosphates). PCS' terminal land lease expires year-end 2007, and is not expected to be renewed. PCS "replacement" options are:

- Build new tank elsewhere (difficult if not impossible, because of permitting).

- Supply ammonia to Florida and North Carolina phosphate plants by rail from other ports (e.g., Tampa, NOLA).
- Terminate ammonium phosphate production in Florida and North Carolina (eliminates demand for ammonia at these locations).

***Tampa, Florida.*** Tampa is the largest ammonia market in the world (2.35 million tons of total imports in 2003). Most product is used as feedstock, over 95 percent for the production of ammonium phosphates (DAP, MAP). Some import product is also railed to the Midwest for DA fertilizer use. In 2003, 62 percent of total supply came from Trinidad, 32 percent from the FSU, 3 percent from Venezuela, and the balance mostly from West Asia. Demand for ammonia feedstock in central Florida has shrunk by about 520 thousand tons per year since 1990 because of plant closures. These lost tons have been partially offset by ammonium phosphate capacity increases at other plants, plus some rail shipments of Tampa ammonia to the Midwest. For the future, the most likely trend is for flat-to-declining ammonia imports due to:

- A gradual trend to produce more MAP (uses 0.14 tons $NH_3$ to one ton of product) and less DAP (uses 0.225 tons $NH_3$ to one ton DAP),
- Potential loss of more U.S. DAP export shipments to Asia,
- Potential closure of one or more DAP/MAP plants by end of decade.

***Pascagoula, Mississippi*** (Mobile, Alabama customs district). Only storage owned by MissChem, who controls all supply (100 percent captive from Trinidad), all used on-site as feedstock for ammonium phosphates. This plant is a weak link in MissChem's portfolio (the company is still in Chapter 11), and might not last the decade.

***New Orleans, Louisiana (NOLA).*** Through the 1990s, the NOLA region was the largest ammonia-nitrogen production center in the United States – in 1998, 6.5 million tons per year of Louisiana ammonia capacity in nine complexes represented 37 percent of total U.S. capacity (17.5 million tons per year). Since then, 4.1 million tons per year of this capacity has shut down, leaving 2.4 million tons per year at the only two sites still in operation. As the closures occurred, the ammonia supply for shipment/sales was replaced by imports, which rose from less than 50 thousand tons per year in the 1990s to 1.5 million tons in 2003. Of this 2003 volume, an estimated 50-55 percent was supplied (sold) as feedstock to chemical plants in the region and in the Midwest and Northeast. The other 45-50 percent was shipped to the Midwest for direct-application to the soil (DA fertilizer). NOLA is the only U.S. ammonia vessel import location that supplies this Midwest DA fertilizer market in volume, i.e., ammonia deliveries to all other port locations are almost all for feedstock use. Of the 1.5 million tons of NH3 imported to NOLA in 2003, 50 percent came from Trinidad, 47 percent from the FSU, and 2 percent each from Venezuela and West Asia. NOLA is the only U.S. ammonia import market with growth potential,

primarily due to potential future $NH_3$ plant closures, i.e., MissChem's remaining train at Donaldsonville, Mosaic train at Faustina/Donaldsonville (512 thousand tons per year, about 2/3 for captive feedstock, rest sold), one or more of CF Industries' four trains at Donaldsonville (2015 thousand tons per year of total capacity, supplying 360-545 thousand tons per year of shippable ammonia). The potential replacement of MissChem's trade ammonia supply from Donaldsonville (equal to or less than 485 thousand tons) and the Mosaic and CF requirements could amount to nearly 900 thousand tons.

Except for these replacement opportunities, however, the markets served by NOLA ammonia are expected to eventually shrink because:

- The large Midwest market for direct-application ammonia fertilizer is declining (replaced by other products, e.g., urea, UAN solutions), with NOLA-supplied product directly impacted, and
- Customers using NOLA-sourced ammonia to produce ammonium nitrate fertilizer are likely to see this product regulated out of the fertilizer market because of its demonstrated "abuse potential," i.e., accidents (e.g., Romania, North Korea), explosives use by terrorists and other disaffected (e.g., Oklahoma City).

***Texas*** In 2003, the four Texas ports (Port Arthur, Houston/Pasadena, Freeport, Pt. Comfort) imported a total of 1.4 million tons $NH_3$, 85 percent from Trinidad, 7 percent from Venezuela, 6 percent from the FSU, and 1 percent from elsewhere. The Texas market for imported ammonia has grown steadily since the mid-1990s (from about 45 million tons to 1.4 million tons in 2003), due to both customer demand growth (capacity expansions), and replacement of domestic-sourced product (from NOLA plants now closed). Both of these market-driver phases are now pretty much complete, except for replacement of Terra Industries' small supply at Beaumont (about 180 thousand tons per year using captive methanol off-gas) due to that plant's closure in December 2004. Otherwise, there may be more potential for the market to shrink into the next decade if/as continued high U.S. hydrocarbon costs, plus continued growth in petrochemical capacity in Asia eventually lead to closure of some nitrogen-consuming U.S. Gulf petrochemical plants.

### A.1.3 Mexico and Central America Ammonia

The ammonia trade market among these countries is small and not growing, especially with the recent closure of the Fertica nitrate plant in Costa Rica. However, the possible future closure of all ammonia production in Mexico (Pemex) could result in some import growth there.

However, imported urea has seen a huge growth market here since 1995 as imports replaced domestic production. This phase is over, however, and Mexican imports have leveled off around 1.2± MMtpy since 1999. FSU shippers (Russia, Ukraine) really dominate the Mexican-Central American market – the only other shipper of note is Agrium out of Alaska to the west coast of Mexico.

Some future market growth is likely, but, as in the past, on a gradual basis only. Opportunities to supply from (any) new Caribbean production thus appear to depend on competitive replacement of material from other sources.

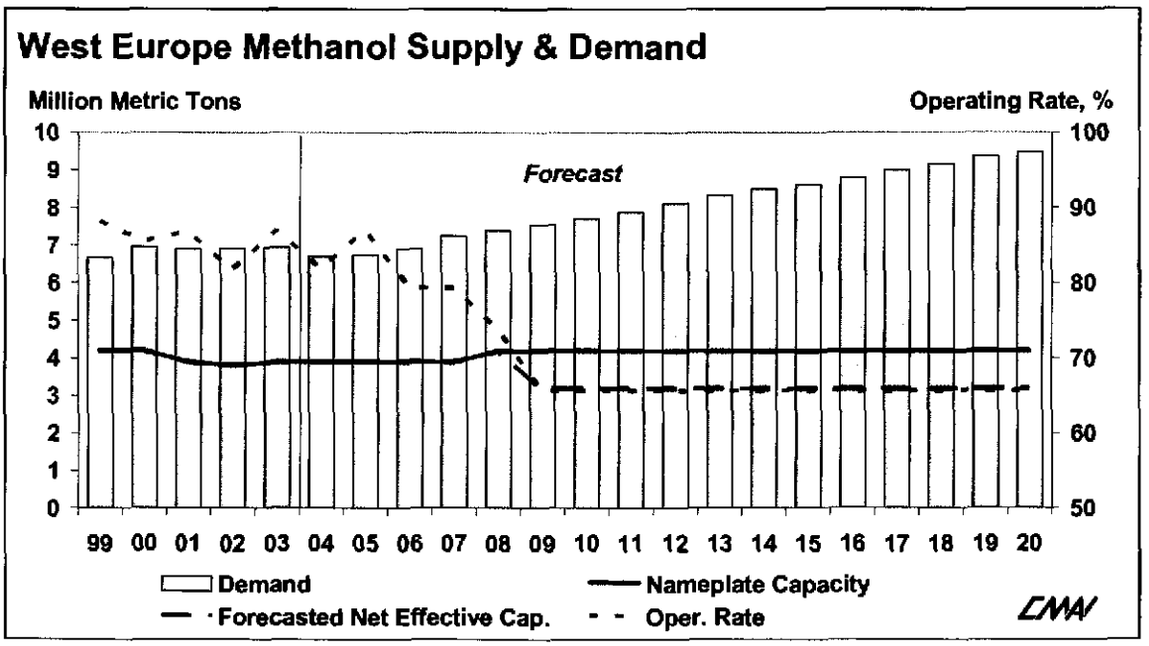
### A.1.4 Europe Methanol and Ammonia

#### A.1.4.1 European Methanol

Western European Methanol

Methanol production in Western Europe has been on a slow decline from 1999 through 2002. In 2003, production rebounded slightly while 2004 is expected to again see a decline, the result of many major second quarter planned turnarounds across the region. In 2004, production is estimated at 3.2 million metric tons.

Formaldehyde, MTBE, and acetic acid demand account for almost 66 percent of the region's methanol consumption, but will move in different directions during the study period. Formaldehyde will follow GDP upwards while MTBE will decline, impacted by the U.S. phaseout programs as well as the push by the EU for alternate gasoline oxygen additives. Acetic acid is expected to witness significant growth, driven by new methanol based capacity.




Like North America, Western Europe became a larger importer of methanol rather than being a producer in 2001. Expected imports will total 3.6 million metric tons in 2004, about 54 percent of demand.

Exports outside the region are small, totaling less than 100,000 metric tons per year. However, within the region, significant volumes move from the Netherlands, Norway, and Germany to other intra-regional locals, going forward intra-regional trade figures will increase significantly as the EU expand from 15 countries to 25.

Methanol demand in West Europe is estimated at 6.7 million metric tons for 2004, about 21 percent of global consumption. Demand continues to grow near GDP levels, forecast at 2.4 percent through the next several years.

The growth of methanol demand for West Europe has been quite low over the last several years, averaging 7.0 million metric tons from 1999-2004. Prior to 1997, the majority of methanol supply came from imports, but the Statoil facility startup in 1997 reversed this trend until 2000, as domestic production supplied a greater portion of demand than imports. The closure of the ICI facility in 2001 and the continued growth in overall methanol demand again reversed this supply situation, and is not expected to change during the study period.

Methanol consumption in this region of the world is well developed. While formaldehyde consumption has dominated methanol demand in West Europe for more that 20 years, there was a period when the second largest single outlet for methanol was for direct gasoline blending

(together with a co-solvent). However, with the collapse in oil prices in the mid-1980s, methanol became too expensive and the practice of blending methanol into gasoline stopped quickly. Shortly thereafter the demand for MTBE more than doubled, and now demand has quadrupled as 2003 ends. European reformulated gasoline (RFG) has an oxygen component specification of 2.7 weight percent maximum, with no minimum. Fuel additives containing oxygen are not a requirement or a mandate. However, with a reduction of aromatics and benzene in gasoline, and phase out of lead, there has been an increased demand for high octane blending components such as MTBE. However, similar to the United States situation, there is pressure to move away from MTBE, and companies have switched production to ETBE in some instances. Bio-fuels are also receiving a lot of government attention, with economic incentives for those types of new uses as well. As a result, MTBE production has likely stabilized, at best, through the forecast period.

There is no foreseeable new methanol production capacity in Western Europe during the forecast period, except for some debottlenecking of the Statoil, Norway facility and the Methanol plant in the Netherlands. Statoil announced in mid-2004 studies were underway to explore the possibility of expanding their methanol facility from 900,000 metric tons per year to 1.2 million metric tons per year. A decision is expected in late 2006. Based on their very attractive natural gas position, an expansion is clearly feasible. The impact to the region would likely result in a reduction in production costs compared to other sources.

Rather than additional capacity, a better case can be made for further rationalization of Western Europe methanol capacity. Some units are believed to be immune, such as the methanol plant in Norway that will operate under essentially any (and all) global/local market conditions because it uses associated gas that cannot be flared. Others use process off-gas or "waste" as feedstock and likewise are extremely unlikely to shut down. However, there are relatively large merchant market methanol producers in Western Europe that might consider rationalizing facilities at some time in the future. The upcoming production in Trinidad, Chile, and the Middle East capacity additions will clearly target the Western Europe market for a significant portion of its output.

Methanol production in Western Europe is forecast to increase from today's level of 3.4 million metric tons in 2005, and then trend downward through the study period.

Methanol demand for the production of formaldehyde has dominated, and will continue to dominate, Western Europe consumption, accounting for about 48 percent of total methanol consumed. This is forecast to continue, as we expect formaldehyde growth to outperform its 1.6 percent per year growth through the 1999-2004 period and strengthen to a rate of 2.3 percent per year for the next five-year period.

In 2003, approximately 3.6 million metric tons of imports entered the region to supplement local production, representing just over half of total demand. Exports outside the region are minimal, predominantly moving to countries within Central Europe. By 2009, imports are forecast to increase to almost 5.5 million metric tons, almost 75 percent of demand.

Imports to the region are dominated by South America, the Middle East and Russia (currently), and will continue to be targeted by new capacity from Trinidad, Saudi Arabia, Iran, Qatar, and Oman.

Based on the combination of new production in South America and the Middle East countries, and the phase out of MTBE demand in the U.S., it is clear that some difficult decisions will have to be made in Western Europe in the not too distant future about whether to run plants or not. Beginning in 2000, the overall market tightness and run-up of international pricing presented an unlikely scenario for further rationalization. The subsequent shutdown of the ICI capacity further squelched the probability of additional short-term shutdowns. The last two years have been quite snug as well. With the delay of new capacity in 2004, supply, and demand has been kept in check, awaiting production from Trinidad and Iran, and the next wave of new capacity planned for the 2005-2007 timeframe. CMAI does not currently identify any potential plant shutdowns; however, the supply and demand balances suggest that as much as 1.0 million metric tons of production will be rationalized over the next 5 years. While capacity ownership is not identified, this is a high probability the region and the industry will face for global operating rates to remain in a reasonable range.

Overall, we forecast methanol demand in this region will grow at about 2.4 percent per year for the next five years, better than the 0.1 percent growth over the last five years. Imports are forecast to grow at a rate of about 9.1 percent per year, nearly triple the rate over the previous five years.

Central European Methanol

Production in Central Europe appears to have peaked in the 2000-2002 timeframe, the result of tighter supply fundamentals and the restart of the Viromet facility in Romania. Production in the former Soviet Union has increased steadily from 1999 to 2003, in recent years the result of tight supply and the resulting higher international pricing. Production is expected to fall slightly in 2004, the result of major planned turnarounds at the two largest facilities.

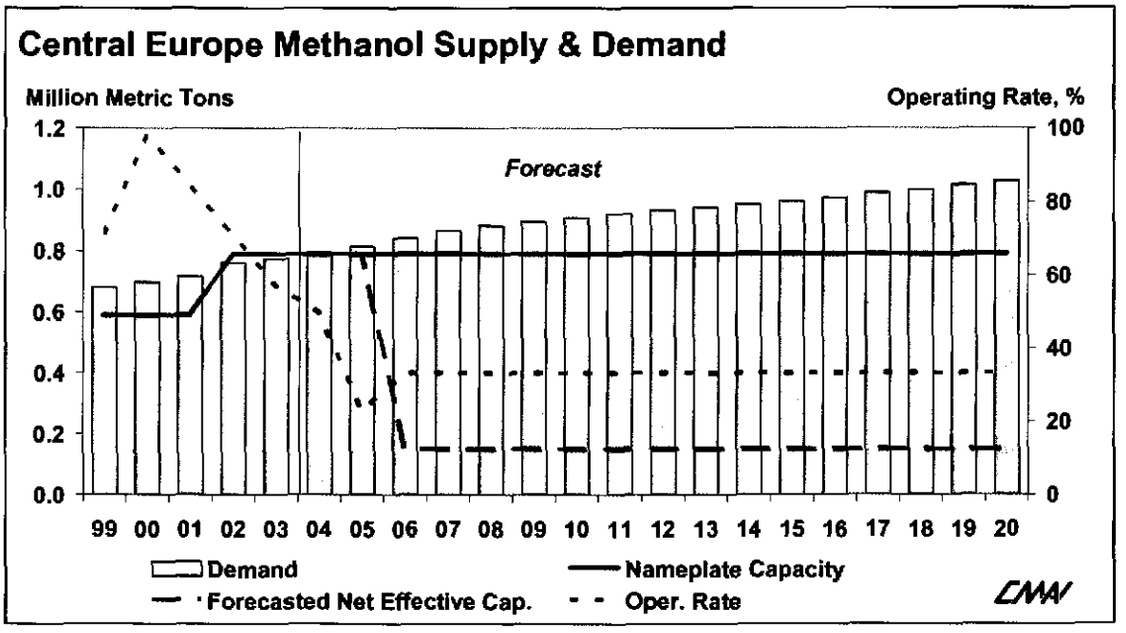
Central Europe remains a net importer of methanol, approximately 300,000 metric tons per year on average, often supplied from Germany and the FSU. Russia methanol capacity dominates supply, constituting almost 95 percent of production in the region. In recent years, about 40 percent of this production is exported out of the region.

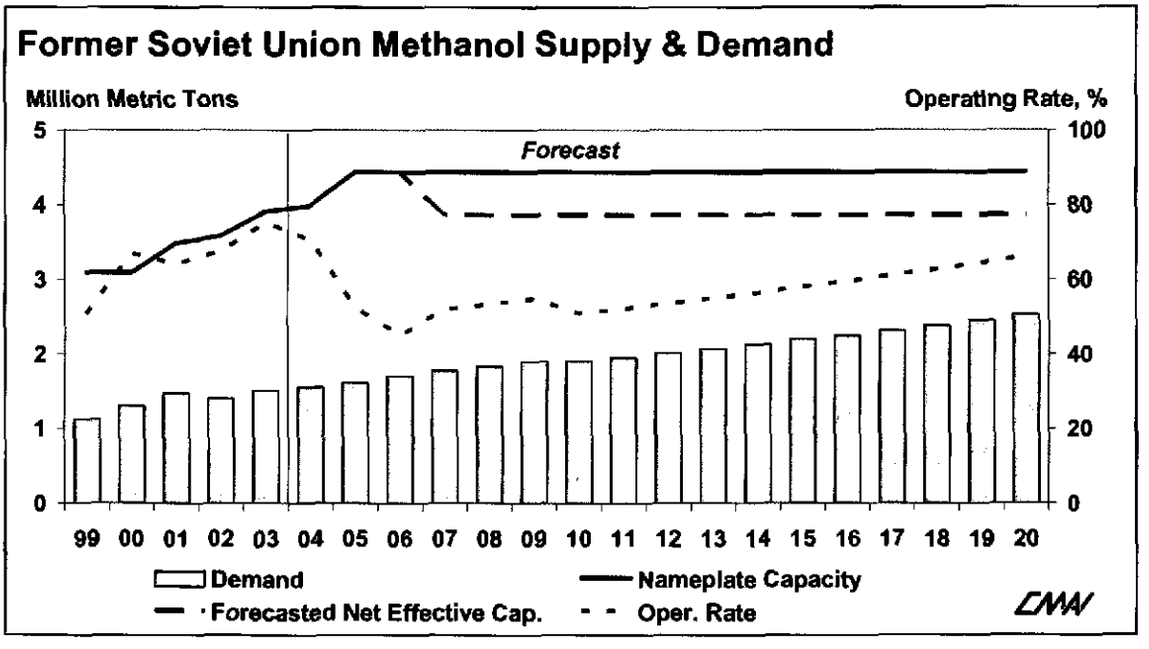
With significant natural gas reserves in Siberia, Russia continues to talk about future methanol capacity expansions. Future studies include the construction of natural gas pipelines into China, or construction of methanol units with output destined for China. A doubling of capacity at the Togliatti facility, from 450,000 to 900,000 metric tons, is included in 2005.

Approximately 190,000 metric tons of methanol (49 percent of production) will be exported from Central Europe to other parts of the world in 2004. At the same time, almost 600,000 metric tons of methanol will be imported into Central Europe. Both volumes have been very consistent over the last several years.

By 2009, imports into Central Europe are expected to increase by about 40 percent. In the early years, CMAI believes it will be very difficult for Central Europe, like the FSU, to continue its current export programs. As a result, the regions will focus production on domestic demand, and exports beyond the region will be eliminated.

For the methanol industry in the Central European countries, we do expect a drop in production in the next two years. It seems difficult for some of the methanol producing countries in this region to continue production on the same scale as the recent past. Overall, we forecast methanol production in Former Soviet Union will decline by 5.5 percent per year and Central Europe will decline by 33.9 percent through 2004-2009. Much of their feedstocks (natural gas) originate in Russia, and they must now pay world prices in hard currency. Because of this, we are of the opinion that some methanol production has been shut down in Bulgaria, Czech Republic, Poland, and at times facilities in Yugoslavia.


Central Europe Methanol Supply & Demand
Million Metric Tons
Operating Rate, %
1.2
1.0
0.8
0.6
0.4
0.2
0.0
100
80
60
40
20
0
Forecast
99 00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20
Demand
Nameplate Capacity
Forecasted Net Effective Cap.
Oper. Rate
CMAI


Former Soviet Union Methanol Supply & Demand
Million Metric Tons
Operating Rate, %
5
4
3
2
1
0
100
80
60
40
20
0
Forecast
99 00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20
Demand
Nameplate Capacity
Forecasted Net Effective Cap.
Oper. Rate
CMAI

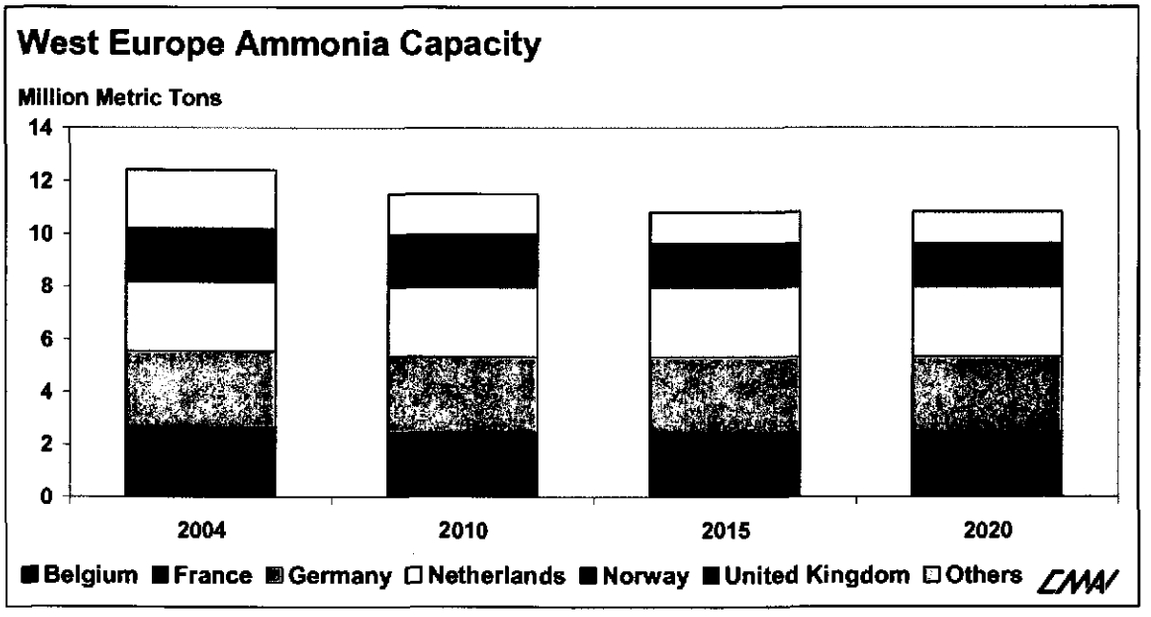
As far as the methanol business is concerned in the Central European and Former Soviet Union countries, major changes are not expected. Methanol derivative figures have been revised downward, and growth in methanol demand is negligible during the next few years.

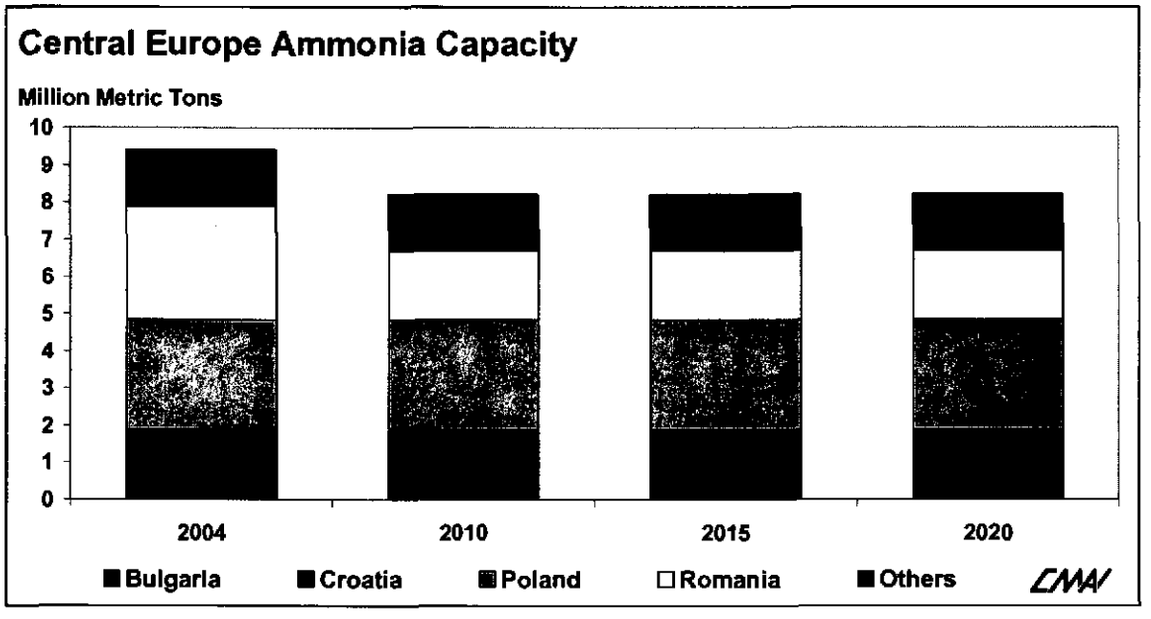
Given the current cost structure to deliver methanol to consuming markets, production in these regions of the world are not expected to grow significantly. In fact, some less efficient production located in Russia, Yugoslavia, and Romania could be campaign run or rationalized. The primary reason is that these facilities are unable to compete in global methanol markets in times of soft pricing. As long as global methanol prices are at or above $200 per ton, most of these facilities can compete. But when pricing declines to the levels given in the price forecast, these facilities are at an economic disadvantage and must pull out of the marketplace. Although there have been announcements of some new world-scale export-oriented methanol plants for Russia, because of these difficult economic factors, it is assumed that they will not be constructed in the foreseeable future.

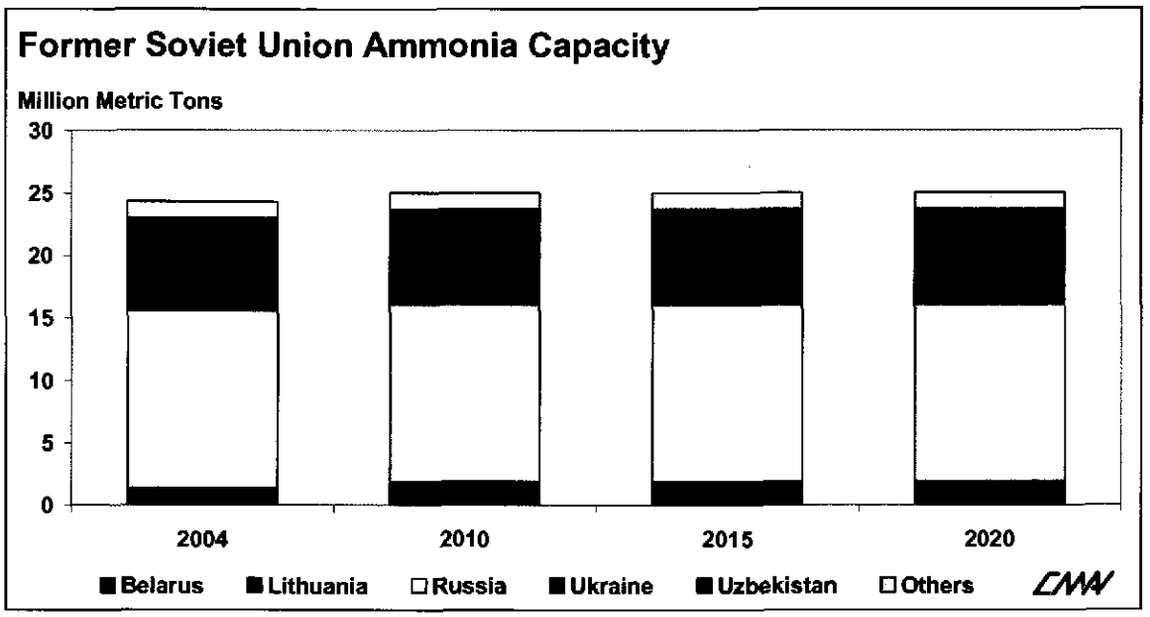
Methanol demand in this region of the world between 2004 and 2009 is expected to realize an annual aggregate growth of about 4.1 percent in the Former Soviet States, and 2.4 percent for Central Europe. But much depends on potential military, political and economic developments in the region as it continues to change from communism to capitalism. Over the extended forecast from 2009-2020, methanol demand growth is anticipated to improve to 2.6 percent and 1.3 percent respectively as the economies of these regions slowly recover.

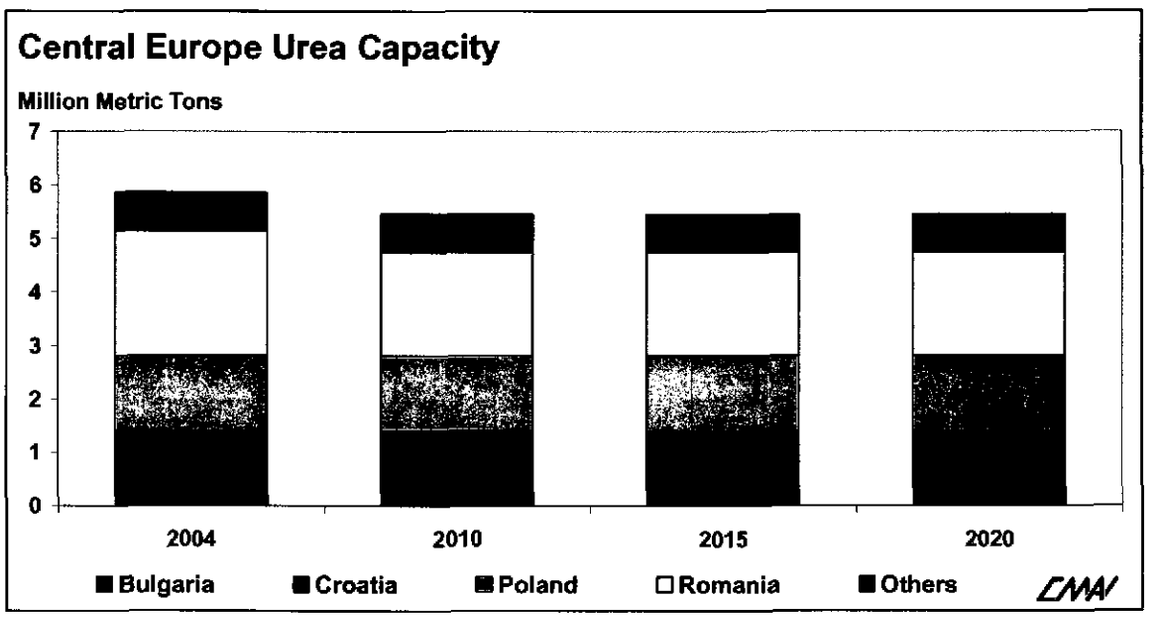
### A.1.4.2 European Ammonia

Europe remains a major import trade market for ammonia, with demand spread across most of the countries therein, basically all for feedstock use. Through the mid-to-late 1990s, total regional import volume trended relatively flat around 4.5 million metric tons per year. Since 2000, demand has fallen substantially as declining "N" fertilizer demand in Europe, coupled with rising imports of finished nitrogen products, have prompted the closure of a number of fertilizer plants based on import $NH_3$. There are no apparent reasons why this trend will reverse itself. The largest share of European ammonia trade is intraregional (46 percent in 2003), followed by the FSU (36 percent). North Africa makes up most of the rest (Algeria, Libya).


West Europe Ammonia Capacity
Million Metric Tons
14
12
10
8
6
4
2
0
2004
2010
2015
2020
Belgium
France
Germany
Netherlands
Norway
United Kingdom
Others
CMAI


Central Europe Ammonia Capacity
Million Metric Tons
10
9
8
7
6
5
4
3
2
1
0
2004
2010
2015
2020
Bulgaria
Croatia
Poland
Romania
Others
CMAI


Former Soviet Union Ammonia Capacity
Million Metric Tons
30
25
20
15
10
5
0
2004
2010
2015
2020
Belarus
Lithuania
Russia
Ukraine
Uzbekistan
Others
CMAI

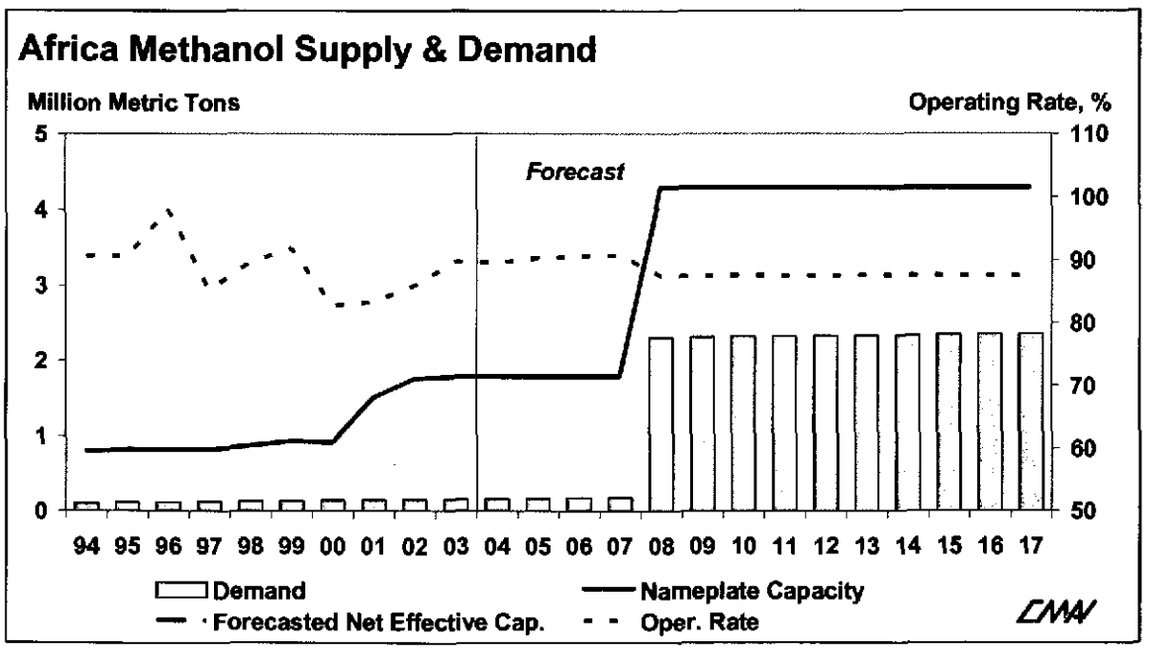

Central Europe Urea Capacity
Million Metric Tons
7
6
5
4
3
2
1
0
2004
2010
2015
2020
Bulgaria
Croatia
Poland
Romania
Others
CMAI

## A.1.5 Africa and Middle East Methanol and Ammonia

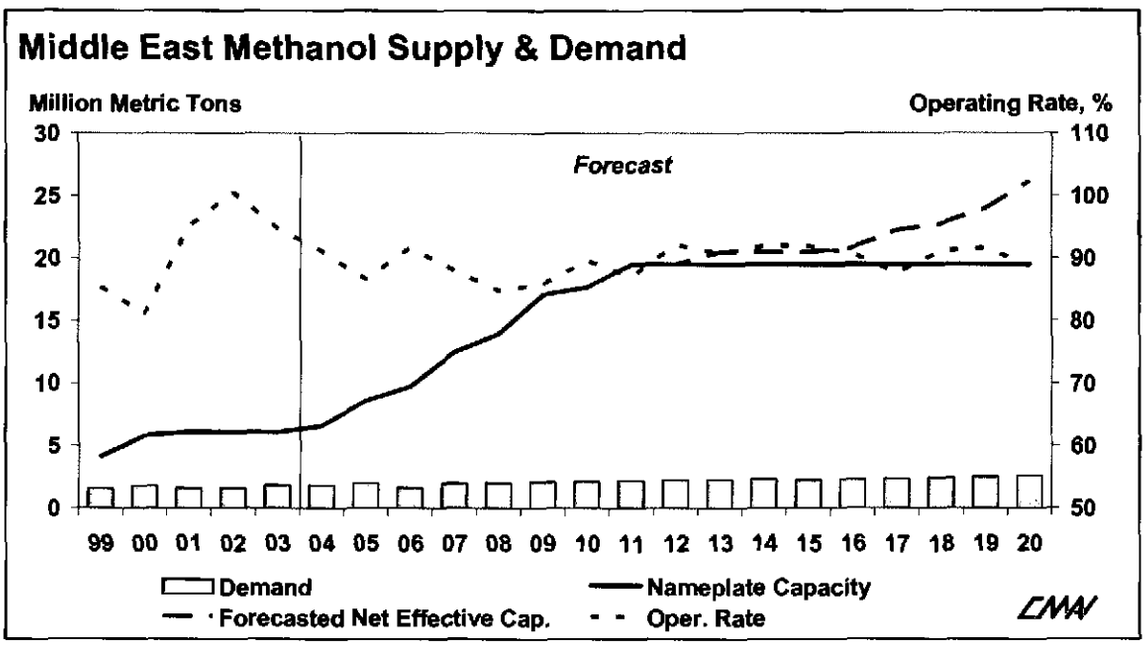
### A.1.5.1 African and Middle East Methanol

The Arabian Gulf, much of the Middle East and a portion of North Africa have large amounts of methanol feedstock in the form of associated and non-associated natural gas. It is not surprising some of these locations have concentrated on upgrading their resources in the past two decades, in an effort to get closer to downstream petrochemicals.

World-scale methanol facilities in this region are currently located in Saudi Arabia, Bahrain, Equatorial Guinea and Libya, and these countries are all major exporters. Smaller and more local methanol production is located in Israel, Iran, Algeria and South Africa. However, there are many ambitious plans to build additional methanol producing capability in Iran, Oman, Qatar, Nigeria, Egypt and South Africa, among others. Some of these projects have been going on for a number of years and have changed partners a number of times. They all have one common hurdle: arranging the proper off-take agreements in order to get the projects financed.



Methanol production in Africa was historically not as sophisticated as other regions of the world, but took a significant step-change in 2001. Originally, a 330,000 metric ton per year facility was brought on-line in Libya in 1978, and was doubled in size in 1985, dedicated to the export markets. A smaller facility has operated in Algeria for a number of years, but problems in producing specification methanol persist from this existing 110,000 metric ton per year plant. The product generally has high ethanol content and is suitable mostly for formaldehyde, MTBE or solvents uses. An 850,000 metric ton per year methanol plant in Equatorial Guinea began production in early 2001, targeting sales in Europe and the United States, and nearly the doubling capacity of the entire country.




At this time, it appears there are as many as six new methanol units, maybe more, that will be built in the next five years. In Al Jubail, Saudi Arabia, a new 1.0 million metric ton per year facility is scheduled to be operational as 2005 begins, for Saudi International Petrochemical Company, as well as the Tasnee facility, scheduled for startup in 2007 (1.7 million metric tons). Ar Razi V, with a capacity of 1.7 million metric tons as well, is scheduled to begin operation in 2008. Oman is scheduled to bring a 1.0 million metric ton facility online in Sohar, in 2007. This unit may likely be expanded to 1.7 million metric tons within a few years following startup. QAFAC, Qatar, is expected to expand the capacity of their existing methanol facility by about 2.2 million metric tons in the 2009 timeframe. The National Petrochemical Company of Iran will double the capacity at Kharg Island in 2008, adding a second 660,000 metric ton unit, following a fourth unit in Bandar Assaluyeh (1.7 million metric tons) scheduled early 2006.

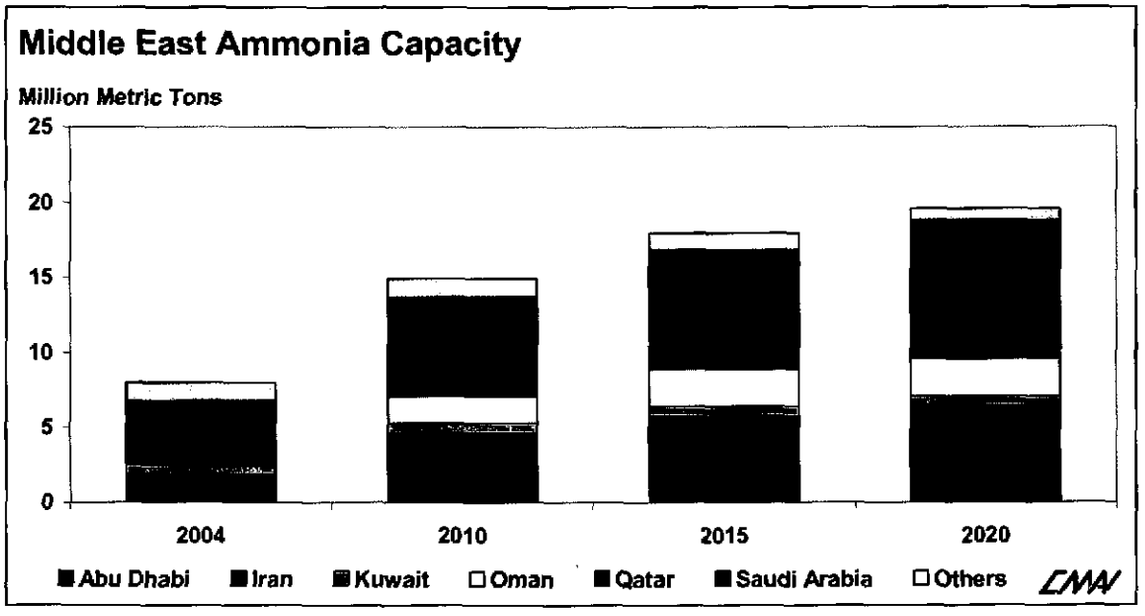
Saudi Methanol Company (Ar Razi) is a joint venture between SABIC and a consortium of Japanese companies led by Mitsubishi Gas Chemicals, which also provided the technology for the four methanol units. The first facility, Ar Razi I, came online in early 1983. The second methanol plant, Ar Razi II, came on-stream in 1992 within the same complex. Ar Razi III came on-stream in late 1997/early 1998. Ar Razi IV came on stream in late 1999, and now Ar Razi V is scheduled for 2008. The primary markets for the Japanese portion of this production are in the Far East. SABIC markets the remaining volume (not used for their domestic MTBE production), predominantly in Europe and Asia, with small volumes targeted for the United States. For the Middle East region, approximately 1.5 million metric tons of the 1.8 million metric tons of methanol consumed goes to produce MTBE. This is expected to increase through 2005 before taking a downward step change in 2006 as both United States and Europe MTBE usage declines as well.

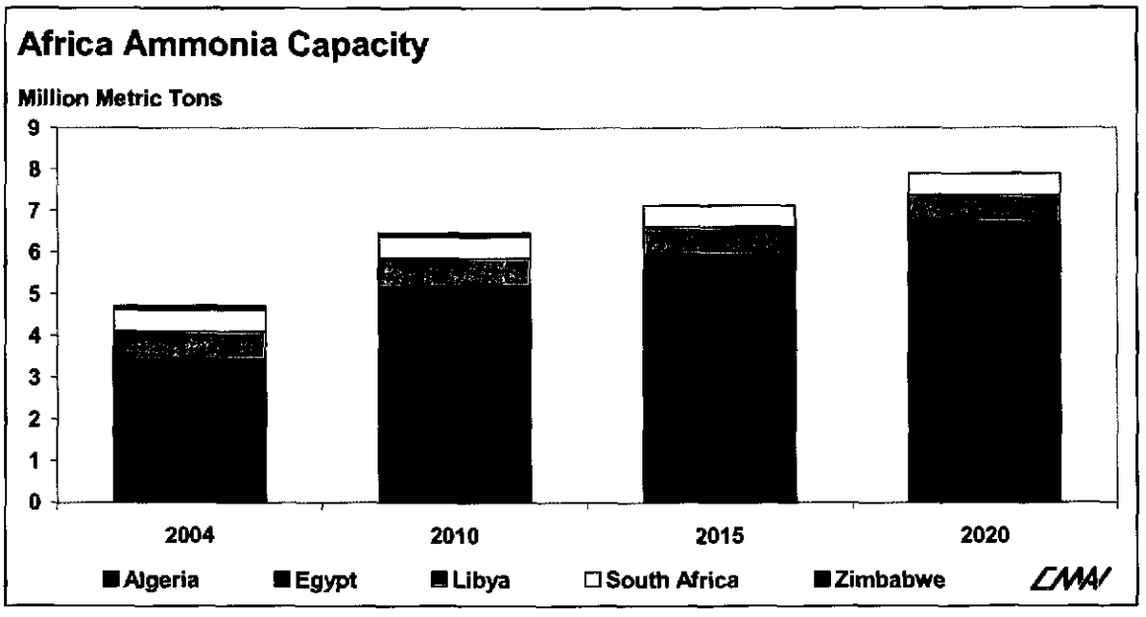
The Middle East is rich in natural gas reserves, and methanol serves as an excellent avenue for monetization of these assets. This is expected to continue, with a significant number of new methanol facilities planned through the study period. Overall, we forecast that methanol demand in this region will grow at about 2.8 percent per year for the next five years, while production and exports will grow at an estimated 19.5 percent and 23.1 percent per year, respectively. Countries in the Middle East are looking to significantly increase the use of MTBE in the gasoline pool as an offset to the loss of exports into Europe and North America.

### A.1.5.2 African and Middle East Ammonia

The African market for ammonia is over 80 percent in the north, specifically as feedstock supply to the large phosphate fertilizer industries in Morocco and Tunisia (and to a lesser degree in South Africa). These two large country markets will continue to grow as a function of periodic increases in capacity to produce ammoniated products (DAP, MAP). Current, trade is dominated by the FSU (Russia and the Ukraine) out of the port of Yuzhnny on the Black Sea, e.g., 85 percent of Moroccan-Tunisian imports were FSU-sourced in 2003.

Middle East ammonia imports are all for feedstock use in Israel, Jordan, and Turkey. Thus, demand is driven by annual output rates of existing chemical plants based on import NH3, plus any changes (additions, closures) in their capacities. Based on current knowledge, growth in this regional trade demand is not expected. As in other parts of the Mediterranean ammonia trade, the FSU out of Yuzhnny is by far the largest supplier (80 percent of total trade in 2003).

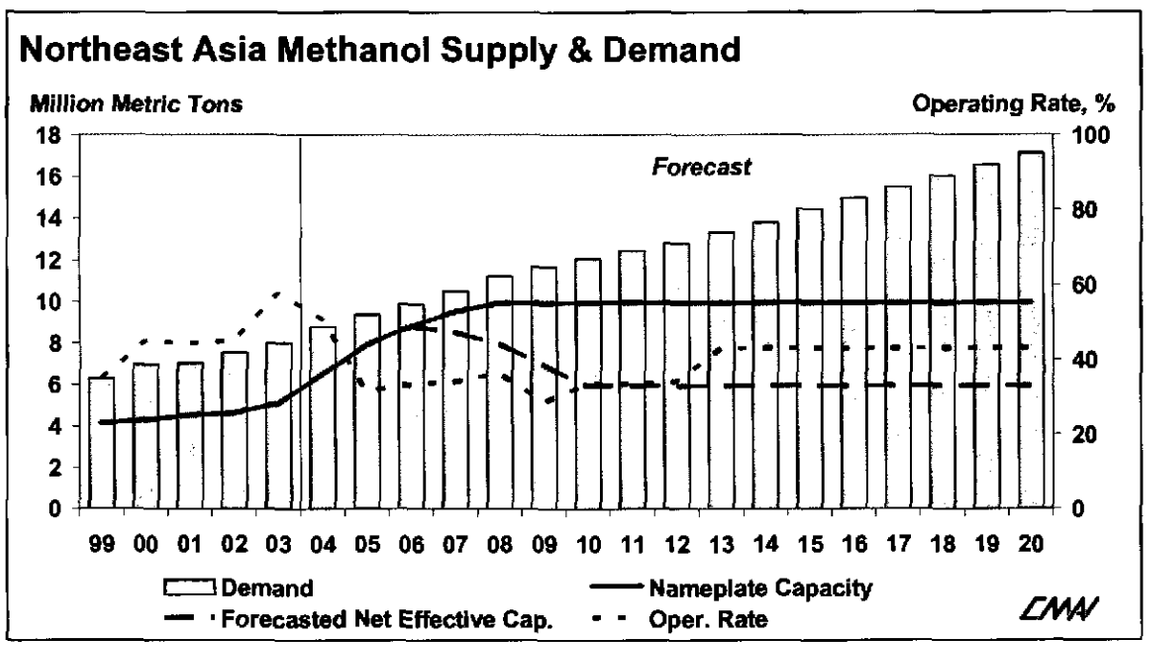


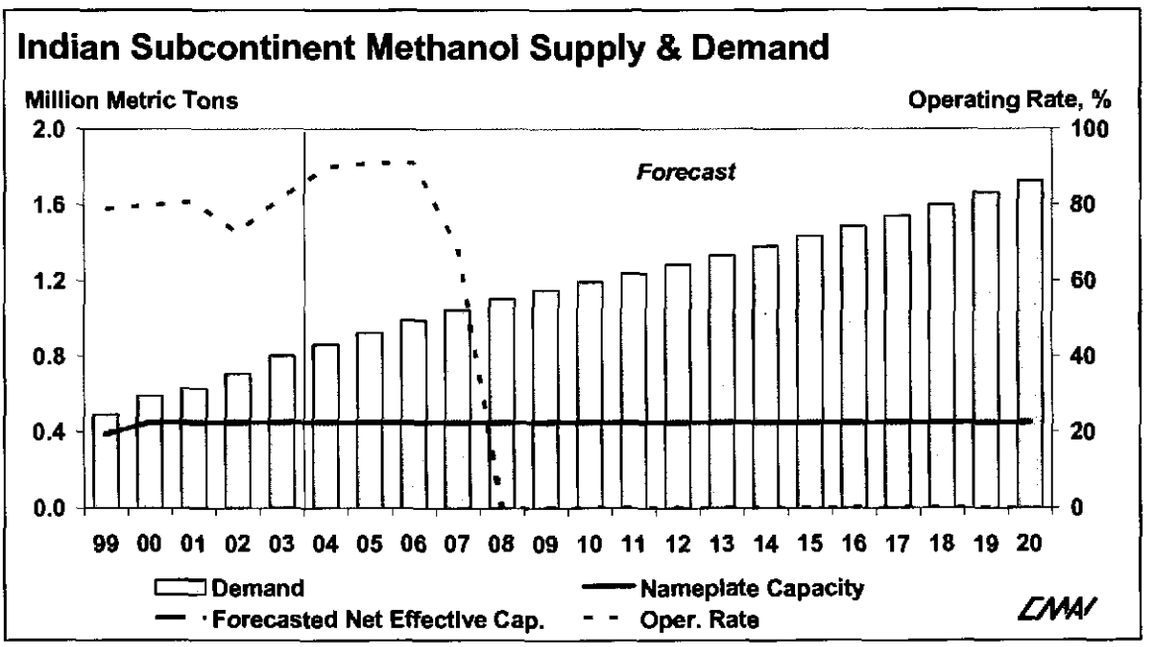



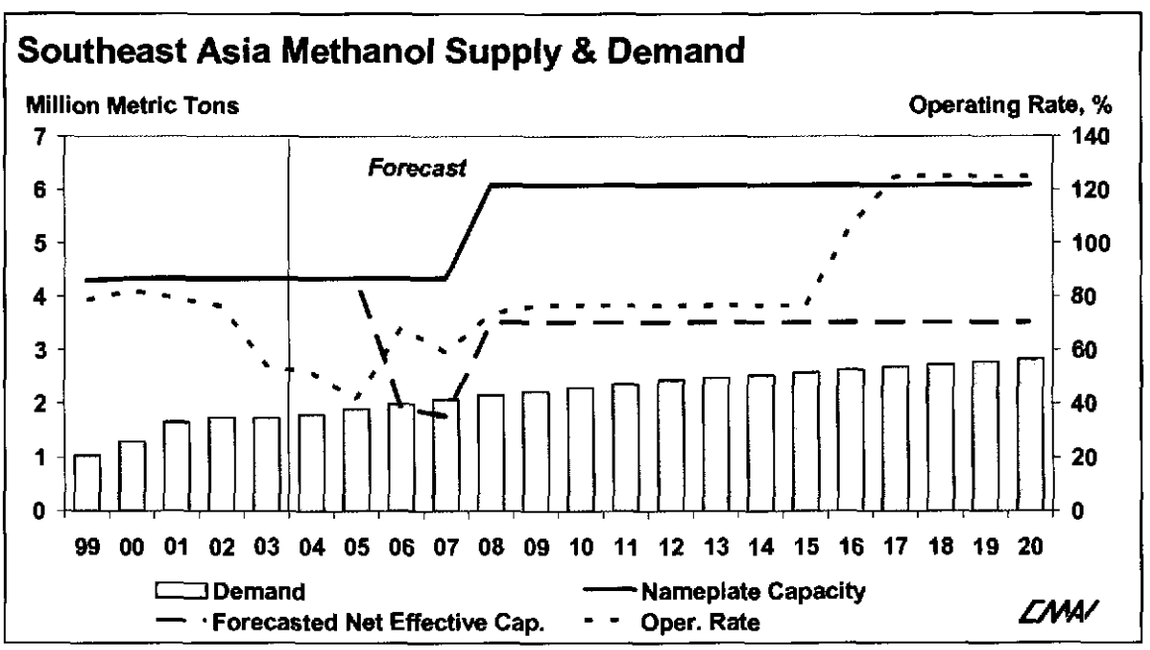
## A.1.6 Asian and Pacific Methanol and Ammonia

### A.1.6.1 Asian and Pacific Methanol

Domestic demand in Northeast Asia has grown at a rate of almost 7 percent for the past five years and is expected to grow by an annual average of almost 6 percent over the near term. Rationalization on the order of 4 million tons in the long term is expected. Domestic demand in Southeast Asia has grown by an annual average of more than 11 percent since 1999. However, this rate is expected to slow to an annual average of 4.5 percent through the near term. More than two million tons of capacity is forecast to be rationalized in Southeast Asia through 2020. Longer term (2009 - 2020), Northeast Asia is expected to have annual growth in the range of 3.5 percent per year while Southeast Asian demand growth is anticipated to be on the order of 2.2 percent per year.




Indian Subcontinent Methanol Supply & Demand
Million Metric Tons
Operating Rate, %
2.0
1.6
1.2
0.8
0.4
0.0
100
80
60
40
20
0
Forecast
99 00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20
Demand
Nameplate Capacity
Forecasted Net Effective Cap.
Oper. Rate
CMAI


Southeast Asia Methanol Supply & Demand
Million Metric Tons
Operating Rate, %
7
6
5
4
3
2
1
0
140
120
100
80
60
40
20
0
Forecast
99 00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20
Demand
Nameplate Capacity
Forecasted Net Effective Cap.
Oper. Rate
CMAI

This region of the world is widespread geographically and methanol shipments and deliveries can range from full ships of 40,000 tons or more, down to small bulk tanker deliveries of about 700 tons to very remote islands where formaldehyde plants might be located. These logistics provide a challenge to the transportation industry and they also present extreme differences in methanol pricing. For example, a 40,000 ton tanker load delivered to one terminal in Japan would be done at a much lower price than a 700 ton parcel delivered to a remote island in Indonesia that had to be transshipped, say in Singapore.

These three regions in aggregate are, and will continue to be, net importers of methanol. This position is required, as high energy (read feedstock) costs in the region preclude production from being competitive with remote production, such as New Zealand and the Middle East.

Some years ago, Japan made a very realistic appraisal of the future of its methanol industry. More expensive producing plants were closed, and methanol was imported from various worldwide sources at cheaper prices. These decisions were inspired by the industry for the good of the industry, and the previous producers still market imported methanol through their existing networks. The end result is a more competitive methanol position that should carry over to the derivatives and export markets. South Korea and Taiwan have followed Japan's lead in this approach, shutting down expensive methanol production and importing at cheaper world prices.

Methanol demand in Asia Pacific is expected to grow only as MTBE and chemical uses grow. Consumption for formaldehyde is, and will continue to be, the largest single outlet. Japan has had the most stable methanol market in the world, and there is one basic reason. Practically all the major methanol marketers were previous producers who have shutdown plants but retained market share through imports. These markets are tightly controlled by only a handful of players, some of whom have an interest in the Japanese-Saudi Arabian consortium. The working relationship is one of mutual cooperation, an approach that is prevalent in Asia but difficult (or illegal) to practice in other regions.

One of the more significant supply developments in the Asia and Pacific region in recent years has been both the loss of a significant portion of supply from New Zealand, and major expansion plans for Australia, Southeast Asia and a myriad of new low-cost, world scale facilities in the Middle East. Concurrently, China continues to promote very aggressive growth plans, expecting to increase methanol production capacity from an estimated 6.5 million metric tons in 2004 to almost 10.0 million metric tons by 2009.

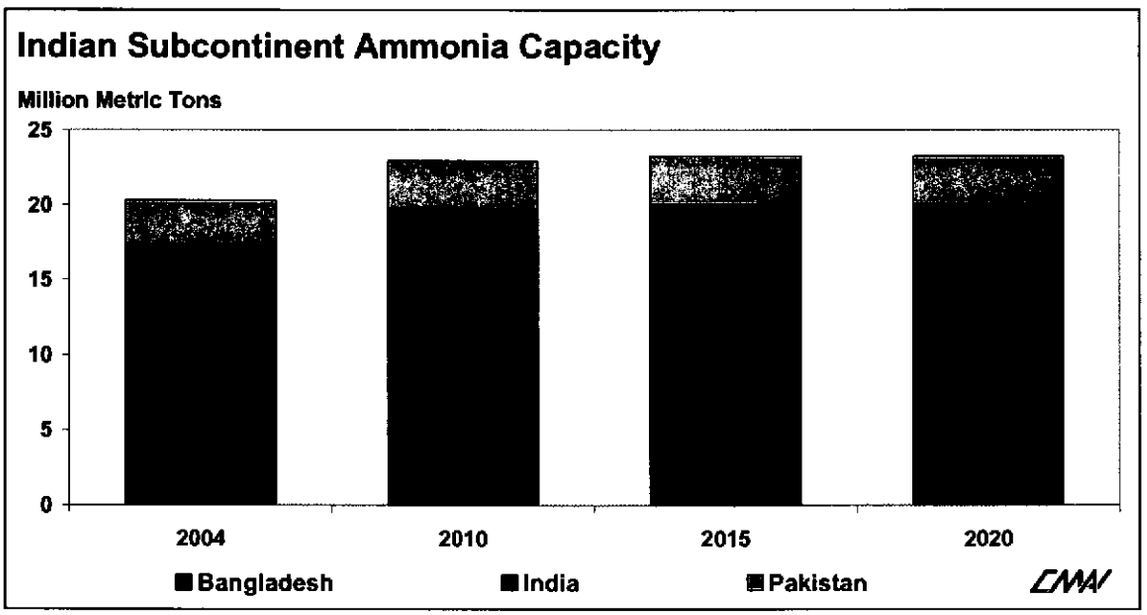
In 2003, Methanex was forced to reduce production in New Zealand from approximately 2.4 million metric tons annually, to near 1.0 million metric tons. This was the result of a re-determination of natural gas reserves which concluded far less gas than originally thought remained available. As a result, production was limited to a similar 1.0 million metric ton level in

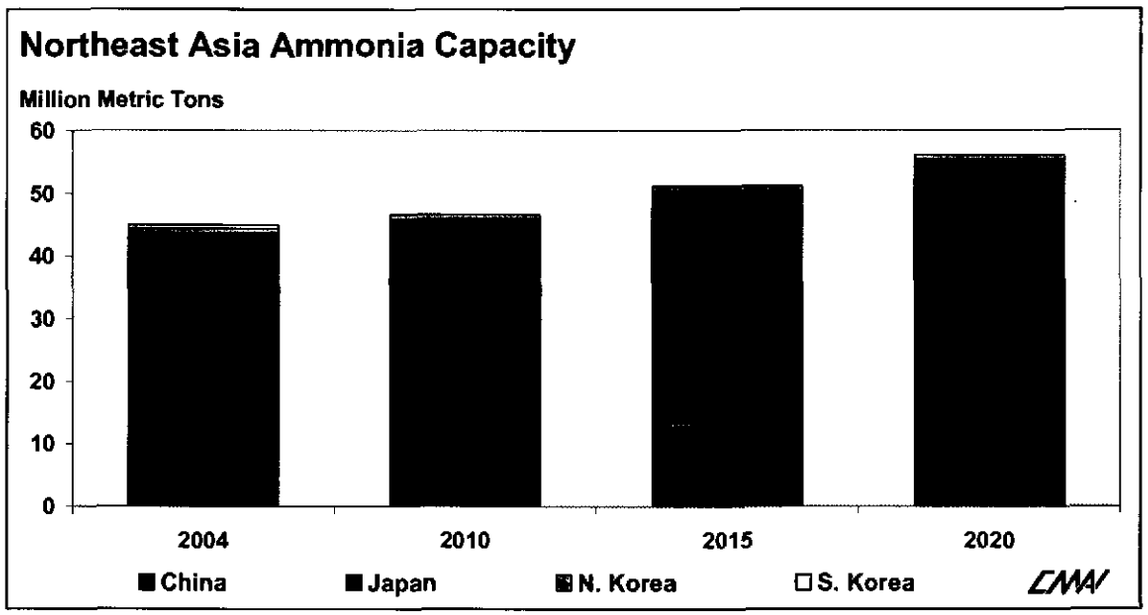
2004, expected to decline to approximately 400,000 metric tons in 2005 and shut down completely in 2006. During this timeframe, incremental supply from the Middle East and South America made up much of the shortfall, as well as a significant increase in production from facilities in China, a country that typically has operated near the 30-40 percent capacity utilization level due to its poor methanol production cash cost position.

The many new methanol facilities planned for the Middle East previously mentioned will aggressively target both the Asia and European markets. Methanol Australia is working on a new 1.7 million metric ton unit targeting production in 2008, while Petronas has recently made public plans to build a second unit in Malaysia, with an annual capacity of 1.7 million metric tons, targeting the 2007 timeframe. The Brunei government is understood to be well into plans to build an 850,000 metric ton per year methanol facility to come on stream in 2007 as well.

A.1.6.2 Asian and Pacific Ammonia

All imports feed coastal plants producing (primarily) ammoniated phosphate fertilizers. Recent growth in this trade has been per growth in Indian's phosphate capacity. Future increases in such capacity may be limited, with ammonia import demand then primarily a function of efficient operation of existing plants, and the role of Indian government subsidies thereon. Over 95 percent of Indian ammonia supplies are Asian sourced, over 60 percent from West Asia. A new trade ammonia plant with Indian ownership is scheduled on stream in Western Australia next year, which should also feed the Indian market.

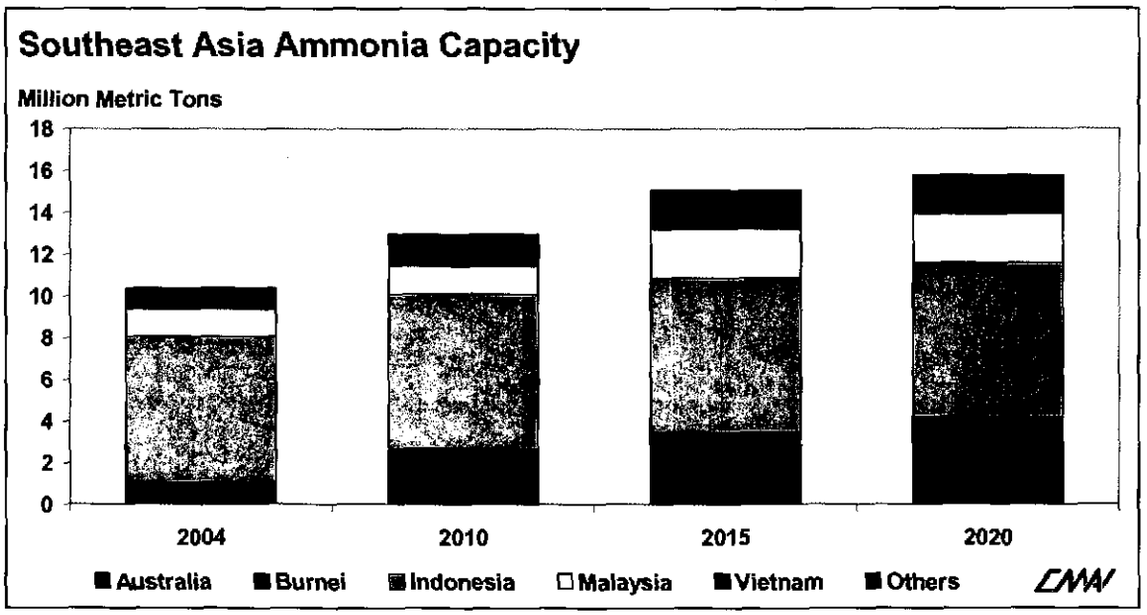





Ammonia imports have been negligible, but are expected to grow substantially to feed a number of new coastal plants producing a variety of chemicals/fertilizers requiring $NH_3$ feedstock. A major Russian nitrogen producer/exporter has recently invested in a new ammonia import tank at Zhanjiang to handle increased import volumes.

These two regions are one of the world's larger markets for trade ammonia. The biggest importers are South Korea, Taiwan, and Thailand, but Japan is growing as internal capacity based on high-cost liquid feedstocks gradually closes. Most imports feed nitrogen-based industrial chemical plants, capacities of which keep on growing based on rising personal incomes in Asia and continued exports of petrochemical-based consumer products to the United States. Regional ammonia demand growth shows no sign of abating. The current market is served mostly by Asian plants, primarily Indonesia and Malaysia. The second largest source is Alaska (freight advantage to Korea).

At present, Australia appears self-sufficient in ammonia, but imports may return to feed coastal plants producing blasting-grade ammonium nitrate for various mining operations.




## A.4 PRICE FORECAST

### A.4.1 Methanol Price Forecast

To forecast petrochemical prices in the short term, the following steps are taken:

- Analyze a market's supply and demand balance
- Calculate the product's cost of manufacturing (which helps indicate the floor price)
- Examine the capital necessary to add new capacity and calculate the level to which margins have to climb to reach re-investment economics (which indicates the ceiling price)
- Determine the economics of the derivatives (what consumers can afford to pay)
- Examine the psychology and strategies of major market participants.

With this information, plus some experience at market price forecasting, a reasonable attempt at providing a near-term (up to five-year) outlook is possible. Forecasting petrochemical prices beyond the near-term cycle can be much more difficult. In this case, more emphasis is placed upon regional and global economic factors, which can either stimulate or depress demand from time to time. Additionally, in longer term forecasting, it is assumed there will be sufficient financial return from the overall market to provide investment incentives for new capacity, and production will thus keep pace with forecast demand. However, in situations a market experiences significant capacity additions across a very short timeframe, overcapacity is the

result and guideline return on investments are often not achieved. (See Appendix 5 for further cost data)

Forecasting methanol industry pricing can require a slightly different technique, as assumptions regarding natural gas pricing, and the impact of these prices, have played such a major role. For the methanol industry, and pricing, the historical methodology has been to first concentrate on conditions in the U.S. This is particularly true since the 1998 timeframe. The U.S., in the last 20 years, has been both the largest methanol producing and consuming region in the world, has relied heavily on methanol imports, and has become the marginal global producer. That is to say, while the cost structure of U.S. production has not always been the absolute highest in the industry, it has since early in this decade represented the largest incremental (and manageable) "block" of high-cost capacity in the industry. Therefore, the U.S. market has evolved into the "engine" that often times has driven methanol market pricing not only in North America, but the other key markets of Asia and West Europe as well.

Through this evolution, the U.S. production cash cost structure now dictates the global floor-price for methanol at any point in time. Like any commodity, in times demand exceeds supply, pricing will move higher and higher, searching for a level the market will no longer support. Eventually, some level of demand is "crushed" until supply and demand return to better balance. Conversely, in times of excess supply, industry pricing drops to the level it is no longer economically viable for some production to operate. These incremental facilities reduce production rates, or shut down entirely, which in time brings supply and demand into balance. It is this scenario, and the incremental production block, which is now represented by U.S. production. If the price of methanol falls below the nominal cost of production of U.S. facilities, for an extended time, production will cease. Again, in time, supply no longer keeps pace with demand, at which time pricing begins to climb to a level it is once again profitable for the incremental producer (U.S. production) to operate, setting a floor price that keeps supply and demand in balance. This describes the plight, or role, U.S. production/producers now fill. For a U.S. industry facing $5.00-6.00 per million Btu natural gas feedstock costs, the "floor price" of the methanol industry is now in the 60-70 cents per gallon range ($200-235 per metric ton).

Methanol production cash costs in the U.S. are comprised of the raw material feedstock costs, the cost of plant operations (variable catalyst, chemicals, energy plus operations, laboratory and maintenance costs) and a reasonable amount for sales, administration and overhead. Offshore, export-oriented methanol producers have to contend with additional costs including ocean transportation, terminal throughput, duty, extra financing, insurance, etc., which are often offset by lower and more stable feedstock natural gas costs than can be realized in the U.S. Therefore, even under the weakest of market conditions in the U.S., a number of deep-sea methanol producers still survive and compete.

Once primarily a product produced within the major consuming regions of the world, methanol is now a supply driven commodity, produced in locations where feedstock natural gas is more available and far less expensive because of fewer alternate uses. Methanol has become a technologically safe method of monetizing remote natural gas reserves. While this trend has been growing for years, the growth in global methanol demand and natural gas pricing in the U.S. averaging $2.00 per million Btu or less until 1999, kept U.S. production economically viable. All the while, a number of higher-cost methanol producers in other parts of the world were the better rationalization targets, and kept U.S. production away from the role of industry "floor price-setters" as described earlier.

At the start of this decade, as natural gas pricing in the U.S. moved consistently from $3.00 per million Btu levels to $5.00 per million Btu levels, and higher, North America production too began to rationalize in earnest, due to economic reasons. Georgia Gulf, Ashland, Methanex (3 Canadian locations and Fortier), Borden, Sterling, Enron and ICI in Europe have all shut down methanol plants during the last five years. Some have exited the business entirely, while others have signed long-term supply agreements with remote, "natural gas advantaged" producers to cover their requirements.

This rationalization is the result of more and more, larger, deep-sea methanol production based upon very inexpensive natural gas and thus greatly advantaged economics. (This latter point will contribute greatly to accelerating the trend away from consuming region-based production.) Natural gas prices in the United States (soaring to $5.00 per million Btu levels and above), also facilitated a smoother industry rationalization, as existing U.S. capacity was large and in a very compact geographical area.

#### A.4.1.1 Near Term Pricing – U.S. Methanol Production Cash Cost Influence

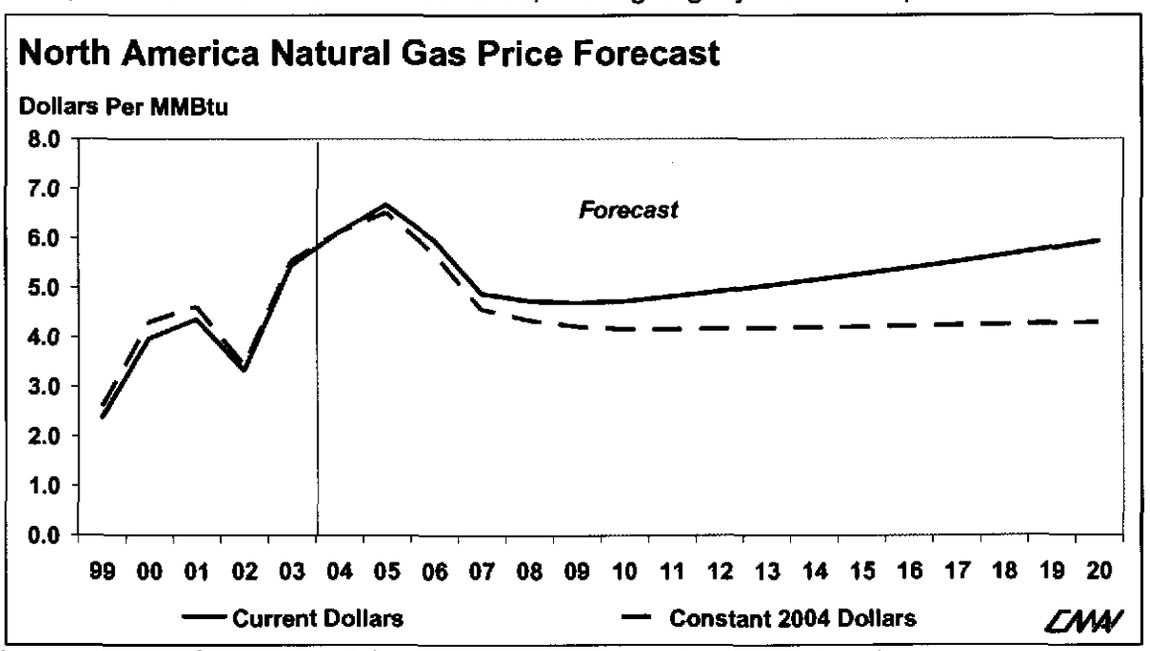
U.S. methanol prices are forecast in the manner described previously, wherein cash costs are determined based on an energy outlook, and using econometric models. Margins for methanol are then determined, based upon supply/demand factors and market knowledge, and added to the cash cost to determine pricing. This pricing can be used to check the return on investments to establish floors and ceilings for prices. However, in the case of methanol in the United States, the high cost of energy precludes U.S. reinvestment.

A price forecast rests entirely upon the assumptions developed. Understanding these assumptions can make a forecast useful without regard to its accuracy in actually predicting the future. This usefulness is based on the fact a forecast makes the implicit statement if the assumptions occur, then anticipated results will follow. With this information, the desirability of the results contained in the forecast can be determined and the work can be studied to analyze the elements of the assumptions. Further, understanding the assumptions allows one to gain insight as to their applicability and validity of the forecast.

For the purpose of this study, near term is defined as 2005-2007. For the methanol industry, these years likely represent the transitions years as well, as U.S. production will all but cease, and the long-standing "floor price" level for methanol dictated by U.S. natural gas economics will no longer apply. Added difficulty in the near term exists, as the current level of methanol pricing in the industry is not driven by the U.S. production cash cost structure, and has "disconnected" from U.S. production costs since early 2002, when the industry began a series of well-documented production losses, removing over 1 million metric tons of methanol supply from the industry. Industry pricing for 2003, 2004, and likely much of 2005 has been, is being, and will be, driven by supply and demand fundamentals, with little to do with production cash costs anywhere in the world.

In 2005, while moving toward a better balanced supply and demand situation, a significant level of U.S. production will still be required, and as a result industry pricing will be supported by the production cash cost structure of these facilities in the near term.

The near term price forecast for the United States assumes a transition from the current demand driven price levels of 2004 and early 2005, towards the incremental production cash cost structure of a typical U.S. producer, based on U.S. natural gas, for the remainder of 2005. For 2006, this downward trend will continue, moving slightly below the production cash cost level as motivation for the remaining "high-cost" U.S. production to shut down.




The basic energy assumptions used in developing the global methanol price forecast are shown in the graph above.

The base crude price forecast is from a long term forecast of crude oil and refined products prices which are generated by CMAI's joint venture partner and energy experts, Purvin & Gertz, independently of any single project. Close attention is given to factors which affect supply or demand globally. Clearly established technological, business, or political trends are considered in the forecast. This case is a "surprise free" forecast. Natural or man-made disasters, major wars, climate changes, or spectacular technological breakthroughs were deliberately eliminated from consideration.

A.4.1.2 Near Term Methanol Pricing – Europe and Asia

West Europe and Asian prices have been strongly influenced by North America pricing for over 20 years, and it is not expected to change in the next few. With the freer flow of information and the ability of international producers and traders to select markets more quickly (even while vessels are en route), the pricing between the regions tends to equalize within months. While in retrospect anomalies clearly occur, and can often be explained as single events, strong empirical relationships between the three major regions of the world exist. These functional relationships are expected to remain in place until the 2007 timeframe, when North America ceases to drive methanol industry pricing.

In Asia, most methanol is imported by Taiwan, South Korea, Japan and China. The Northeast Asian prices are generally reflective of the methanol prices in the other regions of the world, as the material is easy to ship, and market efficiencies do not last for long periods. Prices are expected to be the average of U.S. Gulf and West European prices, with variations in weighting of these two influences depending upon circumstance. For instance, as most transactions in Japan are done via contract, CIF Japan pricing will hover above this Northeast Asian average by as much as 10 percent during the forecast period. Alternately, as China typically buys when spot pricing is low, one can expect pricing in coastal China to be as much as 10 percent below the average shown.

A.4.1.3 Long Term Methanol Pricing

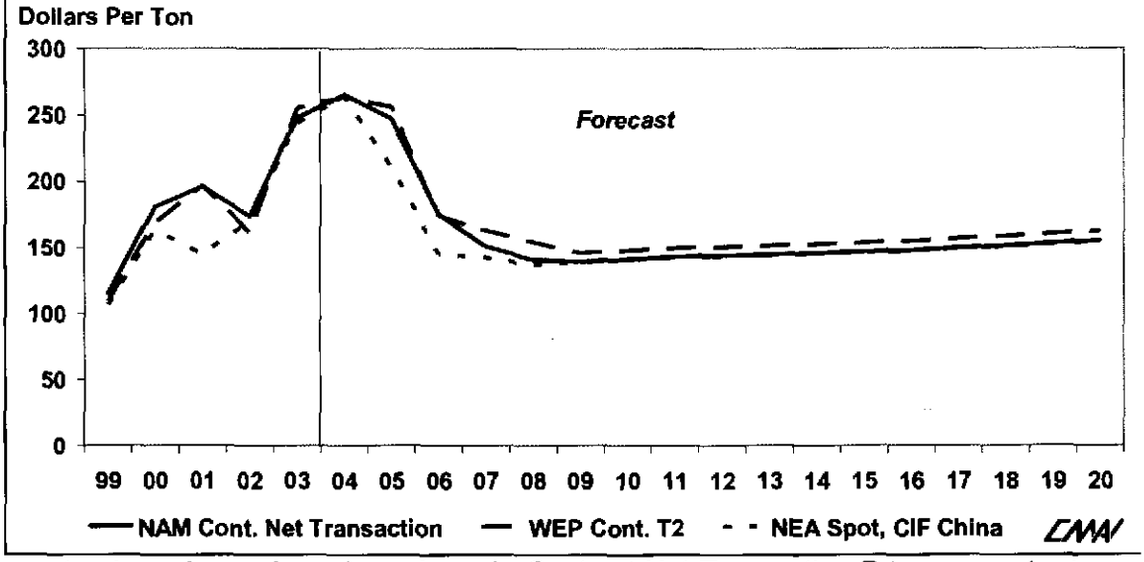
The challenge in predicting future pricing lies in determining the economics of the new incremental supplier to the major markets. Three large production points, Trinidad, Venezuela and Chile primarily supply the Western Hemisphere. While volumes from Africa, Europe and Canada are not insignificant, they do not represent the same density of supply. New Zealand, in-region production and the Middle East, with Australia joining this supply within the next several years, supply the Eastern Hemisphere. As mentioned, as much as 20 million metric tons of new capacity is expected within the next five years. Trinidad, Chile, Iran, Qatar, Oman, Saudi Arabia and China will all introduce new capacity in this timeframe, with most competing for the same end-market.

For future methanol industry pricing, defined as 2007 and forward for this analysis, CMAI has examined the costs of delivering methanol to the three major consuming regions of the world and compared this with total volumes required by each. The results indicate the Middle East is/will be the regional supplier of choice to the Asian markets, compete very favorably to Europe, and will arguably become the incremental supplier to the United States. South America production is/will be most economical to North America, competes favorably in the European marketplace as well, and be relegated to the role of incremental supplier into much of Asia. Australian production will clearly enjoy an advantage into the Asian markets, and likely not pursue Europe and/or North America.

Therefore, as U.S. production is eliminated, the industry will logically seek the next level of "high-cost" production necessary to dictate a floor price mechanism. It is likely China production, and cost structure, will have a small and likely very short-lived role in this scenario. However, with the huge amount of new capacity from the Middle East region, the fragmented China producers will be quickly overwhelmed. Thus, in CMAI's opinion, the huge block of Middle East capacity will likely inherit the role of industry floor-price setter. With the ability to market material in Asia, West Europe or North America, the Middle Eastern producers will be indifferent to the destination, providing the netbacks are essentially equivalent. Consequently, the longer-term price forecast is based upon the production cash cost structure of Middle East production (nominally a Saudi Arabian producer with $.75 per MMBtu gas cost), a reinvestment level of capital return, plus the ocean freight costs to deliver product to any of the three major methanol-consuming regions of the world. In the mid term, the same methodology is employed, but a margin cycle (in place of the reinvestment value) is introduced to take into account the supply and demand balances. Ideally, one would continually examine the world cost curve for methanol and base the price forecast off the cost structure of the incremental producer, giving him essentially only cash cost. Due to the difficulty in continuously knowing the cost structure of the absolute incremental supply, CMAI looks to the more visible cost structure of the Saudi Arabian producers on the "flatter" part of the cost curve. As their margins are manipulated to generate the price forecast, those producers with lower cost structures will enjoy higher margins while those with higher costs will earn lower returns. It should be noted that this CMAI has recently reevaluated some of the costs and capital costs used in our forecast models. This was done based upon CMAI's continued work in the Middle East region and a "finer tuning" of our assumptions. This is reflected as a slight upward revision to our methanol forecast long term since the time when this report was first issued

A.4.1.3 Methanol Pricing Data

The methanol price forecast is shown graphically on the next page. The U.S. Gulf prices apply to barge quantities, FOB the U.S. Gulf. Prices are shown for both spot markets and CMAI's Contract Net Transaction Price, which is intended to reflect the representative price from which




contract purchases have been based. Contract Net Transaction Prices are prior to any type of discount agreed to between buyer and seller.

In West Europe, the "ocean side" price point is referred to as T-1. This price point is prior to any duties that must be paid, any throughput costs or currency conversion. T-2 is priced in Euros, has duty paid (where applicable depending on shipper) and has paid throughput charges. In Northeast Asia, the CIF price that is reported is similar to the West European T-1 in that no duties, no currency conversion and no throughput costs are in this price. The Asian prices are CMAI's blended prices Northeast Asia (Korea, Taiwan and N.E. China) and are CIF main ports.

CMAI has not attempted to predict the timing of the inevitable peaks and valleys of cycle pricing because of the multitude of factors that can actually trigger such. With the pending transition from inflated market based pricing, to cost-based pricing, CMAI believes the peak in pricing is being experienced now, in the near term. The forecast shows a continuous drop from the current situation until the 2007/2008 transition period that is ultimately supported by our Middle Eastern producer economics methodology previously described. Contract price forecasts represent pre-discount levels through 2007, at which time the forecast values represent the final (net of discounts) price paid by the consumer.

### A.4.2 Ammonia Price Forecast

International nitrogen prices have a checkered history, wherein volatility and unpredictability have been the norm.

#### A.4.2.1 Nitrogen Industry Features: Revenue History

- Producers are price takers.

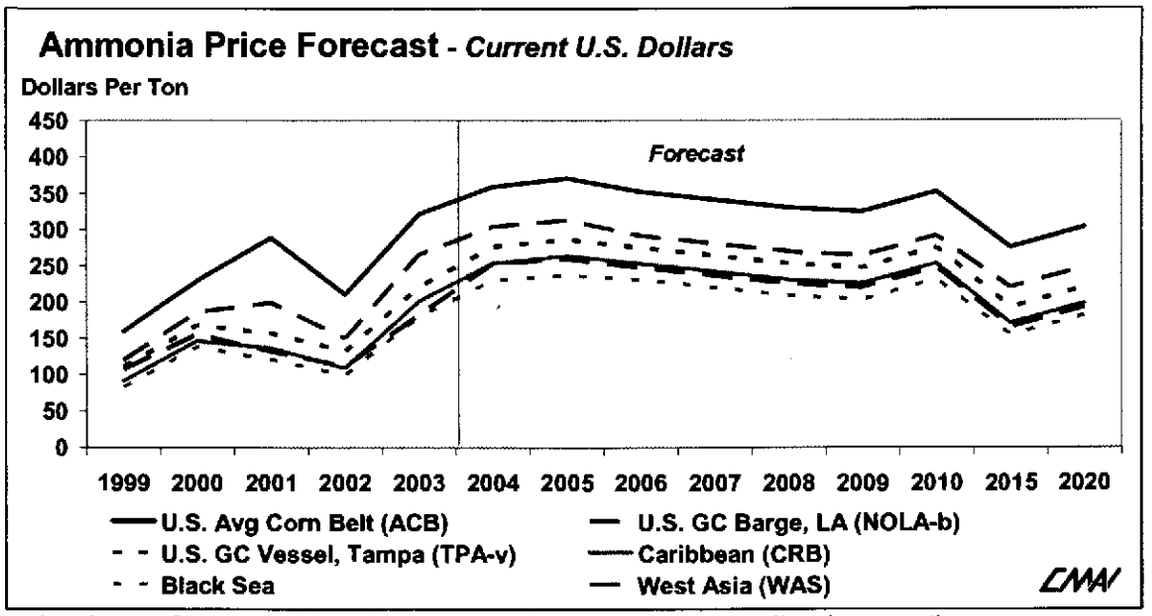
- All periods of major wholesale price movement have been associated with major swings in supply-demand balances, particularly related to trade.
- Most/all of these swings have occurred as "surprises."
- Big price spikes have been infrequent and of relatively short duration.
- Industry consolidation and periodic attempts at trade protection variously around the world have been insufficient to provide producers with meaningful "market control."
- Prices have generally trended down on a constant-dollar basis.
- Trend ammonia prices track closely with trend urea prices.

A.4.2.2 The Future

Overall, expectations are for history to repeat itself, and the factors listed above will continue. Some of these factors appear to be changing; however, with the big driver being rising hydrocarbon prices that affect nitrogen production costs in major nitrogen markets, particularly in the United States and West Europe.

- First, the United States and West Europe account for about 40 percent of world trade (imports) of the combined nitrogen content of ammonia + urea + AN + CAN (excluding trade *between* countries in West Europe).
- Second, these imports account for 35-40 percent of the total nitrogen consumption in these markets (about 35 percent in West Europe, about 40 percent in the U.S.)
- Third, neither market has the capability to significantly expand domestic output, i.e., capacity is declining in each.

- Fourth, high energy prices in each market drive up costs for the 60-65 percent of supply that is internally produced, raising the bar for import product pricing.




Couple these factors with what seems to be more-disciplined operating management of production facilities by major exporters, and it is apparent why, even with new export capacity coming on line, world nitrogen prices have been trending at levels above what history might otherwise suggest. However, there is concern today that the volume cluster of new urea capacity coming on-stream in the next 2-4 years will overwhelm the market. If so, and energy prices remain high, high-cost shutdowns will just accelerate.

## A.5 EVALUATE LIKELY COMPETITION ECHEM MAY BE EXPOSED TO FROM OTHER PRODUCERS AND MARKET FLUCTUATIONS

### A.5.1 Methanol and Ammonia Competition Overview

Echem will face competition from existing producers of methanol, ammonia and urea. These producers by region and their capabilities were explored above and reiterated below for clarity.

#### A.5.1.1 Methanol Competition Overview

Industry capacity totaled 42.6 million metric tons, an increase of about 2.6 million metric tons from 2003. This is a major change in assumptions from just one year ago. It includes the addition of almost 3.5 million metric tons of existing methanol capacity in China. We now believe as much as 6.5 million metric tons of methanol capacity exists in 2004, with planned construction propelling capacity to over 9.0 million metric tons in a few short years.

Due to their vast reserves of natural gas, South America and the Middle East are the largest producing regions in the World, representing approximately 44 percent of total methanol production in 2004. While North America was the third largest producing region, natural gas costs are the highest in the world and rationalization is occurring at a rapid pace.

The largest producer/marketers in the world currently are Methanex, SABIC (Ar-Razi) and MHTL (Methanol Holdings Trinidad Limited), combined, representing almost 30 percent of the capacity around the world. The other 70 percent of capacity is owned by smaller players, including governments and small producing companies.

Several expansions of more than 300,000 metric tons per year have been announced to come online between 2004 – 2010. In addition, another 2.5 million tons is anticipated to come online in China alone in this time period.

Methanol is an extremely efficient way to transport, and thus monetize, natural gas. Since the early 1990s, countries in the Middle East, South America and other remote countries, sitting on huge reserves of stranded natural gas, have chosen ammonia, methanol or LNG as avenues to generate cash. These areas, and Australia in the future, will continue to add world-leading low-cost methanol capacity and target high-cost production in North America, West Europe and Northeast Asia. These exporting "mega-centers" will continue to dominate methanol supply.

When global methanol capacity utilization rates are at a level of 85 percent or above, the methanol market is generally considered to be "strong" with higher prices and good cash margins, even for the high-cost producers. When methanol capacity utilization rates fall to the 75 percent range, the market is generally considered to be "weak" with market prices very near the cost of production for the incremental producers.

Most petrochemical industries add capacity during periods of high profitability, causing the market to be subsequently over-supplied with relatively low profitability for the 3-5 years following the peak in margins. During the over-supplied period, industries usually avoid capacity additions, causing the market to be subsequently under-supplied for 3-5 years following the trough in margins. These cycles continue to perpetuate themselves with 5-7 years between peaks. The addition of more than 20 million metric tons of capacity will clearly put a lot of pressure on existing production capacity.

Methanol is not like most petrochemicals. Because lesser developed economies happen to have large reserves of natural gas, for over 10 years now most capacity expansions have been driven by the desire to monetize these assets (not demand driven). The result is the rationalization of higher natural gas-cost facilities in North America, Europe and other parts of the world. This industry tends to experience 3-year cycles between peaks, not 5-7 year cycles for other petrochemicals.

Global methanol capacity utilization rates have risen to near 85 percent in 2002-2003 due to a rash of operating problems. While the large Atlas and Iran facilities (2.7 million metric tons) began operations in mid 2004, this new capacity served to offset lost New Zealand capacity and the shutdown of both the Lyondell and Beaumont Methanol Company-BMC (and Air Products in late 2003) units, netting little new production.

The methanol industry has been very much driven by supply limitations for two years now, and may actually see little change into early 2005. Overall growth for the industry will be less than it has been historically as MTBE demand peaked and will continue to erode over time. For the near term forecast, the addition of over 20.0 million metric tons of capacity is huge, and rationalization of high cost producers will have to occur, willingly or unwillingly.

A.5.1.2 Ammonia Competition Overview

The growth portion of ammonia import trade (3.8 million tons total) will primarily occur in Latin America, Africa, and Asia. This increase will be offset by import declines in the United States and Europe (1.6 million tons total) resulting from:

- Closures of chemical plants using imported ammonia feedstock (both regions),
- Declining use of ammonia as a direct –application fertilizer (United States).

The amount of new-plant capacity increases forecast is actually about 42 million tons, with the additional volume required to offset assumed closures in (unprotected) high-cost production regions.

The sharply higher cost of liquid and gaseous feedstock for ammonia production since 1999 is rapidly changing the face of international nitrogen. Capacities/production have already shrunk to a significant degree in countries where feedstock prices are high, unpredictable, and Nitrogen producers unprotected, e.g., the United States, Mexico, parts of Europe, Japan, Korea. As a corollary, all new world nitrogen capacity (ex-China) is being installed in countries/regions where feedstock costs are both "low" (reasonable) and predictable. These patterns will continue – total ammonia capacity growth of 40 million tons between 2004-2020 will include 71 percent for market growth and 29 percent as replacement for expected additional capacity closures (e.g., United States, Europe, Japan, Korea).

The top global suppliers of Ammonia and Urea have been identified in Task A.1-3 above

## A.5.2 North American Competition

### A.5.2.1 North American Methanol Competition

Methanol production in North America has steadily decreased as new world scale capacity has come online in other areas of the world. In 2004, production is estimated at about 4.1 million metric tons, an aggregate decrease of about 10 percent per year since 1999. The United States and Canada represent over 95 percent of this region's production.

Feedstock natural gas represents a very large portion of the production cost of methanol. In the last two years, natural gas costs in the United States have touched the $10.00 per MMBtu level twice, with the typical monthly price above $6.00 per MMBtu for much of 2004. The outlook for consumption of natural gas is rather strong for the next five-year period. Since residential, commercial and other such uses represent a very large outlet for gas, and can/will pay higher prices as compared to a feedstock for methanol, U.S. methanol production has become the "high-cost" incremental producer, and will continue to be under fire, cost wise, for the foreseeable future. Canadian methanol production is no exception. Already significant capacity has been rationalized at the expense of low-cost production from South America and the Middle East. Between the loss of MTBE and lower natural-gas-cost based methanol capacity starting up over the next few years, the remaining capacity in North America will be forced to rationalize.

Given the current and forecast global methanol conditions, methanol production in North America is forecast to continue to decline through the next few years, with the largest year-over-year decrease already recorded, from 2000 to 2001. Enron, Borden, Sterling/BP and Medicine Hat have all rationalized production capacity over the last few years, at the hand of lower cost production from South America, the Middle East and other countries. At the present time there are two projects underway to add methanol capacity in Trinidad. The Atlas unit (1.75 million metric tons), with startup in mid-2004, is the sixth methanol unit in this complex. MHTL (Methanol Holdings Trinidad Limited) has announced plans to construct a new 1.9 million metric ton unit in Trinidad, the seventh unit (fifth under the MHTL umbrella) with start-up targeted for the first half of 2005. Methanex has also announced plans to construct a fourth methanol unit at their Chile complex, with startup scheduled for early 2005, having a nameplate capacity of 840,000 metric tons. Based on these expansions, the Lyondell and BMC facilities have shutdown, Celanese will idle capacity in mid 2005 and Kitimat will likely idle in the 2005/2006 timeframe.

Methanol production in North America is forecast to decrease from today's level of 4.1 million metric tons, to about 250,000 metric tons by 2009, at which time North America will represent almost nothing of global production.

Based on the new production planned in South America and the Middle East countries, and the phase out of MTBE demand in the U.S., it is clear that shutdown decisions will have to be made in some of the "high-cost" methanol production locations around the world. North America and Europe are the most logical targets for much of this new production. Lyondell and BMC have rationalized in late 2004, while Celanese locations and Kitimat appear poised for rationalization beginning mid 2005-2006 timeframe.

To date, North American production and production costs have dictated the "floor" price for methanol. While not always influencing actual market prices, North American (namely United States) producers have been the high cost incremental production, which shuts down in a long market as prices are driven below U.S. cash cost levels, and restarts once prices move above cash costs. Within the next few years, it is likely most of the capacity remaining in the U.S. will rationalize, thus removing them from the role of setting the "floor" price for methanol. The question then is, "Who will be the next high-cost producer, and dictate the floor price of methanol?" South America will likely be the low-cost supplier to North America and Europe, and the Middle East/Australian capacity will clearly be the low-cost supplier to Asia. The Middle East may inherit the role of incremental supplier to North America, and industry pricing may be based on the cost of production, plus delivery from these remote areas.

A.5.2.2 North American Ammonia Competition

Six customs district destinations in five states (eight ports) account for about 99 percent U.S. vessel imports of ammonia. The individual ports are defined by the existence of dock-tank infrastructure that can receive vessel ammonia – no others exist in the United States except at Stockton and Sacramento in California (on the Sacramento River), both of which are primarily supplied from Canada.

***Savannah, Georgia*** Only storage owned by PCS, who controls all supply and ships most/all product to North Carolina and Florida (some to Augusta) for captive feedstock use (ammonium phosphates). PCS' terminal land lease expires year-end 2007, and is not expected to be renewed. PCS "replacement" options are:

- Build new tank elsewhere (difficult if not impossible, because of permitting).
- Supply ammonia to Florida and North Carolina phosphate plants by rail from other ports (e.g., Tampa, NOLA).
- Terminate ammonium phosphate production in Florida and North Carolina (eliminates demand for ammonia at these locations).

***Tampa, Florida***. Tampa is the largest ammonia market in the world (2.35 million tons of total imports in 2003). Most product is used as feedstock, over 95 percent for the production of

ammonium phosphates (DAP, MAP). Some import product is also railed to the Midwest for DA fertilizer use. In 2003, 62 percent of total supply came from Trinidad, 32 percent from the FSU, 3 percent from Venezuela, and the balance mostly from West Asia. Demand for ammonia feedstock in central Florida has shrunk by about 520 thousand tons per year since 1990 because of plant closures. These lost tons have been partially offset by ammonium phosphate capacity increases at other plants, plus some rail shipments of Tampa ammonia to the Midwest. For the future, the most likely trend is for flat-to-declining ammonia imports due to:

- A gradual trend to produce more MAP (uses 0.14 tons $NH_3$ to one ton of product) and less DAP (uses 0.225 tons $NH_3$ to one ton DAP),
- Potential loss of more U.S. DAP export shipments to Asia,
- Potential closure of one or more DAP/MAP plants by end of decade.

***Pascagoula, Mississippi*** (Mobile, Alabama customs district). Only storage owned by MissChem, who controls all supply (100 percent captive from Trinidad), all used on-site as feedstock for ammonium phosphates. This plant is a weak link in MissChem's portfolio (the company is still in Chapter 11), and might not last the decade.

***New Orleans, Louisiana (NOLA).*** Through the 1990s, the NOLA region was the largest ammonia-nitrogen production center in the United States – in 1998, 6.5 million tons per year of Louisiana ammonia capacity in nine complexes represented 37 percent of total U.S. capacity (17.5 million tons per year). Since then, 4.1 million tons per year of this capacity has shut down, leaving 2.4 million tons per year at the only two sites still in operation. As the closures occurred, the ammonia supply for shipment/sales was replaced by imports, which rose from less than 50 thousand tons per year in the 1990s to 1.5 million tons in 2003. Of this 2003 volume, an estimated 50-55 percent was supplied (sold) as feedstock to chemical plants in the region and in the Midwest and Northeast. The other 45-50 percent was shipped to the Midwest for direct-application to the soil (DA fertilizer). NOLA is the only U.S. ammonia vessel import location that supplies this Midwest DA fertilizer market in volume, i.e., ammonia deliveries to all other port locations are almost all for feedstock use. Of the 1.5 million tons of NH3 imported to NOLA in 2003, 50 percent came from Trinidad, 47 percent from the FSU, and 2 percent each from Venezuela and West Asia. NOLA is the only U.S. ammonia import market with growth potential, primarily due to potential future NH3 plant closures, i.e., MissChem's remaining train at Donaldsonville, Mosaic train at Faustina/Donaldsonville (512 thousand tons per year, about 2/3 for captive feedstock, rest sold), one or more of CF Industries' four trains at Donaldsonville (2015 thousand tons per year of total capacity, supplying 360-545 thousand tons per year of shippable ammonia). The potential replacement of MissChem's trade ammonia supply from Donaldsonville (equal to or less than 485 thousand tons) and the Mosaic and CF requirements could amount to nearly 900 thousand tons.

Except for these replacement opportunities, however, the markets served by NOLA ammonia are expected to eventually shrink because:

- The large Midwest market for direct-application ammonia fertilizer is declining (replaced by other products, e.g., urea, UAN solutions), with NOLA-supplied product directly impacted, and
- Customers using NOLA-sourced ammonia to produce ammonium nitrate fertilizer are likely to see this product regulated out of the fertilizer market because of its demonstrated "abuse potential," i.e., accidents (e.g., Romania, North Korea), explosives use by terrorists and other disaffected (e.g., Oklahoma City).

***Texas*** In 2003, the four Texas ports (Port Arthur, Houston/Pasadena, Freeport, Pt. Comfort) imported a total of 1.4 million tons $NH_3$, 85 percent from Trinidad, 7 percent from Venezuela, 6 percent from the FSU, and 1 percent from elsewhere. The Texas market for imported ammonia has grown steadily since the mid-1990s (from about 45 million tons to 1.4 million tons in 2003), due to both customer demand growth (capacity expansions), and replacement of domestic-sourced product (from NOLA plants now closed). Both of these market-driver phases are now pretty much complete, except for replacement of Terra Industries' small supply at Beaumont (about 180 thousand tons per year using captive methanol off-gas) due to that plant's closure in December 2004. Otherwise, there may be more potential for the market to shrink into the next decade if/as continued high U.S. hydrocarbon costs, plus continued growth in petrochemical capacity in Asia eventually lead to closure of some nitrogen-consuming U.S. Gulf petrochemical plants.

### A.5.2.3 Mexican and Central American Ammonia Competition

The ammonia trade market among these countries is small and not growing, especially with the recent closure of the Fertica nitrate plant in Costa Rica. However, the possible future closure of all ammonia production in Mexico (Pemex) could result in some import growth there.

The huge growth market here since 1995 has been Mexico, as imports replaced domestic production (all plants now closed). This phase is over, however, and Mexican imports have plateaued around ±1.2 MMtpy since 1999. FSU shippers (Russia, Ukraine) really dominate the Mexican- Central American market – the only other shipper of note is Agrium out of Alaska to the west coast of Mexico.

Some future market growth is likely, but, as in the past, on a gradual basis only. Opportunities to supply from (any) new Caribbean production thus appear to depend on competitive replacement of material from other sources.

### A.5.2.4 European and FSU Methanol Competition

There is no foreseeable new methanol production capacity in West Europe during the forecast period, except for some debottlenecking of the Statoil, Norway facility and the Methanol plant in the Netherlands. Statoil announced in mid-2004 studies were underway to explore the possibility of expanding their methanol facility from 900,000 metric tons per year to 1.2 million metric tons per year. A decision is expected late 2006. Based on their very attractive natural gas position, an expansion is clearly feasible. The impact to the region would likely result in a reduction in production costs compared to other sources.

Rather than additional capacity, a better case can be made for further rationalization of West Europe methanol capacity. Some units are believed to be immune, such as the methanol plant in Norway that will operate under essentially any (and all) global/local market conditions because it uses associated gas that cannot be flared. Others use process off-gas or "waste" as feedstock and likewise are extremely unlikely to shutdown. However, there are relatively large merchant market methanol producers in West Europe that might consider rationalizing facilities at some time in the future. The upcoming production in Trinidad, Chile and the Middle East capacity additions will clearly target the West Europe market for a significant portion of its output.

For the methanol industry in the Central European countries, we do expect a drop in production in the next two years. It seems difficult for some of the methanol producing countries in this region to continue production on the same scale as the recent past. Overall, we forecast methanol production in Former Soviet Union will decline by 5.5 percent per year and Central Europe will decline by 33.9 percent through the 2004-2009 period. Much of their feedstock (natural gas) originates in Russia, and they must now pay world prices in hard currency. Because of this, we are of the opinion that some methanol production has been shut down in Bulgaria, Czech Republic, Poland, and at times facilities in Yugoslavia.

As far as the methanol business is concerned in the Central European and Former Soviet Union countries, major changes are not expected. Methanol derivative figures have been revised downward, and growth in methanol demand is negligible during the next few years.

Given the current cost structure to deliver methanol to consuming markets, production in these regions of the world are not expected to grow significantly. In fact, some less efficient production located in Russia, Yugoslavia and Romania could be campaign run or rationalized. The primary reason is that these facilities are unable to compete in global methanol markets in times of soft pricing. As long as global methanol prices are at or above $200 per ton, most of these facilities can compete. But when pricing declines to the levels given in the price forecast, these facilities are at an economic disadvantage and must pull out of the marketplace. Although there have been announcements of some new world-scale export-oriented methanol plants for

Russia, because of these difficult economic factors, it is assumed that they will not be constructed in the foreseeable future.

#### A.5.2.5 European and FSU Ammonia Competition

Europe remains a major import trade market for ammonia, with demand spread across most of the countries therein, basically all for feedstock use. Through the mid-to-late 1990s, total regional import volume trended relatively flat around 4.5 million metric tons per year. Since 2000, demand has fallen substantially as declining N fertilizer demand in Europe, coupled with rising imports of finished nitrogen products, have prompted the closure of a number of fertilizer plants based on import $NH_3$. There are no apparent reasons why this trend will reverse itself. The largest share of European ammonia trade is intraregional (46 percent in 2003), followed by the FSU (36 percent). North Africa makes up most of the rest (Algeria, Libya).

### A.5.3 Africa and Middle East Competition

The Arabian Gulf, much of the Middle East and a portion of North Africa have large amounts of methanol feedstock in the form of associated and non-associated natural gas. It is not surprising some of these locations have concentrated on upgrading their resources in the past two decades, in an effort to get closer to downstream petrochemicals.

#### A.5.3.1 African and Middle East Methanol Competition

World-scale methanol facilities in this region are currently located in Saudi Arabia, Bahrain, Equatorial Guinea and Libya, and these countries are all major exporters. Smaller and more local methanol production is located in Israel, Iran, Algeria and South Africa. However, there are many ambitious plans to build additional methanol producing capability in Iran, Oman, Qatar, Nigeria, Egypt and South Africa, among others. Some of these projects have been going on for a number of years and have changed partners a number of times. They all have one common hurdle: arranging the proper off-take agreements in order to get the projects financed.

At this time, it appears there are as many as six new methanol units, maybe more, that will be built in the next five years. In Al Jubail, Saudi Arabia, a new 1.0 million metric ton per year facility is scheduled to be operational as 2005 begins, for Saudi International Petrochemical Company, as well as the Tasnee facility, scheduled for startup in 2007 (1.7 million metric tons). Ar Razi V, with a capacity of 1.7 million metric tons as well, is scheduled to begin operation in 2008. Oman is scheduled to bring a 1.0 million metric ton facility online in Sohar, in 2007. This unit may likely be expanded to 1.7 million metric tons within a few years following startup. QAFAC, Qatar, is expected to expand the capacity of their existing methanol facility by about 2.2 million metric tons in the 2009 timeframe. The National Petrochemical Company of Iran will double the capacity at Kharg Island in 2008, adding a second 660,000 metric ton unit, following a fourth unit in Bandar Assaluyeh (1.7 million metric tons) scheduled early 2006.

Saudi Methanol Company (Ar Razi) is a joint venture between SABIC and a consortium of Japanese companies led by Mitsubishi Gas Chemicals, which also provided the technology for the four methanol units. The first facility, Ar Razi I, came online in early 1983. The second methanol plant, Ar Razi II, came on-stream in 1992 within the same complex. Ar Razi III came on-stream in late 1997/early 1998. Ar Razi IV came on stream in late 1999, and now Ar Razi V is scheduled for 2008. The primary markets for the Japanese portion of this production are in the Far East. SABIC markets the remaining volume (not used for their domestic MTBE production), predominantly in Europe and Asia, with small volumes targeted for the United States.

#### A.5.3.2 African and Middle East Ammonia Competition

The African market for ammonia is over 80 percent in the north, specifically as feedstock supply to the large phosphate fertilizer industries in Morocco and Tunisia (and to a lesser degree in South Africa). These two large country markets will continue to grow as a function of periodic increases in capacity to produce ammoniated products (DAP, MAP). Current, trade is dominated by the FSU (Russia and the Ukraine) out of the port of Yuzhnny on the Black Sea, e.g., 85 percent of Moroccan-Tunisian imports were FSU-sourced in 2003.

Middle East ammonia imports are all for feedstock use in Israel, Jordan, and Turkey. Thus, demand is driven by annual output rates of existing chemical plants based on import $NH_3$, plus any changes (additions, closures) in their capacities. Based on current knowledge, growth in this regional trade demand is not expected. As in other parts of the Mediterranean ammonia trade, the FSU out of Yuzhnny is by far the largest supplier (80 percent of total trade in 2003).

### A.5.4 Asian and Pacific Competition

#### A.5.4.1 Asian and Pacific Methanol Competition

This region of the world is widespread geographically and methanol shipments and deliveries can range from full ships of 40,000 tons or more, down to small bulk tanker deliveries of about 700 tons to very remote islands where formaldehyde plants might be located. These logistics provide a challenge to the transportation industry and they also present extreme differences in methanol pricing. For example, a 40,000 ton tanker load delivered to one terminal in Japan would be done at a much lower price than a 700 ton parcel delivered to a remote island in Indonesia that had to be transshipped, say in Singapore.

These three regions in aggregate are, and will continue to be, net importers of methanol. This position is required, as high energy (read feedstock) costs in the region preclude production from being competitive with remote production, such as New Zealand and the Middle East.

Some years ago, Japan made a very realistic appraisal of the future of its methanol industry. More expensive producing plants were closed, and methanol was imported from various worldwide sources at cheaper prices. These decisions were inspired by the industry for the good of the industry, and the previous producers still market imported methanol through their existing networks. The end-result is a more competitive methanol position that should carry over to the derivatives and export markets. South Korea and Taiwan have followed Japan's lead in this approach, shutting down expensive methanol production and importing at cheaper world prices.

One of the more significant supply developments in the Asia and Pacific region in recent years has been both the loss of a significant portion of supply from New Zealand, and major expansion plans for Australia, Southeast Asia and a myriad of new low-cost, world scale facilities in the Middle East. Concurrently, China continues to promote very aggressive growth plans, expecting to increase methanol production capacity from an estimated 6.5 million metric tons in 2004 to almost 10.0 million metric tons by 2009.

In 2003, Methanex was forced to reduce production in New Zealand from approximately 2.4 million metric tons annually, to near 1.0 million metric tons. This was the result of a re-determination of natural gas reserves which concluded far less gas than originally thought remained available. As a result, production was limited to a similar 1.0 million metric ton level in 2004, expected to decline to approximately 400,000 metric tons in 2005 and shutdown completely in 2006. During this timeframe, incremental supply from the Middle East and South America made up much of the shortfall, as well as a significant increase in production from facilities in China, a country that typically has operated near the 30-40 percent capacity utilization level due to its poor methanol production cash cost position.

The many new methanol facilities planned for the Middle East previously mentioned will aggressively target both the Asia and European markets. Methanol Australia is working on a new 1.7 million metric ton unit targeting production in 2008, while Petronas has recently made public plans to build a second unit in Malaysia, with an annual capacity of 1.7 million metric tons, targeting the 2007 timeframe. The Brunei government is understood to be well into plans to build an 850,000 metric ton per year methanol facility to come on stream in 2007 as well.

### A.5.4.2 Asian and Pacific Ammonia Competition

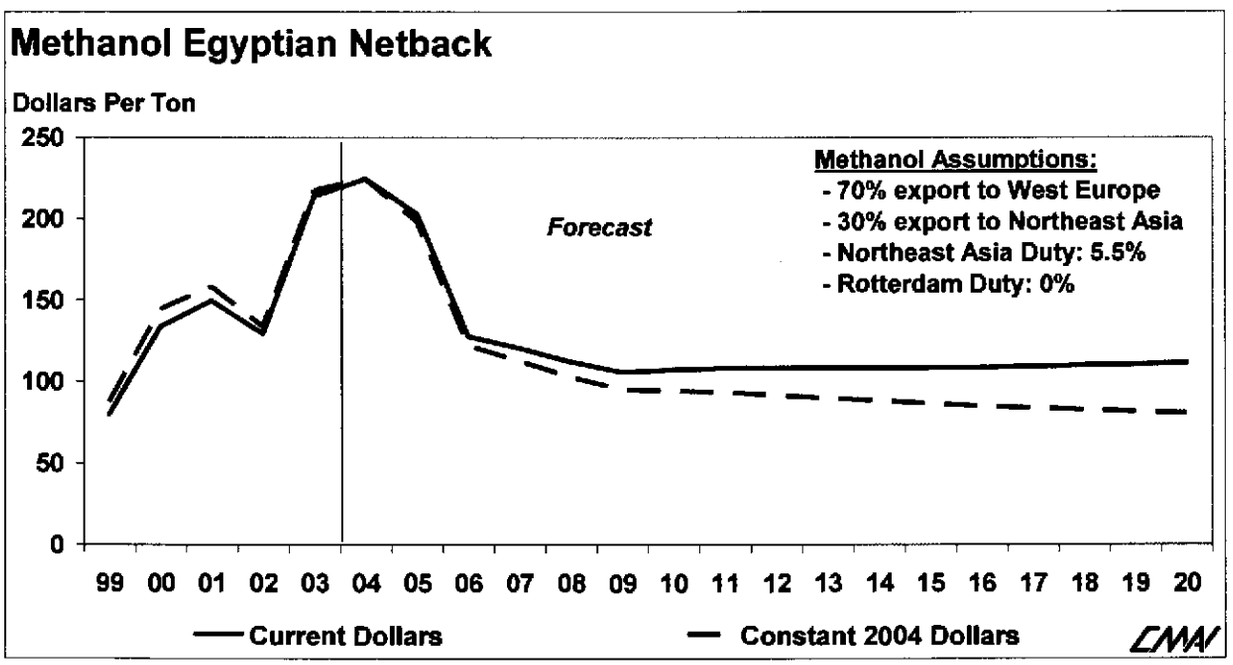
All imports feed coastal plants producing (primarily) ammoniated phosphate fertilizers. Recent growth in this trade has been per growth in Indian's phosphate capacity. Future increases in such capacity may be limited, with ammonia import demand then primarily a function of efficient operation of existing plants, and the role of Indian government subsidies thereon. Over 95 percent of Indian ammonia supplies are Asian sourced, over 60 percent from West Asia. A new

trade ammonia plant with Indian ownership is scheduled on stream in Western Australia next year, which should also feed the Indian market.

Asia is one of the world's largest markets for trade ammonia. The biggest importers are South Korea, Taiwan, and Thailand, but Japan is growing as internal capacity based on high-cost liquid feedstock gradually closes. Most imports feed nitrogen-based industrial chemical plants, capacities of which keep on growing based on rising personal incomes in Asia and continued exports of petrochemical-based consumer products to the United States. Regional ammonia demand growth shows no sign of abating. The current market is served mostly by Asian plants, primarily Indonesia and Malaysia. The second largest source is Alaska (freight advantage to Korea). At present, Australia appears self-sufficient in ammonia, but imports may return to feed coastal plants producing blasting-grade ammonium nitrate for various mining operations.

## A.6 LOCAL MARKET SIZE AND PROJECTED GROWTH, IMPORTS, SOURCES, AND PRICING STRUCTURE

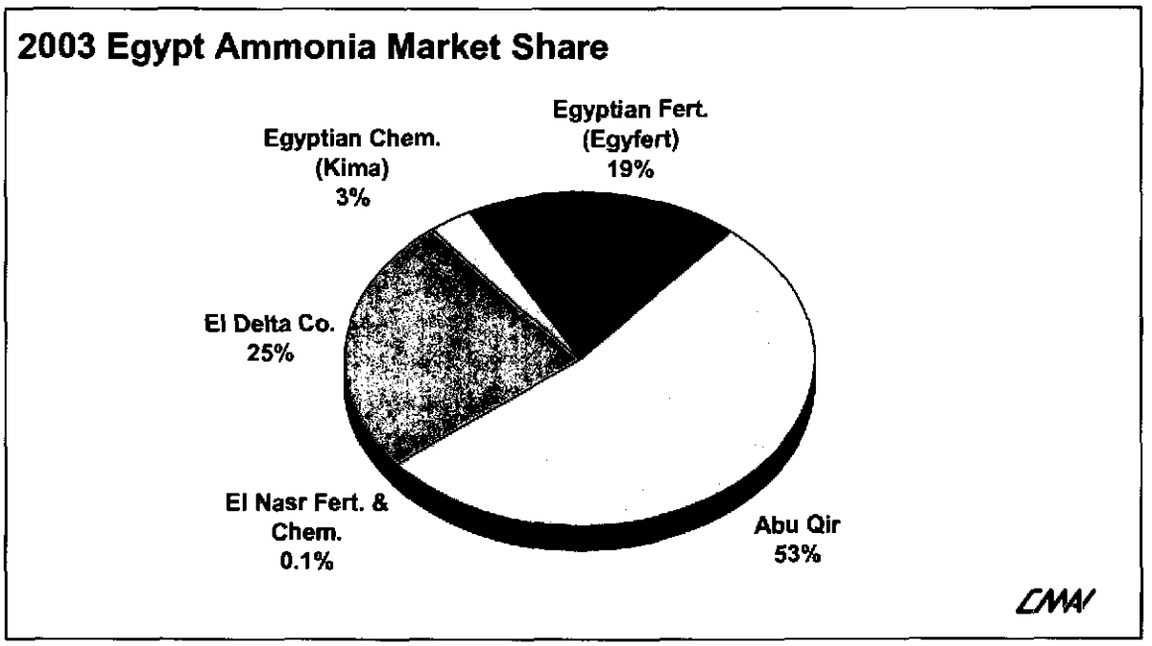
Currently, there is no methanol production in Egypt, nor is methanol imported into the country in notable quantities. Therefore, there is not domestic consumption of methanol into derivative applications. Egypt imports its MTBE requirement of 95 thousand tons per year from the Middle East. There is methanol production in Libya and in Algeria, albeit relatively small in comparison to production in the rest of the world. Potential capacity would have to be for export consumption, and as a region, consumption in Africa is negligible.

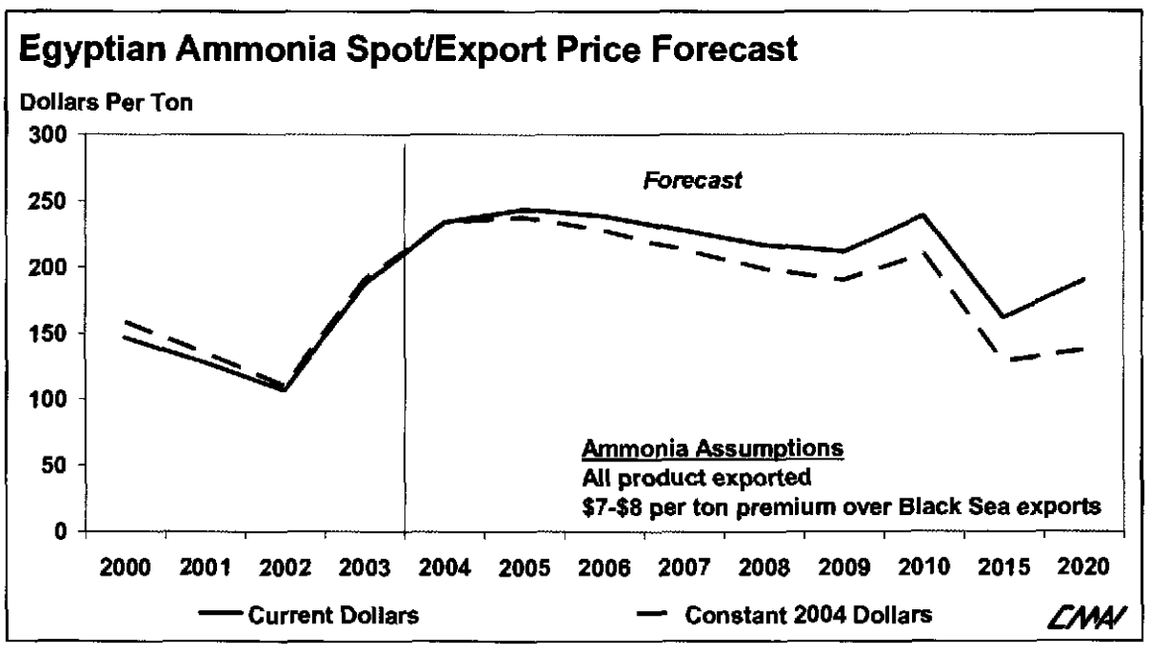


Egypt has a large nitrogen industry currently structured to primarily serve domestic markets. Total capacities approximate: ammonia at 2.4 million tons per year (five complexes) and urea at 2.4 million tons per year (three complexes). The key elements of the industry are fairly efficient – over the three-year period 2001-2003, the average operating rate was 90 percent on ammonia capacity, and even higher for urea capacity. In 2003, about 68 percent of total nitrogen output ($NH_3$ production basis) was consumed internally, 32 percent exported. About 80 percent of nitrogen exports are shipped as urea, most around the Mediterranean (e.g., Europe at 62 percent in 2003) and the United States-Canada (34 percent in 2003).

Egypt is poised to become a much more significant nitrogen exporter, particularly urea. Three large, new ammonia-urea complexes are currently under development (Abu Qir, EFC, Helwan), each rated at 400 thousand tons per year ammonia and 650 thousand tons per year urea, net total of 1200 thousand tons per year for ammonia, 1950 thousand tons per year for urea. Scheduled on stream during 2006-2007, some of this new nitrogen supply may serve to replace part or all of the output of four old, small ammonia units (each equal to or less than 150 thousand tons per year NH3, total 455 thousand tons per year), but the net amount of nitrogen production growth will significantly exceed expected domestic demand growth. The outlook for the project considered in this study report has to be considered as additive to this expanding export position.

Egypt has been/is a de-minimus exporter of ammonia. The most freight-logical markets for such exports would be those around the Mediterranean. However, demand in this region is only nominally growth-oriented, and supply is dominated by Russia and the Ukraine out of the Black Sea. A large Egyptian ammonia-only export plant with low-cost gas could certainly compete, but unless an equivalent amount of FSU supply was "agreeably" diverted to other markets (e.g., China), getting and retaining a market position would probably be a fight. In this regard, it is noteworthy that none of the three under-development projects cited above are dedicated to ammonia.




The international urea market definitely appears as the better option. First, trade demand is growing in West-of-Suez markets effectively supplied out of Egypt, e.g., Europe, Africa, the Americas. Second, export supplies out of the FSU -- that currently have strong positions in some of these markets (Europe, Latin America) -- are not expanding. Third, Egypt has the opportunity/potential to, at times, cut its freight costs to the Americas by virtue of back-haul opportunities when such are available (e.g., vis-à-vis large grain imports shipped to North Africa

out of the U.S. Gulf). Fourth, if natural gas to this study's project is available at low rates, the venture's cash production cost economics could be among the lowest in the world. This will certainly be a boon to investors at times when international markets are in cyclical troughs, also an advantage in competing in the Americas (North and South) against product from the Caribbean, FSU, and West Asian supplies, all with higher gas costs.

# TASK B PROCESS TECHNOLOGY/LICENSOR SELECTION

## Introduction

This Feasibility Study is undertaken for investigating the planned installation of integrated Methanol-Ammonia plants by Egyptian Petrochemical Holding Company (Echem). The capacities of the new units are defined in Metric Tons per Annum (MTPA) and Metric Tons per Day (MTPD) as follows

- Methanol 1,035,000 MTPA (3,000 MTPD)
- Ammonia 414,000 MTPA (1,200 MTPD)

The annual values assume 345 days of production.

Natural gas is used as feed and fuel to produce methanol, and the hydrogen rich purge gas from the methanol plant is used as feed to the ammonia plant.

The selection of the process technologies for these process units will be based on key factors, which will include plant safety, investment cost, plant efficiency, on-stream time, simplicity in operation and maintenance, reliability, and environmental considerations.

## B.1 TECHNOLOGY EVALUATION AND LICENSOR RECOMMENDATION

### B.1.1 Methanol Technology

There are several process/technology options for producing methanol. Methanol production typically requires three steps:

(a) Syngas Preparation

(b) Methanol Synthesis

(c) Methanol Purification/Distillation

There are five major process licensors of Methanol technology, based on the number of large plants built worldwide since 1965 and market share of these technologies. The five technologies considered are:

- One Synergy - incorporating Johnson Matthey (JM), Davy Process Technology (DPT) and Aker Kvaerner Inc.
- Lurgi Mega Methanol
- Haldor Topsoe

- Mitsubishi Gas Chemical Company
- Uhde GmbH

**Major Features**

Methanol production technology is mature, and the majority of processes are very similar. There have been a few recent technology improvements that provide some benefits. These technologies have been considered in this comparison study.

**ONE SYNERGY**

The One Synergy Process, formerly known as ICI Katalco (Synetix) process, offers leading edge proven methanol technology with the following options:

- Conventional Reforming based (LPM)
- Leading Concept Methanol (LCM)

One Synergy can also offer a combined reforming based process consisting of a fired primary reformer and an oxygen blown secondary reformer configured in series.

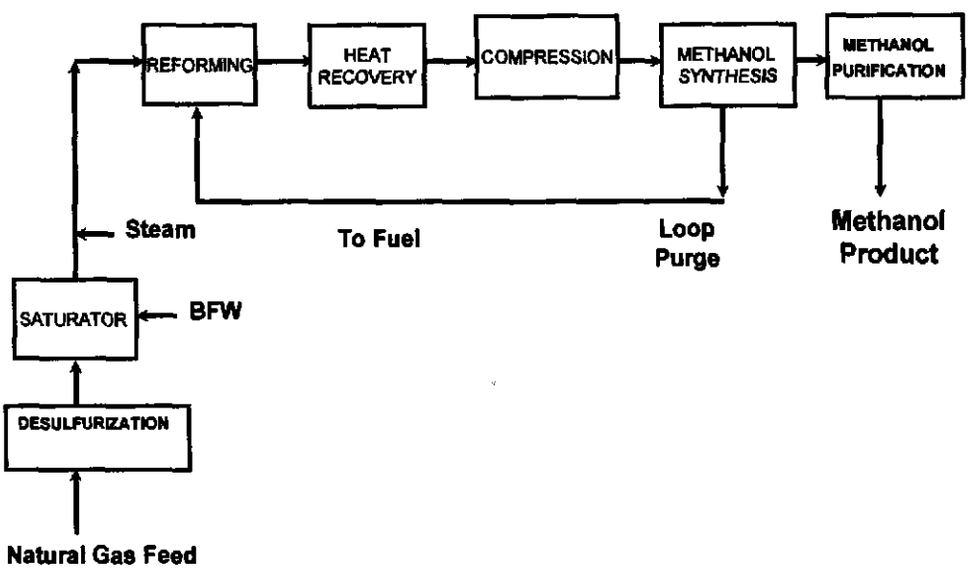
The common key features of One Synergy processes are:

- Application of Feed Gas Saturator
- Efficient Heat Recovery Section
- Optimum Methanol Synthesis Loop Pressure
- Use of JM Proprietary Methanol Catalyst
- Use of Proprietary Methanol Converter Design
- Two Column Purification System (Alternatively three column purification system is available for better energy efficiency)

**Process Description**

The block flow diagram in Figure 1 highlights the major steps in the conventional process.

## Figure 1 – JM Conventional Methanol Process




### Conventional Process

The conventional One Synergy methanol process employs a steam reformer furnace for the generation of synthesis gas. Desulfurized natural gas is first mixed with steam (3 to 1 steam to carbon mole ratio) by feed gas saturation, using the waste heat recovery from synthesis loop or from the front-end reformed gas. The mixture is fed to the steam methane reformer (SMR) containing catalyst tubes. In the presence of a nickel catalyst, steam reacts with the natural gas feedstock at elevated temperature and pressure to produce a reformed gas consisting of carbon dioxide, carbon monoxide, hydrogen, and residual methane.

The reformed gas is cooled by heat recovery in the steam system and the methanol purification system reboilers and finally by water cooling. Process condensate is separated and recycled by feed gas saturation. The gas is then compressed to the synthesis loop pressure.

The conventional process employs a quench-type methanol converter. The gas leaving the discharge of the circulator/compressor is divided into two streams. One stream is converter feed gas, with the rest used as warm shot for moderating the synthesis reaction.

The methanol converter contains methanol synthesis catalyst. Methanol synthesis takes place as gas passes downward through the catalyst. The methanol converter contains several

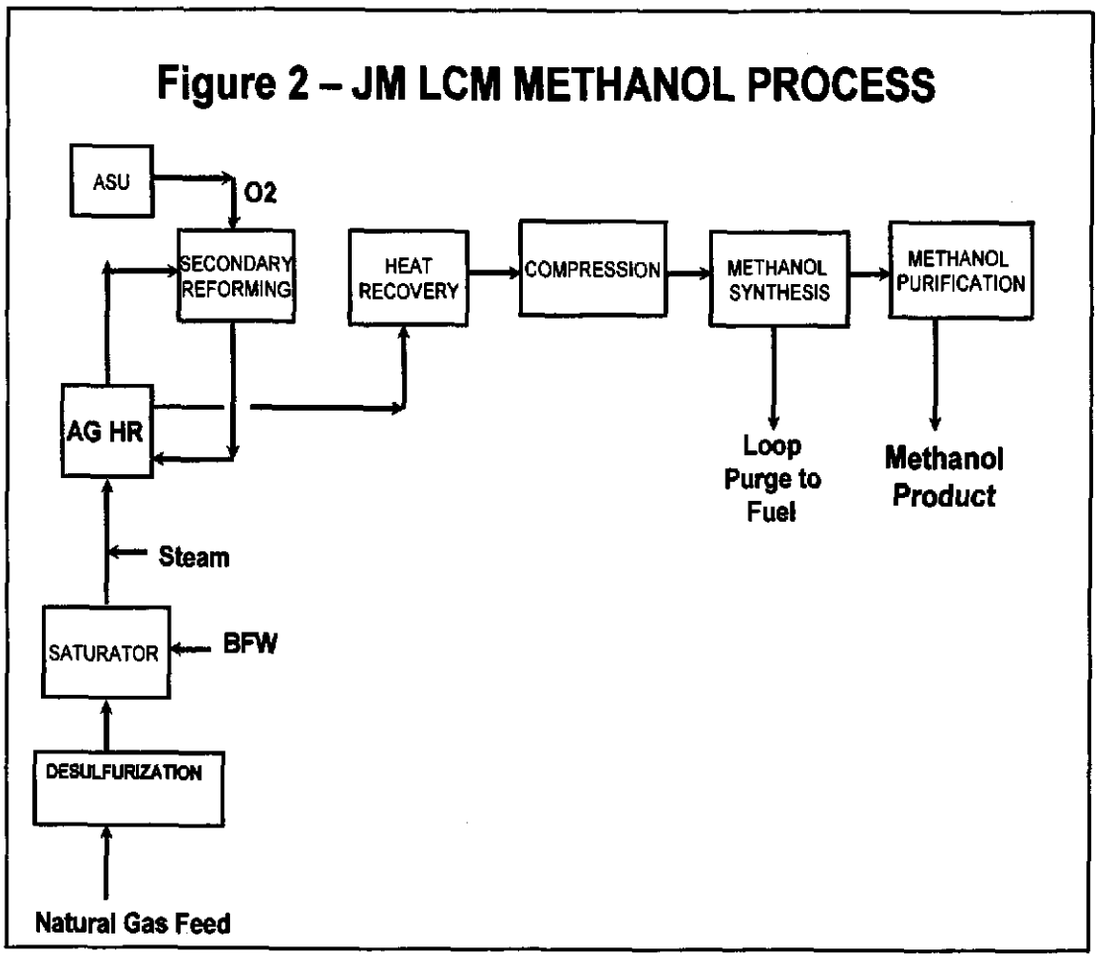
catalyst beds with intermediate injection points for warm shot gas, which is injected into the converter to moderate reaction temperatures. The reaction gas leaving the converter is first heat exchanged with the feed gases to the converter as well as process water for the feed gas saturator and then cooled by air and water heat exchangers to condense methanol and water. Excess hydrogen and methane are removed from the synthesis section as purge gas stream and is burned as fuel in the reformer furnace. Alternatively, the hydrogen rich purge gas can be used as feed for the production of ammonia.

In recent years, One Synergy has commercialized several advanced converter types. One Synergy offers tube-cooled converter and steam raising converters as an alternative to the quench type. The recent designs typically reduce capital and operating costs and improve energy efficiency.

In the purification section, the crude methanol is fed to the topping column to remove the light impurities and then to the refining column to produce the refined methanol.

**One Synergy LCM Process**

The block flow diagram in Figure 2 highlights the major steps in One Synergy's LCM process. The Leading Concept Methanol (LCM) process employs Advanced Gas Heated Reformer (AGHR) and tube-cooled methanol converter. AGHR eliminates conventional fired reforming furnace. Process heater is required for preheating the feed stream.




The major design concept of this process is that the AGHR, which is the primary reformer, uses the heat of the effluent from the secondary reformer to provide the energy for the primary reforming reaction. The desulfurized natural gas is first saturated with water and then fed to the AGHR where the feed gas is partially reformed in the tubes filled with reforming catalyst. The partially reformed gas is then passed onto the secondary reforming catalyst on which the gas is partially oxidized with oxygen. The hot exhaust gas from the secondary reformer is fed back to the AGHR where it passes into the shell side of the reactor. The catalyst-filled primary tubes are enclosed in a coaxial sheath tube, and the hot secondary reformer gas passes up this gap transferring energy into the tubes to drive the primary reforming reaction. The primary reformer tubes are finned to maximize heat transfer.

In the LCM process, a tube-cooled methanol converter is employed for methanol synthesis. Alternative methanol converter designs including steam raising converter are available. The tube-cooled converter contains not only the catalyst, but also a significant portion of the heat exchanger area. The tube-cooled converter moves some of the external heat exchange surface

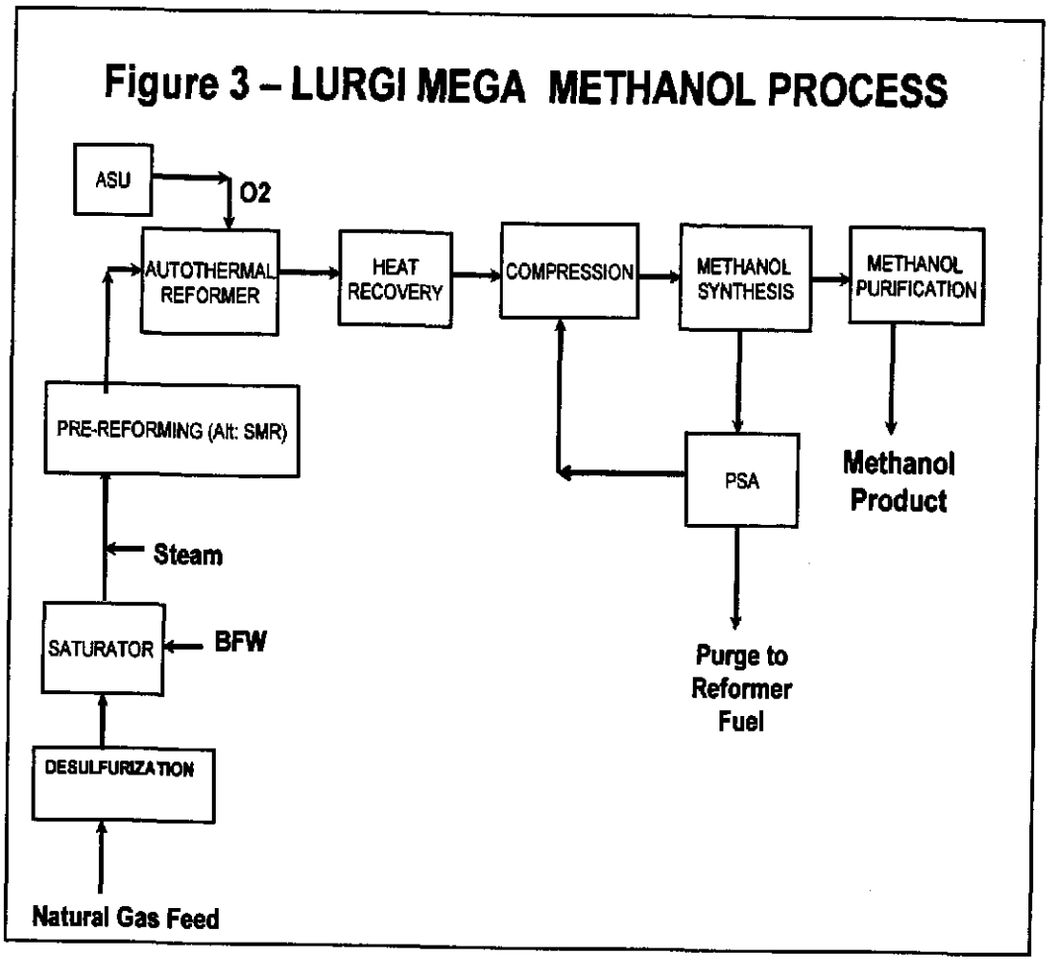
area to within the converter without the complexity of a full internal heat exchanger. The design is a simple gas-to-gas heat exchanger without differential tube sheets. The raw reactant gas is fed to the bottom of the tubes via an internal distributor. The gas flows upward through the tubes and is preheated to reaction temperature via heat exchange with the reacting gases on the shell side. The preheated gases leaving the top of the tubes then pass downward through the catalyst bed, which is packed in the space between the tubes.

**LURGI MEGA METHANOL PROCESS**

Lurgi's Mega Methanol process is based on catalytic pre-reforming and autothermal reforming (ATR) with oxygen to produce synthesis gas in a single-train two-stage methanol reactor system. In its alternative configuration, a conventional steam methane reformer (SMR) is used in conjunction with ATR. Only part of the natural gas feed is processed through SMR; the rest is bypassed around it. SMR helps in maintaining stoichiometric number of the syngas and assists combustion in ATR. Lurgi can also provide methanol technology based on conventional SMR.

The block flow diagram in Figure 3 highlights the major steps in the process:

The reforming pressure of about 40 bar is significantly higher than that in a conventional reformer and allows synthesis gas compression in a single casing compressor without intercooling. Synthesis gas from an autothermal reforming process is characterized by a stoichiometric number SN = $(H_2-CO_2)/(CO+CO_2)$, below 2.0. Adjustment of the SN to the optimum value of about 2.05 is achieved by the addition of $H_2$, which is separated from the purge gas of the synthesis loop.




The process characteristics of the autothermal catalytic reforming include:

- Operating flexibility
- Low steam/carbon ratio
- Elimination of fired primary reformer (optional)
- Stoichiometric synthesis gas composition
- Compact plot plan
- Low $CO_2$ and $NO_x$ emission

Methanol synthesis is based on Lurgi's combined Converter synthesis. In the first stage, synthesis gas is partly converted to methanol in a conventional water-cooled steam generating Lurgi reactor. This reactor operates at very high yield and at higher than normal reaction

temperatures allowing medium pressure steam to be produced, which improves efficiency of the plant. Lurgi uses a methanol catalyst developed in conjunction with Sud-Chemie.

In the second reactor, the reaction rate is much lower and, consequently, so are the yield and the amount and grade of the reaction heat. The remaining reaction heat is used to preheat the feed gas to the first reactor. The continuously-reduced temperature in this reactor provides increasing thermodynamic equilibrium potential.

High pressure steam is generated from process heat in the reforming section and is used for the major steam turbine drives. Medium pressure steam is generated in the steam drum of the first methanol reactor and mainly used as process steam.

The advantages offered by Lurgi's combined converter synthesis include:

- High synthesis gas conversion efficiency
- Extended catalyst life
- High energy efficiency
- Reduced loop size
- Low investment cost

The crude methanol produced in the reactors is routed to the distillation system to produce chemical grade methanol. A three-column (alternative: two column) design is employed for purification.

**HALDOR TOPSOE**

Topsoe offers two types of flowsheets:

- Conventional Reforming based
- Combined Reforming based

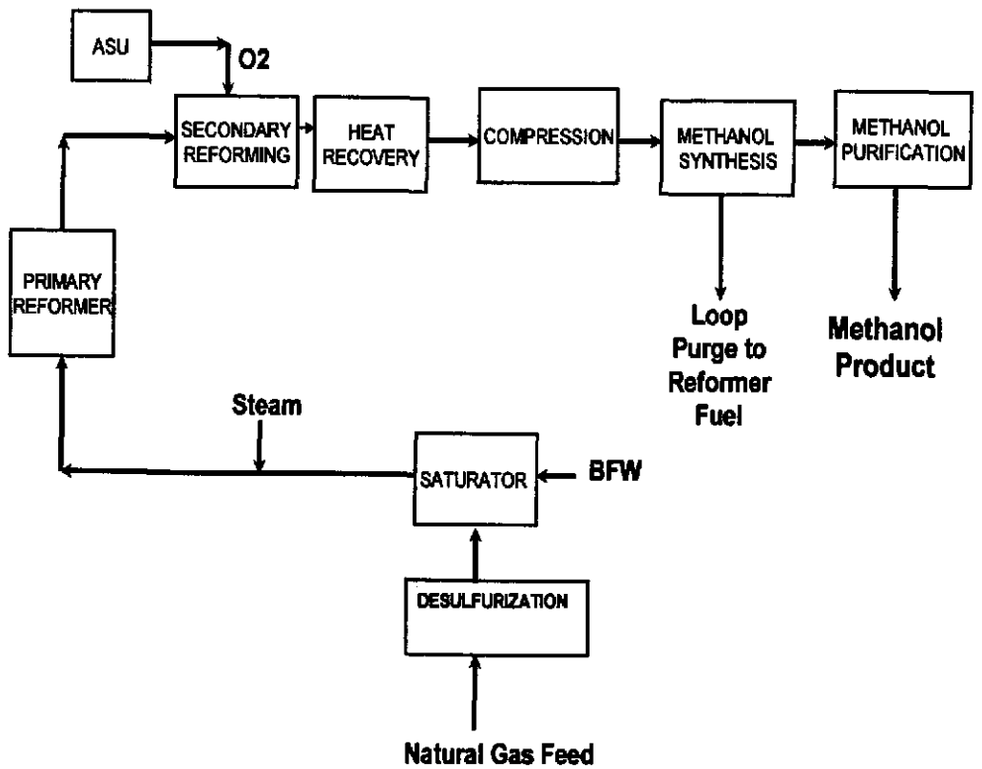
The common key features of Topsoe processes are:

- Optional application of Feed Gas Saturator
- Use of Topsoe Proprietary Methanol Catalyst
- Use of proprietary Methanol Converter Design

The conventional flowsheet is very similar to the other conventional SMR front-end base flowsheets described earlier.

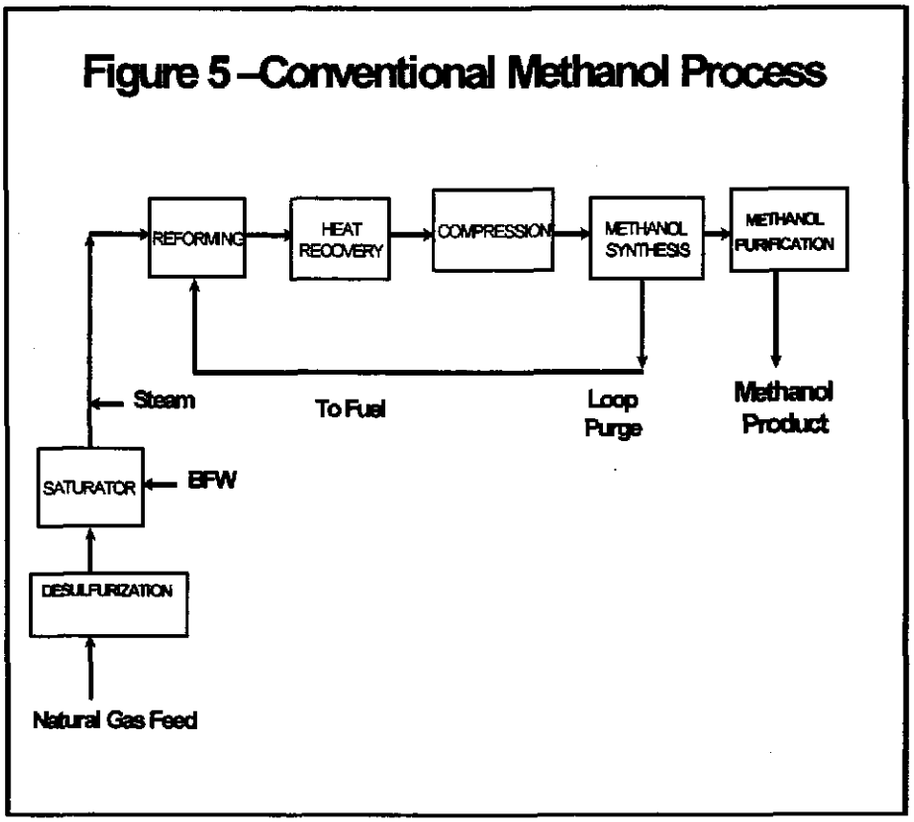
The combined reforming process configures a series installation of a fired primary reformer combined with oxygen-blown secondary reformer. The combined reforming process reduces the size of the primary reformer and allows raising the front-end pressure. Alternative use of a pre-reformer upstream of the primary reformer is possible. It uses a steam raising methanol converter in the synthesis section.

**Figure 4 – TOPSOE COMBINED REFORMING METHANOL PROCESS**




## MITSUBISHI PROCESS

Mitsubishi Chemicals offers methanol technology based on a conventional reforming (SMR) front-end. It uses proprietary catalyst in the synthesis section and has options of quench as well as steam raising converter. Mitsubishi allows the listed contractors to supply their own know-how for the front-end. Other details are very similar to those in other processes.




**Uhde PROCESS**

Uhde process consists of processing steps of a typical conventional reforming process, namely, feed desulfurization, steam reforming, syngas compression methanol synthesis, and crude methanol distillation. The steam reformer is a top-fired, box-type furnace with a cold outlet header system developed by Uhde.

Uhde's methanol reactor is an isothermal tubular reactor with a copper catalyst contained in vertical tubes and boiling water on the shell side. The heat of methanol reaction is removed by partial evaporation of the boiler feedwater, thus generating 1-1.4 tons of MP steam per ton of methanol.

Crude methanol is purified by an energy saving three-column distillation system.

### B.1.1.1 Preliminary Methanol Technology Screening and Evaluation

It is seen that the steam reforming process generates surplus hydrogen; whereas, the auto thermal reforming process does not. The surplus hydrogen is the main component in the purge gas from the synthesis loop. The required production rates for this study are 3,000 MTPD of methanol and 1,200 MTPD of ammonia. In order to produce sufficient purge gas for the required ammonia production, the methanol plant has to use steam reforming exclusively.

Screening and evaluation of the methanol processes is presented in Section B.3

## B.1.2 Ammonia Technology

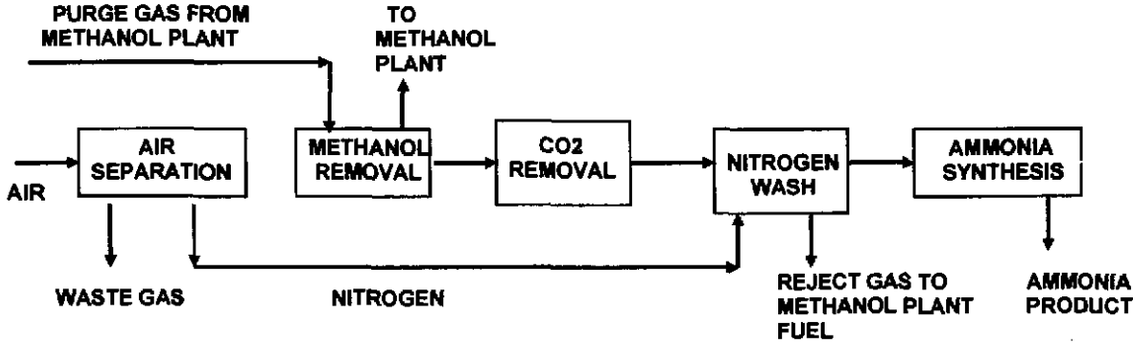
There are currently three established process licensors for ammonia production technology. They are:

KBR (Kellogg Brown & Root, Inc.)

Haldor Topsoe A/S

Uhde GmbH

The typical process steps as shown below, for the Purge Gas Ammonia Plant are would be similar for all licensors.




A purge gas ammonia plant is much simpler and cheaper than a conventional ammonia plant because the purge gas from the methanol plant consists mainly of hydrogen. Therefore, the reforming and shift sections normally used in an ammonia plant to produce hydrogen are not needed. In addition, the purge gas from the methanol plant is available at a higher pressure than is normally used for ammonia plant synthesis loop makeup gas, which saves compression in a purge gas ammonia plant.

The purge gas from the methanol plant needs purification before being charged to the synthesis loop in the ammonia plant to:

- Remove oxygen compounds such as moisture, carbon monoxide and carbon dioxide, which would poison the ammonia synthesis catalyst, and
- Purify the purge gas, removing impurities such as methane, which would build up in the synthesis loop in the ammonia plant.

Purification can be accomplished using two methods: liquid nitrogen wash or pressure swing adsorption (PSA). The nitrogen wash method results in a hydrogen loss of two to three percent. The PSA method results in a hydrogen loss of ten to fifteen percent. In order to meet the required ammonia production of 1,200 MTPD, nitrogen wash is needed. In fact, at the start-of-run in the methanol plant, the purge gas will be just sufficient to meet the demands of the ammonia process. At end-of-run in the methanol plant, somewhat more purge gas will be available, with the excess directed to plant fuel.

With either the nitrogen wash or the PSA method, an air separation unit is needed to provide the nitrogen for the ammonia synthesis. The air separation technology is well demonstrated and competitive, with units available from any of six vendors: Air Liquide, Air Products, BOC, Praxair, Messer, and Linde. The technology is well demonstrated and very competitive. The final selection will be determined by the commercial terms offered with a firm bid.

Screening and evaluation of the ammonia processes is presented in Section B.3

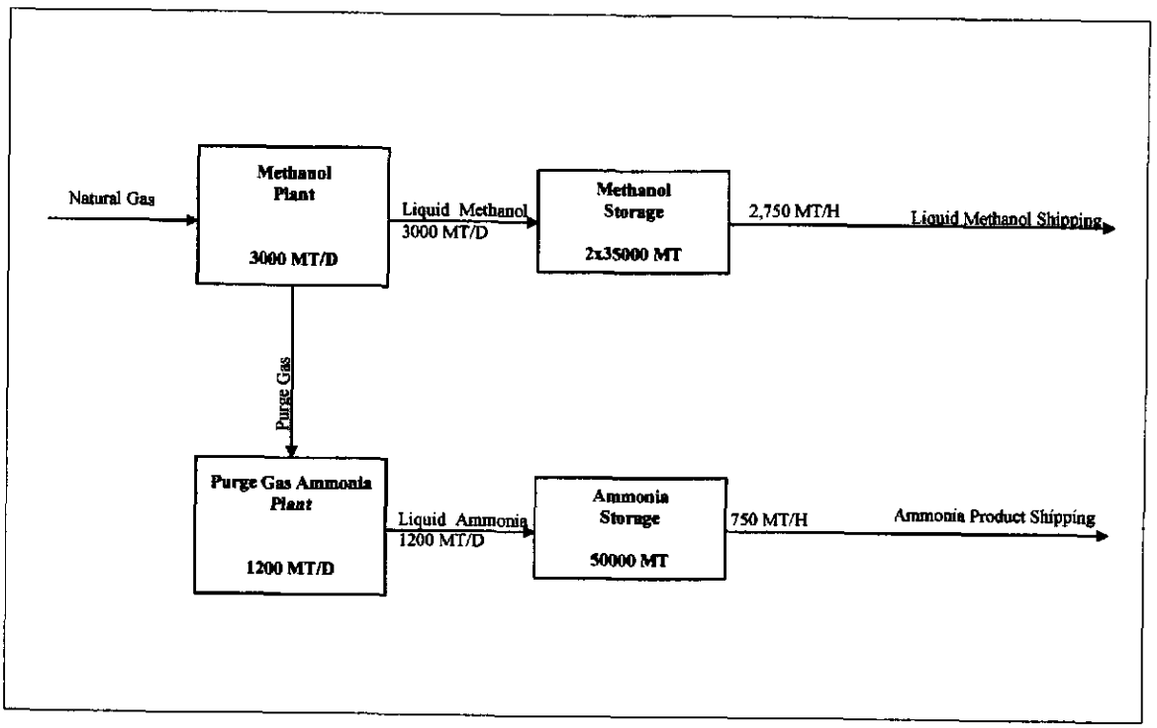
## B.2 PROJECT DESIGN BASIS

### Introduction

The production of methanol and ammonia requires natural gas, water, and electricity. Secondary inputs include catalysts and chemicals. The natural gas, water (also as steam), and electricity are used to produce methanol. The hydrogen rich purge gas from the methanol plant is used as feed to the ammonia plant for production of ammonia.

Figure 6 shows the overall product flow diagram.

**Figure 6 - Overall Product Block Flow Diagram**




## B.2.1 Methanol Plant Project Design Basis

### B.2.1.1 Methanol Feedstock Rates:

| | |
|---|---|
| Natural Gas | 3,264,000 $Nm^3$/day (Process Feed + Fuel) |
| Fuel from Ammonia Plant | 324,000 $Nm^3$/day of equivalent natural gas |
| Net Demineralized Water | 3,300 T/day (Recycle condensates credited) |
| Seawater Circulation | 432,000 $m^3$/day (for ISBL Plant, delta T=10°C) |
| Closed Loop Fresh Water Cooling | 244,800 $m^3$/day (delta=12°C) |
| Power | 5,000 kW |

### B.2.1.2 Composition of Feedstock

The natural gas feedstock composition is stated to be as follows:

## Natural Gas Feedstock and Fuel Composition

| Constituent | | |
|---|---|---|
| Component volume fraction, | Design, mole % | Range, mole % |
| $CH_4$ | 94.75 | 98.23-92.25 |
| $C_2H_4$ | 3.75 | 1.07-4.1 |
| $C_3H_8$ | 0.67 | 0.09-1.87 |
| Iso-Butane | 0.05 | 0.01-0.41 |
| N-Butane | 0.05 | 0.01-0.43 |
| Iso-Pentane | 0.00 | 0.0-0.15 |
| N-Pentane | 0.04 | 0.0-0.15 |
| N-Hexane | 0.03 | 0.0-0.09 |
| $N_2$ | 0.55 | 0.43-0.0 |
| $CO_2$ | 0.11 | 0.16-0.55 |
| Total | 100 | |
| Total Sulfur | 8 ppmv max | |
| Pressure | 35 barg | |
| Temperature | 25°C | |
| LHV @ 0 °C & 1.0138 Bara | 8,876.1 Kcal/Nm3 | |

### B.2.1.3 Key Properties

| | SOR | | EOR | |
|---|---|---|---|---|
| | Natural gas | Purge gas | Purge gas | Methanol |
| Specific gravity | 0.584-0.693 | 0.162 | 0.198 | See B.2.1.4 |
| HHV, Btu/scf | 980 -1180 | | | N/A |
| LHV, Btu/scf | | 337 | 335 | 766 |
| B.L. temperature °C | 38 | 40 | 40 | 40 |
| B.L. pressure, bar-g | min. 35 | 66 | 66 | 5 |

Note: SOR – Start of Run
EOR – End of Run

### B.2.1.4 Methanol Product Specifications

The US-government specification for Methanol, grade AA, is as follows:

| Characteristic | Requirements | Test method |
|---|---|---|
| Acetone, wt-%, maximum | 0.002 | See note 1 |
| Acidity (as acetic acid), wt-%, maximum | 0.003 | ASTM E 346 |
| Appearance | Free of opalescence, suspended matter and sediment | See note 2 |
| Carbonizable impurities, color, Platinum-Cobalt (Pt-Co), maximum | No. 30 | ASTM E 346 |
| Color, Pt-Co, maximum | No. 5 | ASTM E 346 |
| Distillation range at 760 mm, maximum | 1.0°C (and shall include 64.6 +/- 0.1°C) | ASTM E 346 |
| Ethanol, wt-%, maximum | 0.001 | ASTM E 346 |
| Nonvolatile matter, mg/100 ml, maximum | 10 | ASTM D 1353 |
| Odor | Characteristic, non-residual | ASTM D 1296 |
| Permanganate time | No discharge of color in 30 minutes | ASTM E 346 |
| Specific gravity at 20/20°C, maximum | 0.7928 | ASTM E 346 |
| Water, wt-%, maximum | 0.10 | ASTM E 346 |

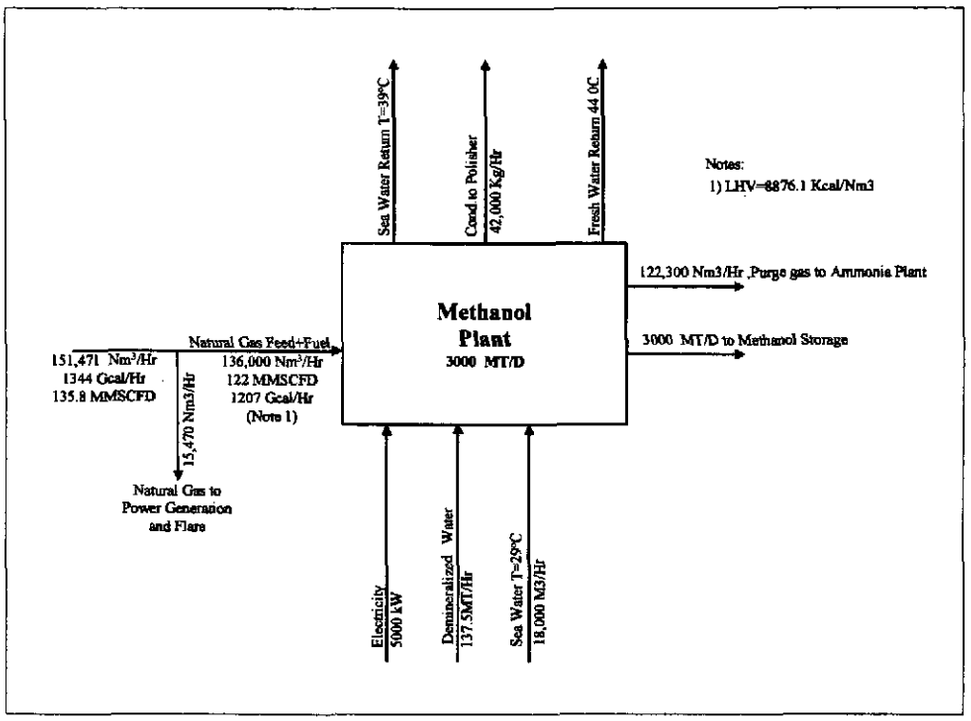
Note 1: Determine the percent by weight acetone in the specimen in accordance with the procedures for acetone in ASTM E 346. Use 1.5 ml of sample and 3.5 ml of water instead of 1 ml of sample and 4 ml of water. Report the acetone content as less than or greater than 0.002 percent by weight.

Note 2: Dilute 15 ml of the specimen to 45 ml with water in a Nessler tube. Visually examine the solution for opalescence, suspended matter and sediment during 30 minutes of standing.

### B.2.1.5 Methanol Block Flow Diagram with Preliminary Material Balance

The methanol plant consumes the natural gas as feed and fuel. The natural gas is reformed into hydrogen, CO, and $CO_2$. Hydrogen is reacted with CO and $CO_2$ to form Methanol. The inputs and products from the methanol plant are shown in Figure 7 – Overall Material and Utility Balance.

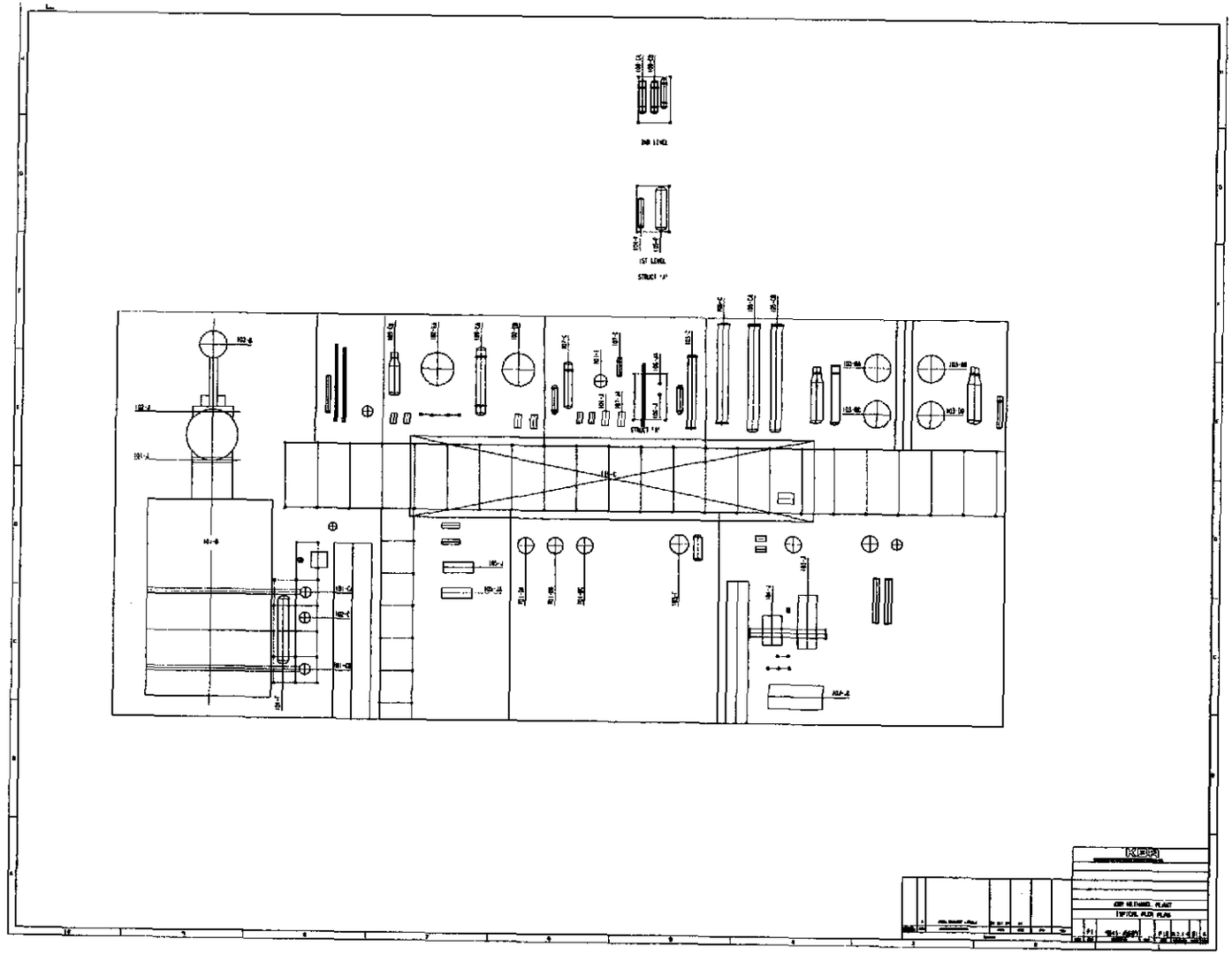
**Figure 7 – Overall Methanol Material and Utility Balance**




## B.2.1.6 Methanol Process Unit Preliminary Plot Plan:

The Methanol Plant would require approximately 25,000 $m^2$ of plot area.

## Preliminary Plot Plan – Methanol



## B.2.2 Ammonia Plant Project Design Basis

### B.2.2.1 Ammonia Feedstock Rates

| | |
|---|---|
| Purge Gas | 2,935,200 $Nm^3$/day (from Methanol plant) |
| Seawater Circulation | 155,950 $m^3$/day (for ISBL Plant, delta T=10°C) |
| Closed Loop Fresh Water Cooling | 97,440 $m^3$/day (delta=12°C) |
| Power | 23,350 kW |

### B.2.2.2 Composition of feedstock

Feedstock (Purge Gas):

| | Start-of-run | End-of-run |
|---|---|---|
| Hydrogen | 86.0 vol-% | 82.9 vol-% |
| Methane | 10.2 vol-% | 10.3 vol-% |
| Carbon dioxide | 1.6 vol-% | 3.0 vol-% |
| Carbon monoxide | 0.9 vol-% | 2.5 vol-% |
| Methanol | 0.8 vol-% | 0.8 vol-% |
| Nitrogen | 0.4 vol-% | 0.4 vol-% |
| Moisture | 0.1 vol-% | 0.1 vol-% |

### B.2.2.3 Key Properties:

| | SOR | EOR | |
|---|---|---|---|
| | Purge gas | Purge gas | Ammonia |
| Specific gravity | 0.162 | 0.198 | 0.684 (-33°C) |
| LHV, Btu/scf | 337 | 335 | N/A |
| B.L. temperature, °C | 40 | 40 | -33°C |
| B.L. pressure, barg | 66 | 66 | 5 |

### B.2.2.4 Ammonia Product Specifications

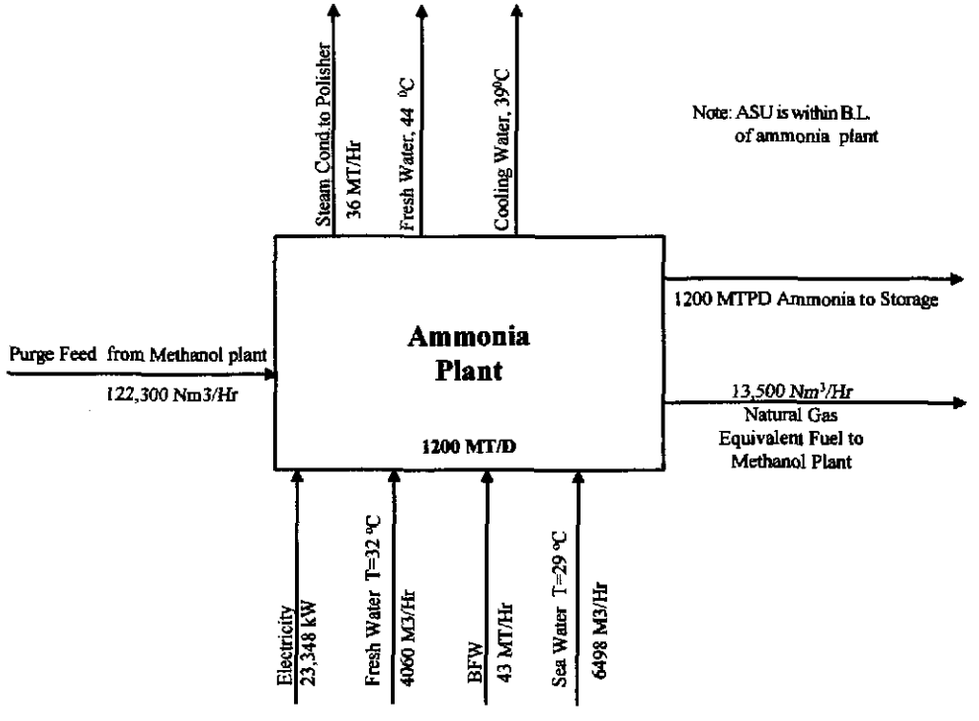
A typical specification for ammonia product is as follows:

| | |
|---|---|
| Ammonia, wt-% minimum | 99.9 |
| Moisture, wt-% maximum | 0.1 |
| Oil, ppmw, maximum | 5 |

B.2.2.5 Ammonia Block Flow Diagram with Preliminary Material Balance

The inputs and products from the ammonia plant are shown in Figure 8 – Overall Material and Utility Balance Ammonia.

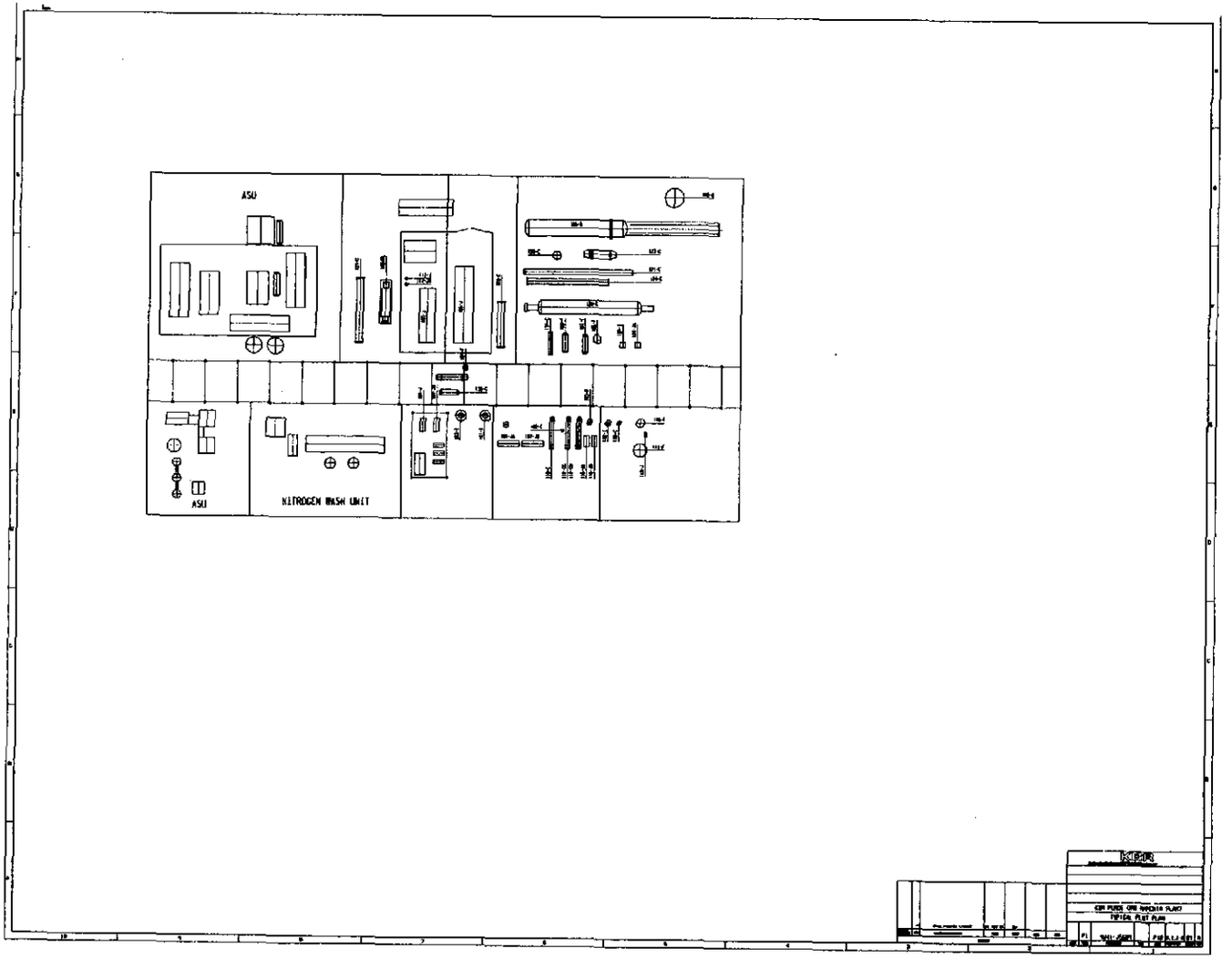
**Figure 8 – Overall Material and Utility Balance Ammonia**



### B.2.2.6 Ammonia Preliminary Plot Plan:

An Ammonia Plant that takes its main feedstock from a methanol plant will require approximately 4,500 $m^2$ plot area. The associated air separation unit (ASU) requires an additional 2,000 $m^2$ plot area.

## Preliminary Plot Plan – Ammonia



### B.2.3 Environmental Mitigation Strategies

In general, the production facilities for Ammonia, Granulated Urea. and Methanol do not generate waste streams, which will create significant environmental problems. The feedstock used for the production facilities and as the source of energy is natural gas with a very low level of sulfur content. Air emissions generated will contain low levels of criteria contaminants, $SO_2$, NOx, CO, and particulate emissions, which are well below the regulated air emission standards set by the Egyptian regulation covered by Law 4.

The major source of wastewater is from the utility systems in the form of blowdown from the seawater cooling tower, process and utility boilers and the backwash and effluents from water treatment. Aqueous waste streams from the production facilities are primarily process steam condensate, which is treated within the process for recovery and reuse as makeup water to steam generation and process unit operations. Apart from neutralization of demineralizer regenerant wastewater waste streams, these streams will meet the contaminant levels specified under Law 4 without further treatment. The exception to this is sanitary wastewater from the various plant buildings, which will require treatment in an onsite package biological treatment system to meet water quality criteria required by Law 4.

Site wastes generated during the construction phases will be collected at the site. They will be segregated and stored in bins or hoppers in defined storage areas. Where possible, the materials will be recycled within the local Egyptian economy, disposed of in existing land fill areas or by local noxious/hazardous waste facilities. In the event of such facilities not being available, the EPC contractor will evaluate the costs of developing such facilities or exporting the noxious waste to handling facilities outside of Egypt.

The solid waste generated by the production facilities include spent catalyst, containing valuable metals, which will be returned to the catalyst manufacturers. Other process solid waste streams including catalyst, desiccants and ion exchange resins, stabilized biological sludge are inert non-hazardous material that can be disposed of at an offsite landfill along with miscellaneous trash/garbage sources generated at the facility.

**Operational Phase Effluents**

- Effluent Summary

Liquid waste would be produced at several stages of the operational phase. A description of the key sources, quantity and composition of waste streams associated with the proposed facility follows along with the proposed mitigation strategy.

| Methanol Process | | | |
|---|---|---|---|
| Source | Flow Rate | Components and Temperature | Environmental Mitigation Strategy |
| Saturator Blow Down | 3.5 (kg/MT MeOH) | Water<br>pH: 10 – 12<br>BOD (mg/l): <210<br>COD (mg/l): < 375<br>Methanol (mg/l): <250<br>Carbon dioxide (mg/l): <150<br>Methane (mg/l): <10<br>TSS (mg/l): <30 | Meets Egyptian regulations covered by Law 4. Discharge to Outfall Sewer where diluted by Seawater |
| Steam System Blow Down | 44 (kg/MT MeOH) | Water<br>pH: 9 – 10<br>BOD (mg/l): <10<br>COD (mg/l): <10<br>TSS (mg/l): <10 | Meets Egyptian regulations covered by Law 4. Discharge to Cooling Tower |

| Ammonia Process | | | |
|---|---|---|---|
| Steam System Blow Down | 400 kg/hr | Water<br>COD (mg/l): < 10 | Meets Egyptian regulations covered by Law 4. Discharged to Cooling Tower |
| Process Air Compressor Condensate | 4100 kg/hr | Clean Water | Meets Egyptian regulations covered by Law 4. Discharged to Cooling Tower |
| **Utilities and Offsites** | | | |
| Sanitary System | 48700 kg/day (Approx 48.7 $m^3$/day) | Temperature (°C): Ambient | Sanitary Treatment System (settling of suspended solids, biological treatment, and chlorination) and discharged to Outfall Sewer |
| Cooling Tower Blowdown | 2360 t/hr | Water<br>(2 cycles of concentration) | Low Cycle of Concentration. Discharge to Outfall Sewer |
| Desalination Unit Reject | 1271 t/hr | Water | Low Cycle of Concentration. Discharge to Outfall Sewer |
| Boiler Blowdown | 0.6 t/h | Water | Meets Egyptian regulations covered by Law 4. Discharged to Cooling Tower |

| | | | |
|---|---|---|---|
| Demineralized Water Plant Effluent | 225 (kg/MT MeOH) | Water Temperature: 45°F | Neutralized in Neutralization Tank and discharged to Outfall Sewer where diluted by Seawater |

- Emission Summary

Gaseous emissions would be produced by several processes of the project. A description of the key sources, quantity and composition of these emissions follows along with the proposed mitigation strategy.

| **Methanol Process** | | | |
|---|---|---|---|
| Source | Flow rate | Components | Environmental Mitigation Strategy |
| Reformer Flue Gas | 4,465 $Nm^3$/MT MeOH | Temperature (°C): 180<br>$O_2$: 1.7 mol%<br>$N_2$: 70.1 mol%<br>$CO_2$: 8.5 mol%<br>$H_2O$: 19.7 mol%<br>[b] $SO_2$: 0.45 ppmw<br>[a] NOx: See Note | Sulfur level of natural gas to be less than 8 ppmv, resulting in $SO_2$ emissions of 0.5 ppmv, below the Egyptian limit of 1100 ppmv.<br><br>Conventional burners are capable of controlling $NO_x$ to 150 ppmv, below Egyptian limit of 155 ppmv. |
| Boiler Flue Gas | 390 $Nm^3$/MT MeOH | $O_2$: 1.7 mol%<br>$N_2$: 70.1 mol%<br>$CO_2$: 8.5 mol%<br>$H_2O$: 19.7 mol%<br>[b] $SO_2$: 0.45 ppmw<br>[a] NOx: See Note | Sulfur level of natural gas to be less than 8 ppmv, resulting in $SO_2$ emissions of 0.5 ppmv, below the Egyptian limit of 1100 ppmv.<br><br>Conventional burners are capable of controlling $NO_x$ to 150 ppmv, below Egyptian limit of 155 ppmv. |
| Deaerator Vent | 10 $Nm^3$/MT MeOH | Temperature (°C): 109°C Steam | None Required |
| Converter Catalyst Oxidation Vent | Occurs for a period of 24 – 36 hours at catalyst change | Temperature (°C): 50<br>$O_2$: 2.0 mol%<br>$N_2$: 98.0 mol% | No Pollutants |

| | | | |
|---|---|---|---|
| Tanks:<br>- Crude Methanol Tank<br>- Refined Methanol Shift Tank Vent<br>- Methanol Product Storage Vent | Subject to equipment size | $N_2$ with low methanol | Floating roof type product tanks to minimize vapor emissions. |
| Miscellaneous Emissions:<br>- Flare Gases<br>- Firewater Pump Diesel Driver<br>- Sample Point Vents<br>- Atmospheric Vents | Subject to equipment size | Combustion products of natural gas / diesel<br><br>Small intermittent flows of process gas<br><br>Releases due to upset | Emission levels low and / or intermittent. |
| **Ammonia Process** | | | |
| $CO_2$ | 4,100 $Nm^3/hr$ | No Sulfur Compounds | High vent to disperse flow.<br><br>No Egyptian regulations which limit $CO_2$ emissions. |
| Oxygen Vent | 25,000 $Nm^3/hr$ | $O_2$: 59 vol%<br>$N_2$ + Ar: 41 vol% | No Pollutants |
| Dryer Vent | 9,600 $Nm^3/hr$ | No Pollutants | No Pollutants |
| **Utilities and Offsites** | | | |
| Gas Turbine Generator Exhaust | 326,349 $Nm^3/hr$ | Temperature (°C): 230<br>$O_2$: 12.3 mol%<br>$N_2$: 76.1 mol%<br>$CO_2$: 4.0 mol%<br>$H_2O$: 7.7 mol%<br>[a] NOx: See Note | Sulfur level of natural gas to be less than 8 ppmv, resulting in $SO_2$ emissions of ~0.5 ppmv, below the Egyptian limit of 1100 ppmv.<br><br>Conventional burners are capable of controlling $NO_x$ to 150 ppmv, below Egyptian limit of 155 ppmv. Provisions for water / steam injection. |

| | | | |
|---|---|---|---|
| Package Boiler | 37,806 $Nm^3/hr$ | Temperature (°C): 315<br>$O_2$: 2.5 mol%<br>$N_2$: 72.6 mol%<br>$CO_2$: 8.5 mol%<br>$H_2O$: 16.3 mol%<br>[b] $SO_2$: 0.45 ppmw<br>[a] NOx: See Note | Sulfur level of natural gas to be less than 8 ppmv, resulting in $SO_2$ emissions of 0.5 ppmv, below the Egyptian limit of 1100 ppmv.<br><br>Conventional burners are capable of controlling $NO_x$ to 150 ppmv, below Egyptian limit of 155 ppmv. Provisions for water / steam injection |
| | | | |

[a] Meets World bank standards for NOx emissions averages
[b] based on a maximum natural gas Sulphur content of 5ppm (vol)

- Noise Mitigation

The law is found to set different noise level criteria at different periods of the day/night within an industrial zone. The reason is that many of the industrial areas in Egypt are intermingled within residential areas, thus requiring more stringent criteria.

During meetings with EEAA officials, it was indicated that in cases where proper noise modeling provides evidence that no significant residential noise impacts would arise from the normal higher noise levels, the facility would be granted an approval for operation. To achieve this, additional noise insulation requirements will be enforced to insulate equipment, valves and piping that are sources of excessive noise.

## B.3 TECHNOLOGY SCREENING ANALYSIS

### B.3.1 Methanol Technology Screening

The potential process licensors are:

Lurgi Oel Gas Chemie GmbH

Mitsubishi Gas Chemical Company

One Synergy (Johnson Matthey Catalysts/Davy Process Technology/Aker Kvaerner Inc.)

Haldor Topsoe A/S

Uhde GmbH

Information on the process technology offered by Lurgi, One Synergy, Haldor Topsoe, and Uhde is presented in Sections B.4.1 through B.4.4. Mitsubishi uses proprietary catalyst in the methanol synthesis section and offers a quench design for the synthesis converter as well as a

steam producing design. Mitsubishi allows their approved contractors to supply their own synthesis gas generation section of the methanol plant.

It was discussed in Section B.1.1 that a steam-reforming process is needed for the methanol plant, as opposed to an autothermal reforming process. This is in order to yield sufficient purge gas for the required ammonia production. Steam reforming is the traditional method to make synthesis gas for methanol. It is a mature technology offered by all of the process licensors, and Granherne considers their technology to be very competitive.

Detailed Technology Assessment

Granherne's evaluation is summarized in the Kepner Tregoe tabulation included at the end of this section.

The most important criterion for selection of a process licensor is the demonstrated commercial experience of their technology. While all five licensors can be considered to have commercially demonstrated technology, Lurgi and One Synergy are clearly the leaders in the field.

This study is based on typical technical information, which the process licensors were willing to disclose without secrecy agreement and without charge. As mentioned above, it is Granherne's opinion that the various licensors' technology is very competitive. This means that the capital cost difference between designs optimized for a particular application will be set more by the aggressiveness of the bidding contractor than by the underlying technology. Also, no major differences in safety, reliability, operating cost, maintenance cost, or plant effluents will exist between designs optimized for a particular application. The optimization will reflect design parameters set during the technical discussions between Owner and Process Licensor/Contractor. This will take place during the firm design phase, after appropriate secrecy agreements have been signed.

The final licensor selection will be determined by the commercial terms offered with a firm bid.

## Table B.3.1 - KEPNER TREGOE ANALYSIS –METHANOL

| Process licensor | | | Lurgi | | | Mitsubishi | | | One Synergy | | | Topsoe | | | Uhde | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Criterion # | Factor | Weight | Facts | Score | Weighted score | Facts | Score | Weighted score | Facts | Score | Weighted score | Facts | Score | Weighted score | Facts | Score | Weighted score |
| 1 | Number of commercial plants licensed | 10 | 35 plants | 10 | 100 | A few plants | 2 | 20 | 63 plants | 10 | 100 | A few plants | 2 | 20 | 11 plants built and revamped | 5 | 50 |
| 2 | Capital cost | 3 | Competitive | 10 | 30 | Competitive | 10 | 30 | Competitive | 10 | 30 | Competitive | 10 | 30 | Competitive | 10 | 30 |
| 3 | Safety | 3 | Competitive | 10 | 30 | Competitive | 10 | 30 | Competitive | 10 | 30 | Competitive | 10 | 30 | Competitive | 10 | 30 |
| 4 | Reliability | 3 | Competitive | 10 | 30 | Competitive | 10 | 30 | Competitive | 10 | 30 | Competitive | 10 | 30 | Competitive | 10 | 30 |
| 5 | Operating cost | 3 | Competitive | 10 | 30 | Competitive | 10 | 30 | Competitive | 10 | 30 | Competitive | 10 | 30 | Competitive | 10 | 30 |
| 6 | Maintenance cost | 3 | Competitive | 10 | 30 | Competitive | 10 | 30 | Competitive | 10 | 30 | Competitive | 10 | 30 | Competitive | 10 | 30 |
| 7 | Plant effluents | 3 | Competitive | 10 | 30 | Competitive | 10 | 30 | Competitive | 10 | 30 | Competitive | 10 | 30 | Competitive | 10 | 30 |
| 8 | **Total weighted score** | | | | **280** | | | **200** | | | **280** | | | **200** | | | **230** |

## B.3.2 Ammonia Technology Screening

There are currently three major established process licensors for ammonia production technology:

KBR (Kellogg Brown & Root, Inc.)

Haldor Topsoe A/S

Uhde GmbH

All three licensors have solid experience with normal ammonia plants fed with natural gas. The licensors' experience with designs specifically relevant to Echem's Methanol and Ammonia Project is as follows:

Since 1977, KBR has started up three ammonia plants using liquid nitrogen wash to clean feed gases consisting of byproduct hydrogen. Two of those plants are fed with purge gas from methanol plants, i.e., exactly the same process configuration as required for Echem's Methanol and Ammonia Project. In addition, KBR has for many years used liquid nitrogen wash in its Purifier ammonia plants. Seventeen plants of this type have been built, and KBR has recently licensed three ammonia synthesis loops, which are fed with gasifier gas cleaned by liquid nitrogen wash.

Topsoe has licensed one ammonia plant using methanol purge gas as feed; however, the purification of the feed gas was by pressure swing adsorption (PSA) as opposed to liquid nitrogen wash. As discussed in Section B.1.3, the PSA method does not yield the amount of hydrogen required for this project. Topsoe has also licensed five plants co-producing methanol and ammonia using a different technology not relevant for this project. The methanol production capacities for these co-producing plants were rather small when compared to the requirements for this project, ranging from 72 to 400 mtpd.

Since 1967, Uhde has completed two ammonia plants based on gasifier gas while using liquid nitrogen wash. One was a new plant, and the other was a revamp. A third plant, also fed with gasifier gas, uses PSA purification. Uhde has no experience with ammonia production from methanol plant purge gas.

Detailed Technology Assessment

Granherne's evaluation is summarized in the Kepner Tregoe tabulation included at the end of this section.

The most important criterion for selection of a process licensor is the demonstrated commercial experience of their technology. For the ammonia plant, KBR is the only licensor who has directly applicable experience (same kind of feed and same process scheme).

This study is based on typical technical information, which the process licensors were willing to disclose without secrecy agreement and without charge. It is Granherne's opinion that the various licensors' technology is very competitive. This means that the capital cost difference between designs optimized for a particular application will be set more by the aggressiveness of the bidding contractor than by the underlying technology. Also, no major differences in safety, reliability, operating cost, maintenance cost, or plant effluents will exist between designs optimized for a particular application. The optimization will reflect design parameters set during the technical discussions between Owner and Process Licensor/Contractor. This will take place during the firm design phase, after appropriate secrecy agreements have been signed.

KBR is recommended based on their commercial experience with the specific feed and the required kind of ammonia plant.

Subsystems

Within the purge gas ammonia plant, there are several major sub-systems. Following is a brief discussion of how they were selected for this study.

Carbon dioxide may be removed by several process technologies. Recently, KBR has used the MDEA process and the Benfield process in ammonia plants. Both are well demonstrated. For this study, KBR chose the MDEA process, following the trend of the most recent ammonia plants.

The air separation unit may be provided by any of six vendors: Air Products and Praxair of the U.S., BOC of the U.K., Linde and Messer of Germany and Air Liquide of France. The technology is well demonstrated and very competitive. The final selection will be determined by the commercial terms offered with a firm bid. For this study, data from Linde was used. Linde delivered the air separation units and liquid nitrogen wash units for three recent gasification-based ammonia plants in China, which use KBR synthesis loops.

Molecular sieve dryers may be provided by UOP of the U.S., Linde of Germany and others. The technology is well demonstrated and very competitive. The final selection will be determined by the commercial terms offered with a firm bid. For this study, KBR used information from Linde, in order to minimize interface problems.

KBR offers two commercially demonstrated technologies for the ammonia synthesis loop: the KAAP technology and the horizontal converter. For this study, KBR chose to use a horizontal converter design, allowing the use of conventional catalyst available from several suppliers and

eliminating the need for a heavy crane for catalyst replacement. The horizontal converter design has been used in two of KBR's three purge gas ammonia plants and in the three KBR gasification/nitrogen wash ammonia plants in China.

## Table B.3.2 - KEPNER TREGOE ANALYSIS –AMMONIA

| Process licensor | | | KBR | | | Topsoe | | | Uhde | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Criterion # | Factor | Weight | Facts | Score | Weighted score | Facts | Score | Weighted score | Facts | Score | Weighted score |
| 1 | Number of commercial ammonia plants licensed, fed with methanol plant purge gas, and using liquid nitrogen wash. | 10 | 2 plants | 2 | 20 | None | 0 | 0 | None | 0 | 0 |
| 2 | Number of commercial ammonia plants licensed, fed with hydrogen from other source, and using liquid nitrogen wash. | 5 | 1 plant<br>3 synthesis loops | 1<br>3 x 0.3 | 5<br>4.5 | None | 0 | 0 | 1 new plant<br>1 revamp | 1<br>0.5 | 5<br>2.5 |
| 3 | Capital cost | 3 | Competitive | 1 | 3 | Competitive | 1 | 3 | Competitive | 1 | 3 |
| 4 | Safety | 3 | Competitive | 1 | 3 | Competitive | 1 | 3 | Competitive | 1 | 3 |
| 5 | Reliability | 3 | Competitive | 1 | 3 | Competitive | 1 | 3 | Competitive | 1 | 3 |
| 6 | Operating cost | 3 | Competitive | 1 | 3 | Competitive | 1 | 3 | Competitive | 1 | 3 |
| 7 | Maintenance cost | 3 | Competitive | 1 | 3 | Competitive | 1 | 3 | Competitive | 1 | 3 |
| 8 | Plant effluents | 3 | Competitive | 1 | 3 | Competitive | 1 | 3 | Competitive | 1 | 3 |
| 9 | **Total weighted score** | | | | **47.5** | | | **18** | | | **25.5** |

## B.4 LICENSOR INFORMATION

### B.4.1 Methanol Licensors

#### B.4.1.1 Process Description

The methanol process uses a combination of Davy Process Technology's (DPT) and Johnson Matthey Catalysts (One Synergy) technologies (jointly known as One Energy), as follows, to produce IMPCA Reference grade methanol:

- DPT's CRG Pre-reforming Technology
- DPT's Steam Reforming Technology
- DPT's Low Pressure Synthesis Technology
- DPT's Radial Flow Steam Raising Converter Technology
- Two Column Distillation

All process equipment is single train. The plant is designed for following natural gas composition and supply conditions.

| Component | Volume % |
|---|---|
| Nitrogen | 0.55 |
| Methane | 94.75 |
| Ethane | 3.75 |
| Propane | 0.67 |
| I-Butane | 0.05 |
| N-Butane | 0.05 |
| I-Pentane | 0.00 |
| N-Pentane | 0.04 |
| Hexane | 0.03 |
| Heptane | 0.00 |
| Carbon Dioxide | 0.11 |
| Sulfur Level (as H2S), ppmv | 8 |
| LHV (HHV), KCal/Nm$^3$ | 8,876 (9,843) (0°C, 1.014 bar abs) |
| Supply Pressure, barg | 35 |
| Supply Temperature °C | 38 |

A Process Flow Diagram for the LCM methanol process is included in Section B.4.1.2. The process includes a series of steps, many of which are promoted by catalysts. The process steps are as follows:

a. Methanol Feedstock Desulfurization

b. Methanol Synthesis Gas Production

c. Methanol Synthesis

d. Distillation

e. Steam System

a. Methanol Feedstock Desulfurization

Natural gas feed is provided at the ammonia plant ISBL at 38°C and 35 barg. After removing its entrained liquid with a knockout drum, the natural gas mixes with a recycle stream of hydrogen-rich purge gas from the synthesis loop. The mixed gas is preheated in the Desulfurization Pre-heater using heat from the Reformed Waste Heat Duct. The preheated gas is then desulfurized in two steps. In the first step, the heated gas passes through a Hydrotreater, which contains a cobalt/molybdenum oxide (CoMox) catalyst. The CoMox ensures hydrogenation of organic sulfur compounds (if present) into hydrogen sulfide. In the second step, the hydrogen sulfide is removed in two desulfurizer vessels, each containing a bed of zinc oxide catalyst. The hydrogen sulfide reacts with and is retained by the bed of zinc oxide producing an effluent stream containing less than 0.1 ppmv sulfur. These two vessels are arranged in a series "lead-lag" configuration such that either vessel can be taken off-line for catalyst change out while the other remains in service.

b. Methanol Synthesis Gas Production

The desulfurized natural gas is mixed with medium pressure steam. The CRG pre-reformer feed is preheated in the Reformer Waste Heat Duct. In the CRG pre-reformer, the heavier hydrocarbons are broken down into lighter components over the catalyst in an endothermic reaction. The pre-reformed natural gas is then reheated in the Reformer Waste Heat Duct before entering the Reformer.

The reformer consists of a rectangular insulated structure containing vertically supported tubes filled with catalyst. The endothermic heat of reaction is supplied from downward firing burners situated in the roof of the reformer. The reformer feed reacts over the catalyst with the steam to form a mixture of carbon oxides, hydrogen, residual methane, and water in the form of steam.

The reformed gas is then cooled by raising HP steam and providing reboiler heat for distillation in the purification section of the plant. The water is condensed and removed as process condensate leaving a mix of carbon oxides and hydrogen which is referred to as synthesis gas. The process condensate is returned to the demineralization plant for treatment.

c. Methanol Synthesis

The synthesis gas generated by the reformer is compressed in a two-stage steam turbine driven centrifugal compressor. The compressed synthesis gas mixes with unconverted circulating gas and is preheated in an interchanger before passing to the Methanol Converter. The gas flows in a radial pattern out from the center of the Methanol Converter passing over the methanol synthesis catalyst. The temperature in the catalyst bed is controlled by raising MP steam, which can be used as part of the steam feed to the reformer.

The hot gas leaving the Converter is cooled in the interchanger before passing to the Loop Condenser and Crude Methanol Separator. The crude methanol/water mixture is separated from the unconverted gases which are recycled to the Methanol Converter by the loop Circulator.

A small purge is taken to control the inerts in the loop. Part of this is recycled to the desulfurization system; the remainder is sent to the ammonia plant as hydrogen feed.

The crude methanol is passed to the distillation section for product purification.

d. Distillation

The methanol product is purified in a two-column system to produce the required specification. In the topping column, light by-products are removed which can be used as fuel in the reformer.

In the refining column, the material product is taken overhead with water removed from the bottoms. Small quantities of ethanol and butanol (known as fusal oil) are removed near the base of the column.

The heat for distillation is provided by the reformed gas and supplemented by LP steam, as required.

e. Methanol Steam System

Steam raised by heat recovery from the synthesis gas and Reformed Waste Heat Recovery Duct is used to drive turbines.

High pressure steam from the superheater drives the Synthesis Gas Compressor Turbine which is an extraction/condensing type unit. The extraction flow to the medium pressure (MP) level

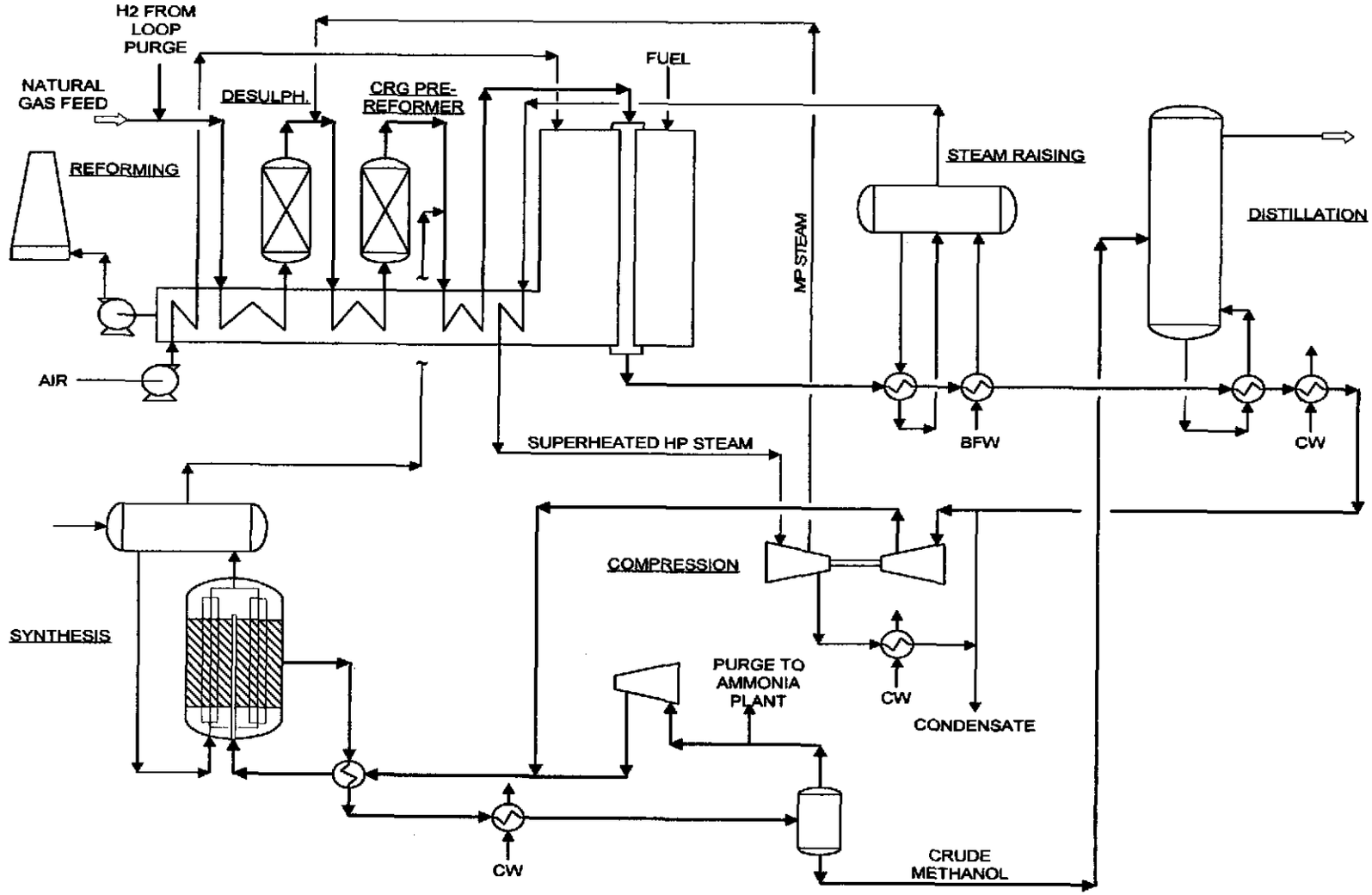
provides steam for the Reformer and MP Steam driven turbines. Steam condensate from a Compressor Turbine Condenser can be returned to the demineralization plant for treatment.

The smaller turbines driving the BFW Pump, Combustion Air and Flue Gas Fans, and miscellaneous pumps are back pressure machines taking steam from the MP level and exhausting to the LP level. Steam for the reformer is also supplied from the MP level. When the Synthesis Gas Compressor is not operational, MP steam is supplied by letting down HP steam and/or MP import from an auxiliary boiler.

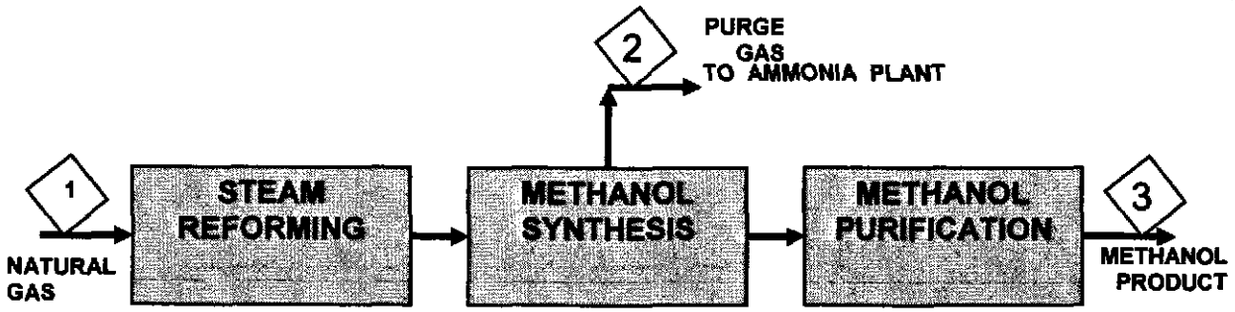
To meet steam demand during start-up and turndown conditions, MP steam may need to be imported.

Low pressure (LP) steam is required by the process to supply heating steam to the Refining Column Reboiler and to the Deaerator.

## B.4.1.2 Preliminary Methanol Process Flow Diagram



## B.4.1.3 Methanol Process Material Balance




| | Natural Gas Feed | Purge Gas To Ammonia Unit | Methanol Product |
|---|---|---|---|
| Stream No. | 1 | 2 | 3 |
| Phase | Vapor | Vapor | Liquid |
| Volume % Dry | | | |
| H2 | | 82.9 | |
| N2 | 0.55 | 0.4 | |
| CH4 | 94.75 | 10.3 | |
| CO | | 2.5 | |
| CO2 | 0.11 | 3.0 | |
| O2 | | | |
| C2H6 | 3.75 | | |
| C3H8 | 0.67 | | |
| IC4 | 0.05 | | |
| NC4 | 0.05 | | |
| IC5 | 0.00 | | |
| NC5 | 0.04 | | |
| C6 | 0.03 | | |
| H2O | 0.00 | 0.1 | |
| Methanol | | 0.8 | 100.00 |
| Total | 100.00 | 100.00 | 100.00 |
| Total Flow kmol/hr | 4,496.7 | 5,456.5 | 3,901.1 |
| Total Flow kg/hr | 76,170 | 31,266 | 125,000 |
| Temperature °C | 38.0 | 40.0 | 45 |
| Pressure Bar, abs | 36 | 67 | 3 |

### B.4.1.4 Methanol Utilities Consumption Estimate

| | |
|---|---|
| Natural Gas Feed | 100,788 $Nm^3/hr$ |
| Natural Gas Fuel | 35,212 $Nm^3/hr$ |
| Fuel from Ammonia Plant | 13,500 $Nm^3/hr$ of equivalent natural gas |
| Net Demineralized Water | 137.5 T/hr (recycle condensates credited) |
| Seawater Circulation | 18,000 $m^3/hr$ (for ISBL Plant, delta T=10°C) |
| Closed Loop Fresh Water Cooling | 10,200 $m^3/hr$ (delta=12°C) |
| Power | 5,000 kW |

### B.4.1.5 Methanol Catalyst and Chemicals Consumption Estimates

| VESSEL | DESCRIPTION | CATALYST TYPE |
|---|---|---|
| 101-B | Steam Reformer Furnace | Nickel Reforming |
| 102-D | Pre-Reformer | High Nickel Content |
| 103-D | Methanol Synthesis Converter | Cu on $Al_2O_3$/CaO with promoter |
| 108-D | Hydrotreater | Co-Mo |
| 101-DA/DB | Desulfurizers | Zinc Oxide |

Chemicals consumed in the Methanol process:

- Caustic (Caustic dosing package)
- Phosphate $Na_2HPO_4$ / $NA_3PO_4$ (BFW dosing package)
- Amine (Oxygen scavenger)

The estimated catalyst and chemical consumption for the methanol process is:

- Total Catalyst and Chemicals cost/MT of methanol: $2.27/MT.

### B.4.1.6 Methanol Major Equipment List

ISBL Methanol Unit

| ITEM NO. | DESCRIPTION |
|---|---|
| **Class B: Fired Heaters** | |
| 101-B | Steam reformer Furnace |
| 102-B | Stack |
| **Class C: Exchangers** | |
| 101-C | Reformer Effluent Steam Generator |
| 102-C | Reformer Effluent BFW Heater |
| 103-C | Reformer Effluent Water Cooler |
| 104-C | Compressor Recycle Cooler |
| 105-C | Reactor Feed/Effluent Interchanger |
| 106-C | Loop Condenser |
| 107-C | Topping Column Reboiler |
| 108-C | Topping Column Overhead Condenser |
| 109-C | Refining Column Reboiler |
| 110-C | Refining Column Overhead Condenser |
| 111-C | Methanol Converter Effluent Water Cooler |
| **Class D: Reactors** | |
| 101-DA/DB | Desulfurizers |
| 102-D | Pre-Reformer |
| 103-D | Methanol Converter |
| 108-D | Hydrotreater |
| **Class E: Towers** | |
| 101-E | Topping Column |
| 102-E | Refining Column |
| **Class F: Vessels** | |
| 101-F | Reformer Steam Drum |
| 102-F | Syn Gas Condensate Separator |
| 103-F | Crude Methanol Separator |
| 104-F | Synthesis Gas Compressor Suction Drum |
| 105-F | Synthesis Converter Steam Drum |
| 106-F | Topping Column Reflux Drum |
| 107-F | Refining Column Reflux Drum |
| 108-F | Fusel Oil Drum |

Class F: Tanks

| | |
|---|---|
| 114-F | Crude Methanol Tank |
| 115-F | Refined Methanol Shift Tank |

Class J: Pumps and Compressors

| | |
|---|---|
| 101-J | Forced Draft Fan |
| 101-JT | Steam Turbine for 101-J |
| 102-J | Induced Draft Fan |
| 102-JT | Turbine for 102-J |
| 103-J | Synthesis Gas Compressor |
| 103-JT | Turbine for 103-J |
| 103-JTC | Surface Condenser |
| 104-J | HP BFW Pump |
| 104-JT | Turbine for 104-J |
| 104-JA | Spare for 104-J |
| 104-JAM | Motor for 104-JA |
| 108-J | Loop circulator |
| 108-JM | Motor for 108-J |
| 112-J | Condensate Pump for 103-JTC |
| 112-JM | Motor for 112-J |
| 112-JA | Spare for 112-J |
| 112-JAM | Motor for 112-JA |
| 113-J | Process Condensate Pump |
| 113-JM | Motor for 113-J |
| 113-JA | Spare for 113-J |
| 113-JAM | Motor for 113-JA |
| 116-J | Crude Methanol Pump |
| 116-JA | Spare for 116-J |
| 116-JAM | Motor for 116-JA |
| 117-J | Topping Column Reflux Pump |
| 117-JM | Motor for 117-J |
| 117-JA | Spare for 117-J |
| 117-JAM | Motor for 117-JA |
| 121-J | Refining Column reflux Pump |
| 121-JM | Motor for 121-J |
| 121-JA | Spare for 121-J |
| 121-JAM | Motor for 121-JA |
| 161-J | Fusel Oil Pump |
| 161-JM | Motor for 161-J |
| 161-JA | Spare for 161-J |
| 161-JAM | Motor for 161-JA |
| 162-J | MP Boiler Feedwater Pump |
| 162-JM | Motor for 162-J |
| 162-JA | Spare for 162-J |
| 162-JAM | Motor for 162-JA |
| 181-J | Product Transfer Pump |
| 181-JM | Motor for 181-J |

| | |
|---|---|
| 181-JA | Spare for 181-J |
| 181-JAM | Motor for 181-JA |
| 190-J | Methanol Sump Pump |
| 190-JM | Motor for 190-J |

Class L: Special Equipment

| | |
|---|---|
| 102-L | Crude Methanol Filter |
| 104-L | Caustic Dozing package |
| 105-L | BFW Dozing Package |
| 143-L | Natural Gas Filter |

Class U: Utility Equipment

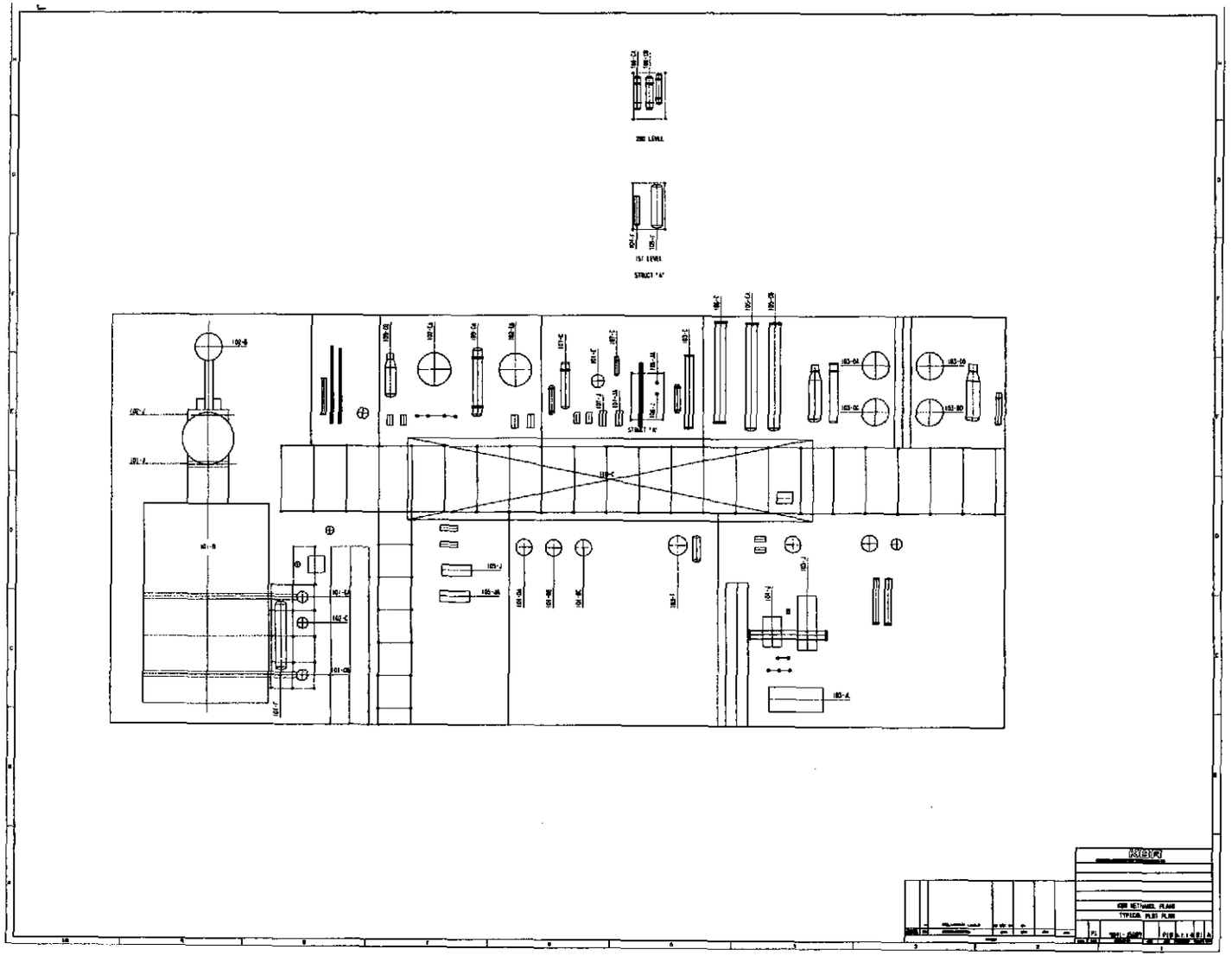
| | |
|---|---|
| 101-U | Deaerator |

Refer to Section B.5.7.10 for the OSBL equipment list.

### B.4.1.7 Methanol Space Requirement and Preliminary Plot Plan

The Methanol Plant occupies and estimated plot are of 25,000 $m^2$.

## Preliminary Plot Plan – Methanol



## B.4.2 Ammonia

### B.4.2.1 Ammonia Process Description

The ammonia process uses KBR's process for producing ammonia from the methanol plant purge gas.

All process equipment is single train. The plant is designed for the following purge gas composition and supply conditions.

| | Start-of-run | End-of-run |
|---|---|---|
| Hydrogen | 86.0 vol-% | 82.9 vol-% |
| Methane | 10.2 vol-% | 10.3 vol-% |
| Carbon dioxide | 1.6 vol-% | 3.0 vol-% |
| Carbon monoxide | 0.9 vol-% | 2.5 vol-% |
| Methanol | 0.8 vol-% | 0.8 vol-% |
| Nitrogen | 0.4 vol-% | 0.4 vol-% |
| Moisture | 0.1 vol-% | 0.1 vol-% |
| Supply pressure, bara | | 67 |
| Supply temperature, °C | | 40 |

The process flow diagrams for the ammonia plant are included in Section B.4.2.2. The process includes a series of steps. The process steps are as follows:

a. Water Wash

b. Bulk Carbon Dioxide Removal

c. Nitrogen Wash

d. Air Separation Unit

e. Ammonia Synthesis and Refrigeration

#### a. Water Wash

The first process step in the purge gas ammonia plant is a water wash, to remove residual methanol and other organic compounds from the purge gas. The wash is performed in a

packed column. The wash water is drawn from the purification section of the methanol plant and pumped to the necessary pressure. The spent water is recycled to the methanol plant.

b. Bulk Carbon Dioxide Removal

The second process step in the purge gas ammonia plant is bulk carbon dioxide removal. This is accomplished in an absorber-stripper system using a solution of methyl-diethanol amine (MDEA) in water as the absorption liquid. The absorption takes place at the pressure of the feed gas stream, and moderate temperature. The rich solution is regenerated in a $CO_2$ stripper by a combination of flashing, caused by pressure reduction, and heating, caused by reboiling. The separated carbon dioxide is washed with water to prevent loss of MDEA, cooled, and discharged to the atmosphere.

The regenerated solution is cooled and pumped back up to absorption pressure. A fraction of the regenerated (lean) solution is filtered to catch particles, which could cause foaming.

A sump is provided to catch any discharges of solution. The solution is returned to the process system, keeping MDEA out of the plant wastewater system. A storage tank sized to hold the total inventory of solution in the process system is provided for storage during shutdowns.

The cleaned process gas leaving the top of the absorber passes through a knockout drum to remove any carry-over solution. The gas is then cooled by two stages of ammonia refrigeration. The condensed water is used as wash water in the top of the $CO_2$ stripper.

c. Nitrogen Wash

Moisture and the remaining carbon dioxide are removed from the purge gas by solid adsorbent. The adsorbent is regenerated by nitrogen from an air separation unit, with the regeneration gas vented to the atmosphere.

The purge gas is then washed with liquid nitrogen to remove the methane and carbon monoxide. The nitrogen wash, which is performed in an auto-refrigerated cryogenic system, also adds the correct amount of nitrogen for the ammonia synthesis.

The purge gas and the feed nitrogen are cooled by heat exchange with the synthesis gas and the vent gas. The separation of the impurities from the purge gas takes place in an absorption column, where the purge gas is washed with liquid nitrogen, vaporizing part of the nitrogen. The products from the column leave through the heat exchangers to cool the feeds. The pressure reduction of the vent gas provides sufficient refrigeration for the nitrogen wash system so that no external refrigeration is needed.

d. Air Separation Unit

The air separation unit provides the nitrogen for the nitrogen wash and for the dryer regeneration. The air separation unit employs a standard design. The process steps are as follows:

- Pre-cooling of air in direct-contact air cooler and chilled-water refrigeration unit.
- Air purification by molecular sieves.
- Double cryogenic rectification column with sieve trays.
- Expansion turbine driving booster compressor.

The oxygen separated from the nitrogen is vented back to the atmosphere.

e. Ammonia Synthesis and refrigeration

The synthesis gas enters a synthesis gas compressor, which increases the pressure of the gas to the level needed for the ammonia synthesis. The compressed gas is heated against the converter effluent in a heat exchanger and then directed to the ammonia synthesis converter.

The ammonia synthesis converter uses KBR's well-proven horizontal intercooled design. The converter has four catalyst beds and two built-in heat exchangers. The catalyst beds and heat exchangers are all mounted in a basket, which can be removed from the shell by a wheel-and-track arrangement. This means that a heavy-duty crane is not needed for catalyst replacement. The converter provides three equilibrium stages of reaction, and all of the feed passes through all of the catalyst. This results in a high conversion per pass. A start-up heater is provided to raise the temperature to a level, where the ammonia synthesis reaction is self-sustaining.

The converter effluent is cooled by steam superheating, steam generation, feed/effluent exchange, and water cooling. The cooled converter effluent is routed to a KBR Unitized Chiller. Here, the effluent is cooled by recycle gas and by ammonia refrigeration, to maximize the condensation of the produced ammonia. The condensed ammonia is separated, let down in pressure, and routed to the coldest compartment in the Unitized Chiller.

Ammonia vapor from the Unitized Chiller, as well as from the ammonia chillers upstream of the nitrogen wash, are compressed in an ammonia refrigerant compressor and routed to a receiver. From here, the ammonia refrigerant is returned to the Unitized Chiller. Ammonia product at -33°C and atmospheric pressure is drawn from the coldest compartment of the Unitized Chiller and pumped to storage.

### B.4.2.2 Ammonia Process Flow Diagrams (PFD)

The ammonia process is shown on the following Process Flow Diagrams:

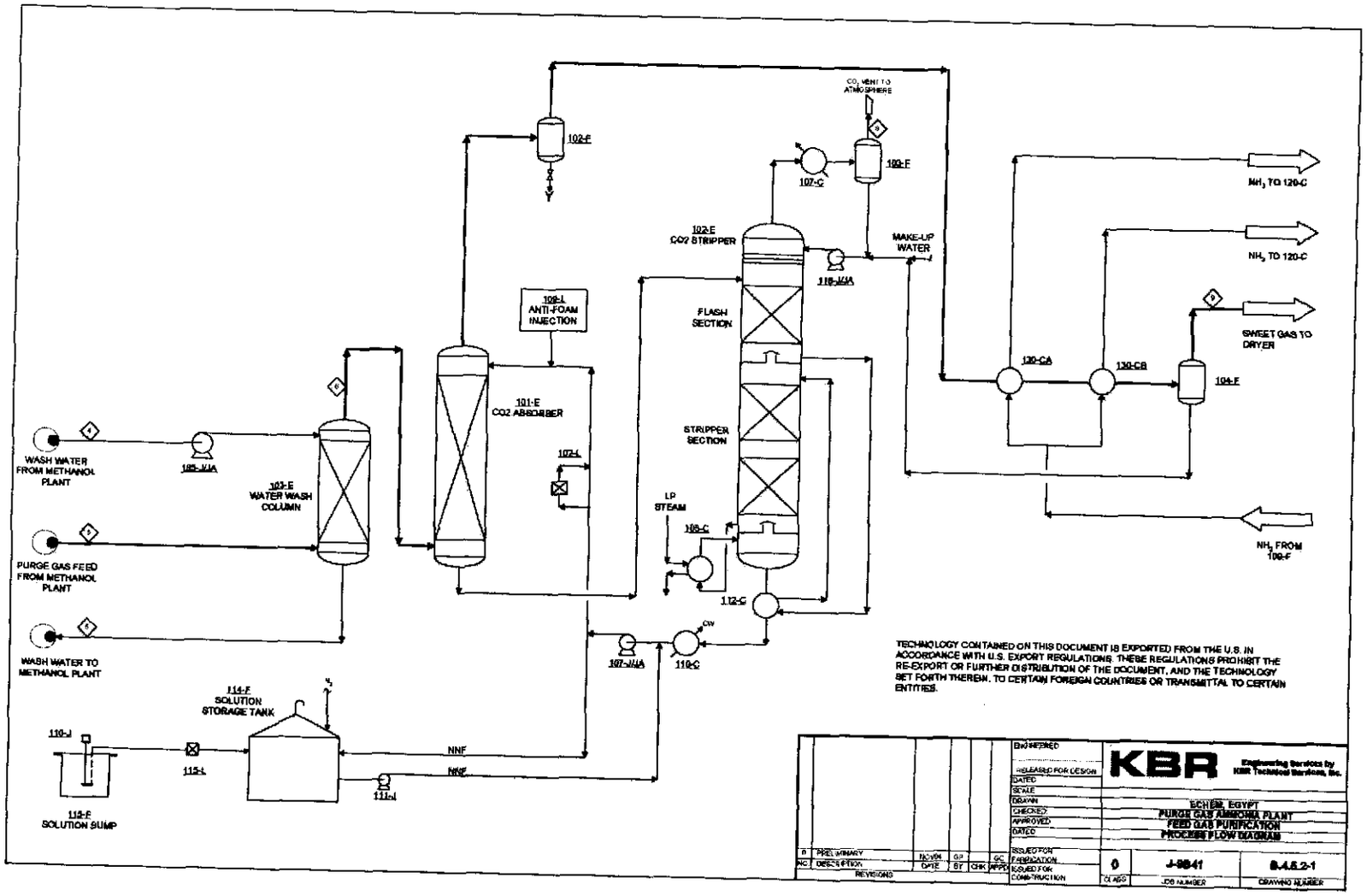
a. Feed Gas Purification

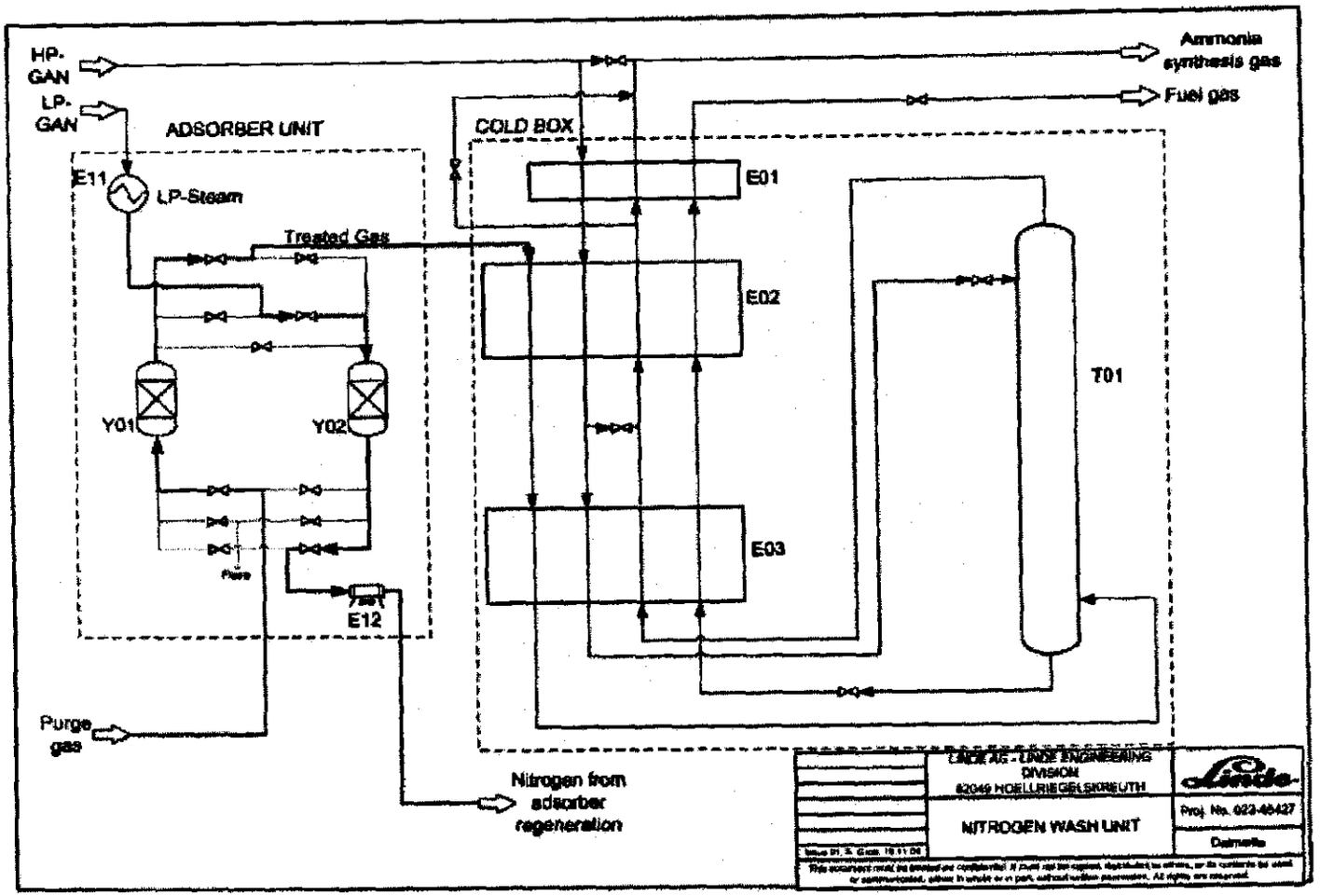
b. Nitrogen Wash

c. Air Separation Unit

d. Synthesis and Refrigeration

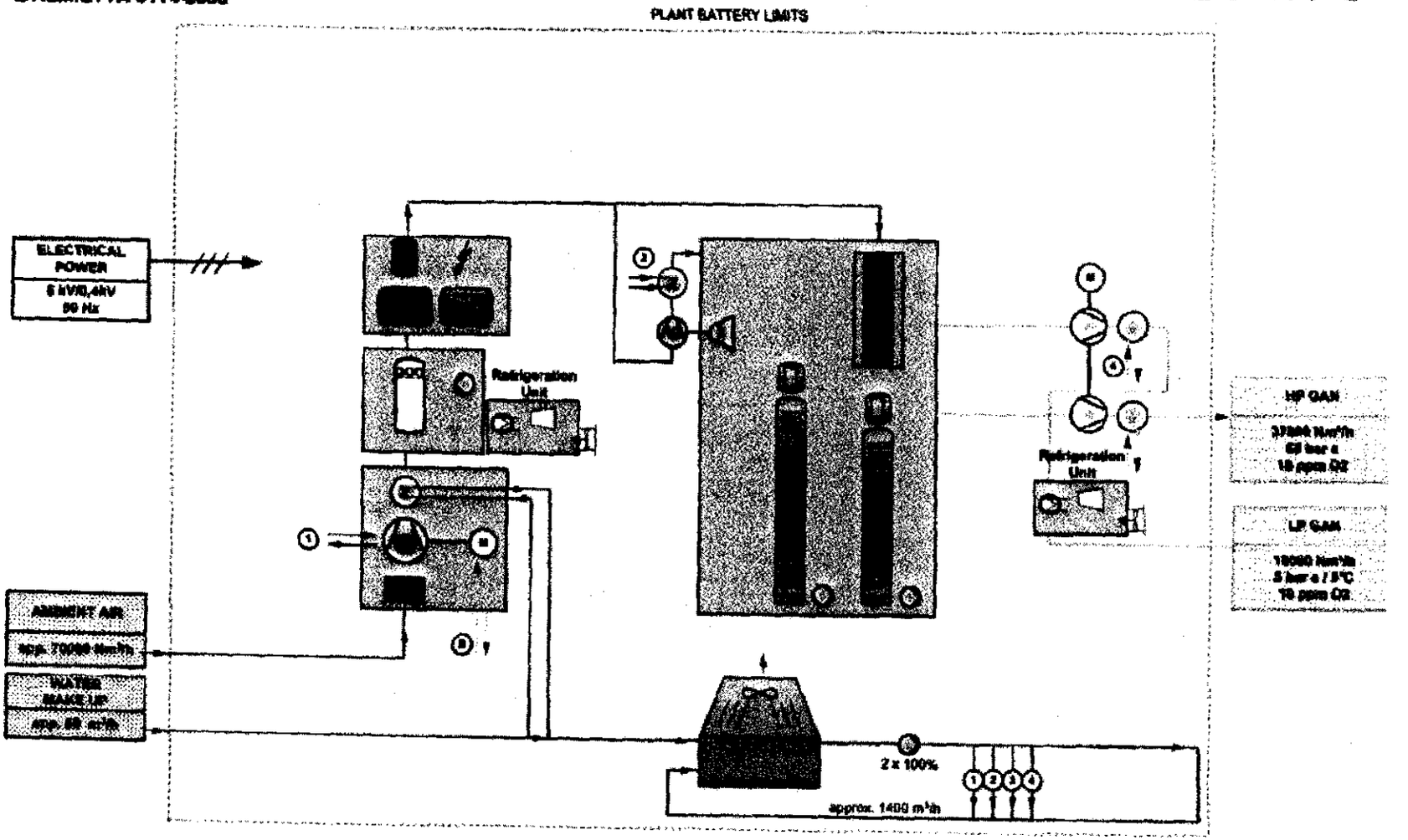
# AMMONIA FEED GAS PURIFICATION DIAGRAM



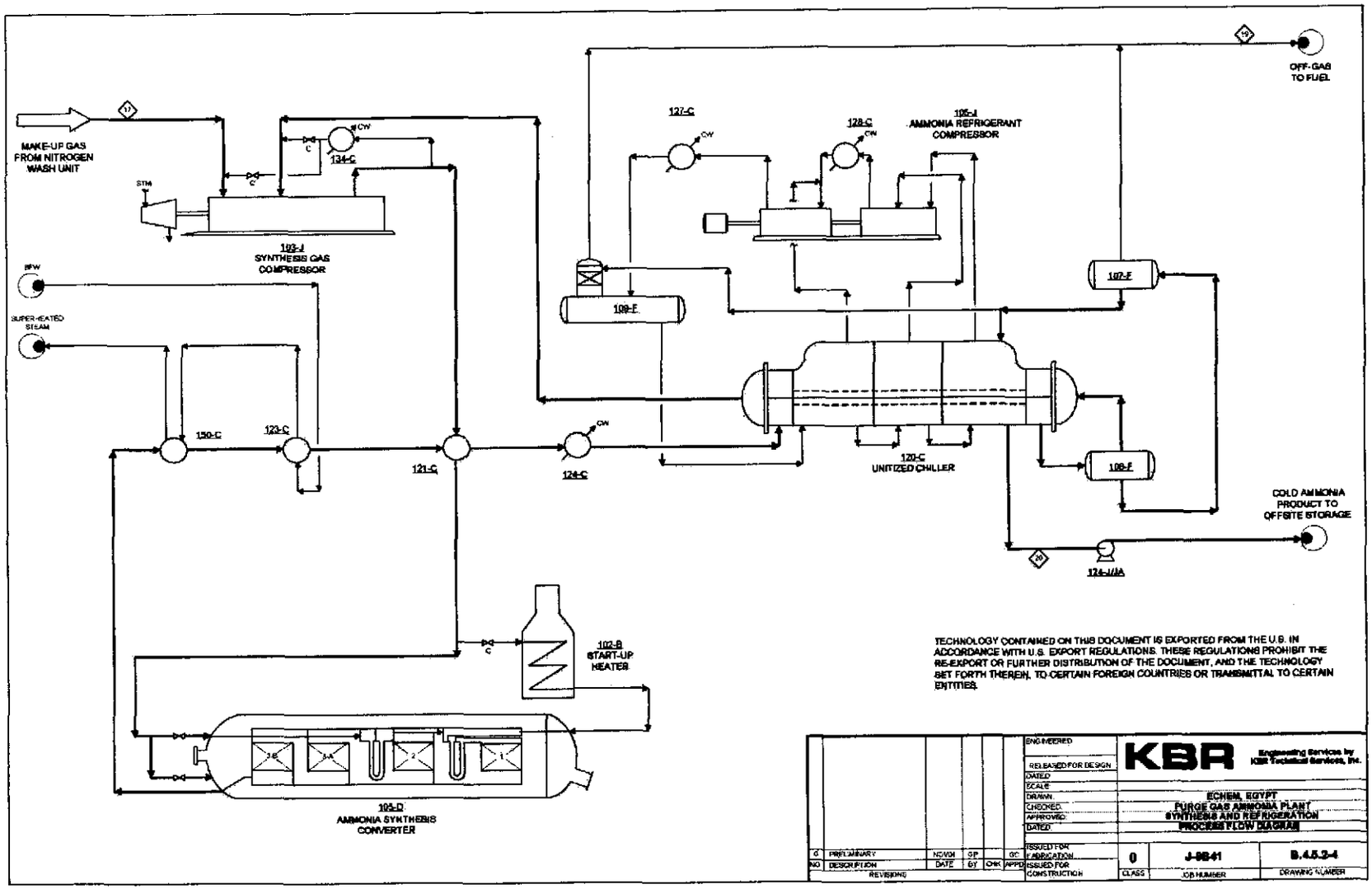

HP-GAN
LP-GAN
ADSORBER UNIT
COLD BOX
Ammonia synthesis gas
Fuel gas
E11
LP-Steam
Treated Gas
E01
E02
E03
T01
Y01
Y02
E12
Purge gas
Nitrogen from adsorber regeneration
LINDE AG - LINDE ENGINEERING DIVISION
82049 HOELLRIEGELSKREUTH
NITROGEN WASH UNIT
Proj. No. 023-65427
Damietta

# AIR SEPARATION PLANT

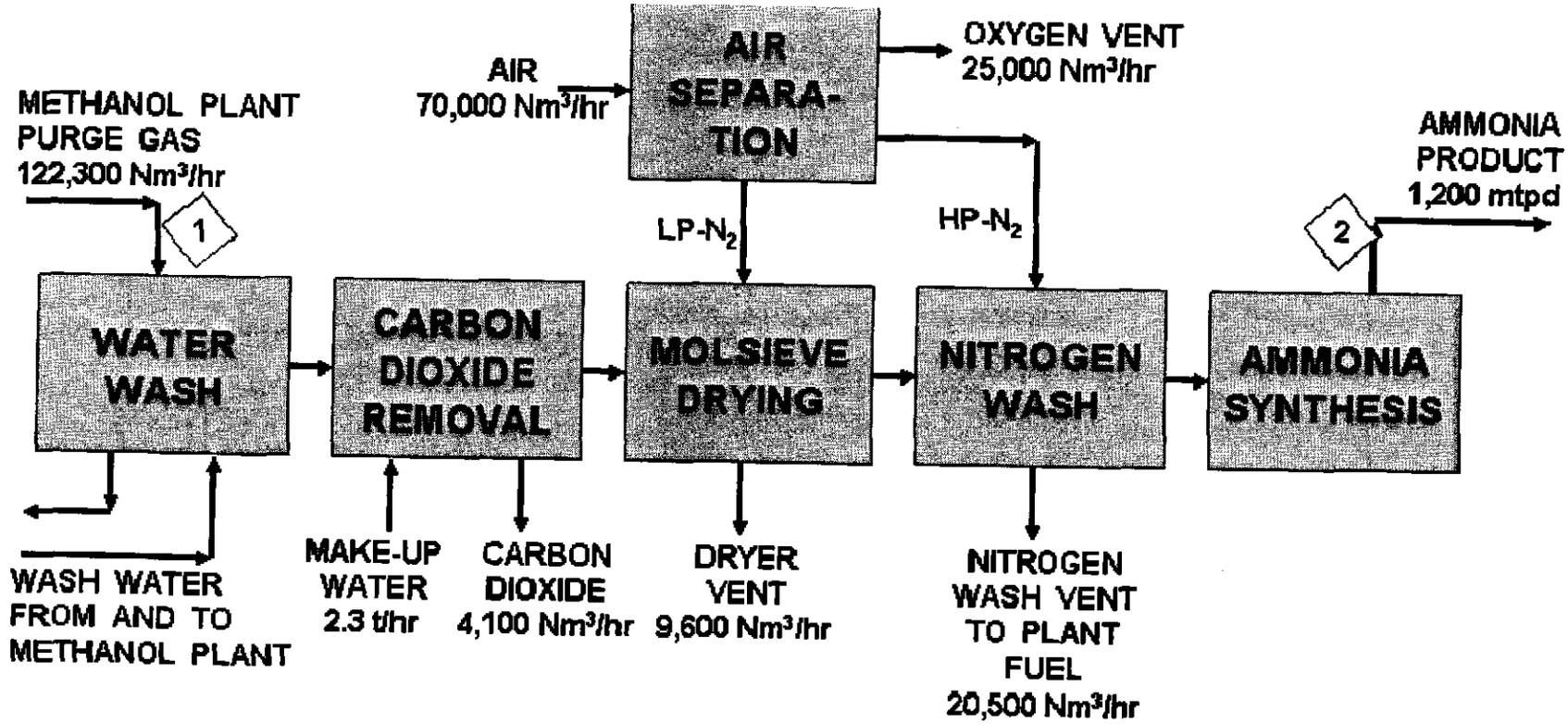
## DALMIETTA 0114-2606




LINDE AG LINDE ENGINEERING


MAKE-UP GAS FROM NITROGEN WASH UNIT
103-J SYNTHESIS GAS COMPRESSOR
134-C
127-C
128-C
105-J AMMONIA REFRIGERANT COMPRESSOR
OFF-GAS TO FUEL
BFW
SUPER-HEATED STEAM
109-F
107-F
150-C
123-C
121-C
124-C
120-C UNITIZED CHILLER
108-F
COLD AMMONIA PRODUCT TO OFFSITE STORAGE
124-J/JA
102-B START-UP HEATER
105-D AMMONIA SYNTHESIS CONVERTER
TECHNOLOGY CONTAINED ON THIS DOCUMENT IS EXPORTED FROM THE U.S. IN ACCORDANCE WITH U.S. EXPORT REGULATIONS. THESE REGULATIONS PROHIBIT THE RE-EXPORT OR FURTHER DISTRIBUTION OF THE DOCUMENT, AND THE TECHNOLOGY SET FORTH THEREIN, TO CERTAIN FOREIGN COUNTRIES OR TRANSMITTAL TO CERTAIN ENTITIES.
KBR
ECHEM, EGYPT
PURGE GAS AMMONIA PLANT
SYNTHESIS AND REFRIGERATION
PROCESS FLOW DIAGRAM
J-9B41
B.4.5.2-4

B.4.2.3 Ammonia Plant Material Balance



**Ammonia Plant Material Balance**

| | Purge Gas from Methanol Plant | Ammonia Product |
|---|---|---|
| Stream No. | 1 | 2 |
| Phase | Vapor | Liquid |
| Volume % Dry | | |
| $H_2$ | 82.9 | |
| $N_2$ | 0.4 | |
| $CH_4$ | 10.3 | |
| CO | 2.5 | |
| $CO_2$ | 3.0 | |
| Total | 100.00 | 100.00 |
| Total Flow kmol/hr | 5,456.5 | 2,935.8 |
| Total Flow kg/hr | 31,266 | 50,000 |
| Temperature °C | 40.0 | -33 |
| Pressure Bar,abs | 67 | 6 |

B.4.2.4 Utilities Consumption Estimate

| | |
|---|---|
| Purge Gas Feed | 122,300 $Nm^3$/hr (from Methanol Plant) |
| BFW | 43 T/hr |
| Seawater Circulation | 6,498 $m^3$/hr (for ISBL Plant, delta T=10°C) |
| Closed Loop Fresh Water Circulation | 4060 $m^3$/hr |
| Power | 23,350 kW |

B.4.2.5 Catalyst and Chemical Consumption Estimates

| Vessel | Description | Catalyst Type | Expected |
|---|---|---|---|
| 105-D | Ammonia Synthesis Converter | Iron/Pre-reduced | 8 - 10 |
| 109-DA/DB | Molecular Sieve Dryer | Zeolite | 3 - 5 |

Chemicals consumed in the Ammonia process:

- Concentrated aMDEA (aMDEA Premix)
- Amine (Anti Foam Agent)

The estimated catalyst and chemical consumption for the methanol process is:

Catalyst & Chemicals Cost/MT of ammonia: **$1.50 / MT**

B.4.2.6 Major Equipment List

The following list of major equipment covers the ISBL ammonia plant.

Class B: Fired Heaters

| | |
|---|---|
| 102-B | Startup heater |

Class C: Heat Exchangers

| | |
|---|---|
| 103-JTC | Steam surface condenser |
| 105-C | $CO_2$ stripper reboiler |
| 107-C | $CO_2$ stripper overhead condenser |
| 110-C | Lean solution cooler |
| 112-C | Lean/semilean solution exchanger |
| 130-CA/CB | Ammonia chillers |
| 120-C | Unitized chiller |
| 121-C | Ammonia converter feed/effluent exchanger |
| 123-C | Ammonia converter effluent steam generator |
| 124-C | Ammonia converter effluent cooler |
| 127-C | Refrigerant condenser |
| 128-C | Refrigerant compressor intercooler |
| 134-C | Syngas compressor kickback cooler |
| 150-C | Steam superheater |
| 201-C | Dryer regeneration heater |
| 202-C | Dryer regeneration cooler |
| 203-C | 1st core exchanger |
| 204-C | 2nd core exchanger |
| 205-C | 3rd core exchanger |

Class D: Reactors

| | |
|---|---|
| 105-D | Ammonia synthesis converter |

Class E: Towers

| | |
|---|---|
| 101-E | $CO_2$ absorber |
| 102-E | $CO_2$ stripper |
| 103-E | Water wash column |
| 201-E | Nitrogen wash column |

Class F: Vessels

| | |
|---|---|
| 102-F | Absorber overhead separator |
| 103-F | $CO_2$ stripper overhead knockout drum |
| 104-F | Chilled condensate separator |
| 106-F | Ammonia separator |

| | |
|---|---|
| 107-F | Ammonia letdown drum |
| 109-F | Refrigerant receiver |
| 114-F | Solution storage tank |
| 115-F | Solution sump |
| 201-FA/B | Dryers |

Class J: Rotating Machinery

| | |
|---|---|
| 103-J | Synthesis gas compressor |
| 103-JT | Synthesis gas compressor turbine |
| 104-J/JA | HP boiler feedwater pumps |
| 105-J | Ammonia refrigerant compressor |
| 107-J/JA | Solution pumps |
| 110-J | Solution sump pump |
| 111-J | Solution transfer pump |
| 112-J/JA | Turbine condensate pumps |
| 116-J/JA | $CO_2$ stripper reflux pumps |
| 124-J/JA | Ammonia product pumps |
| 195-J/JA | Wash water pumps |

Class L: Special Equipment

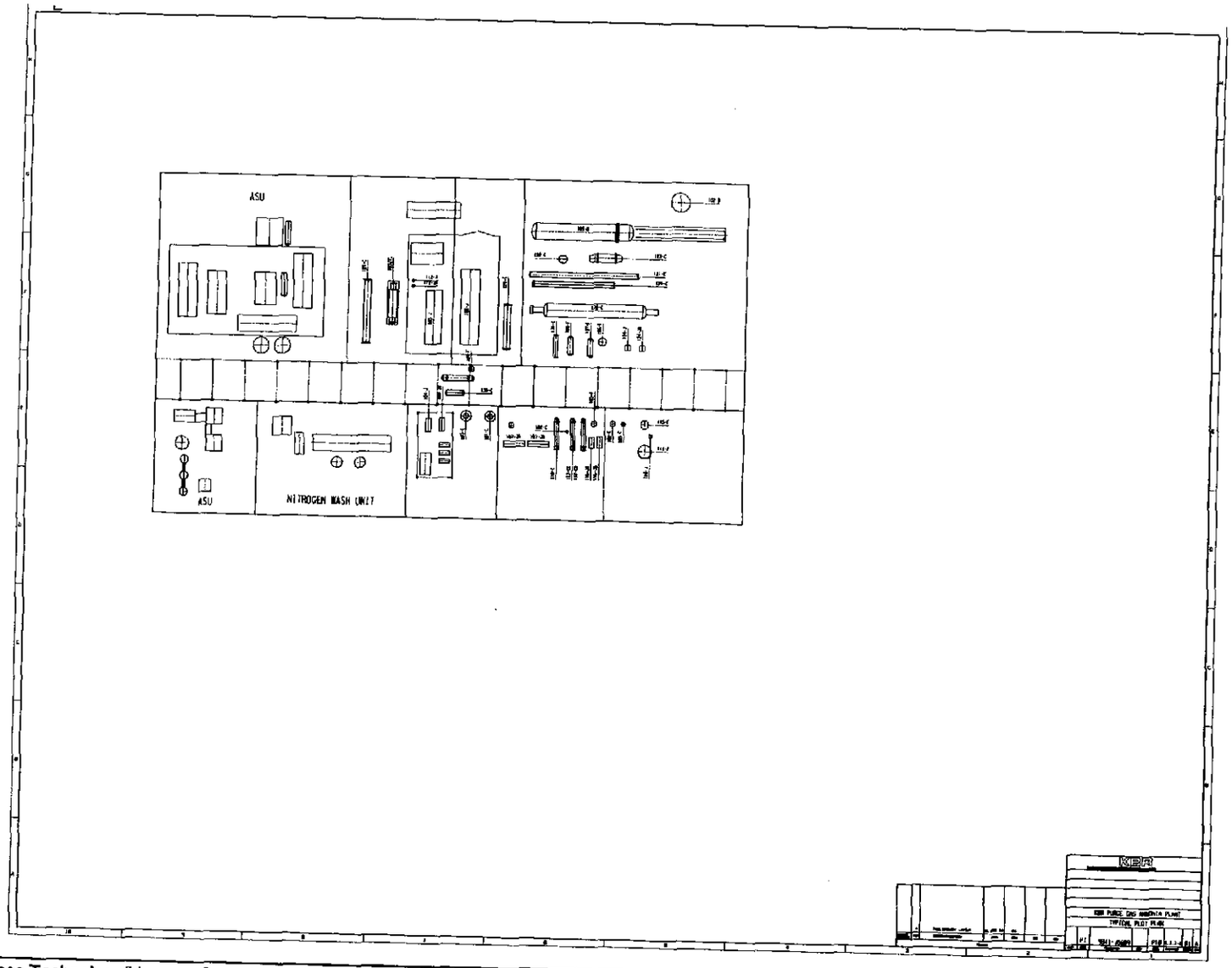
| | |
|---|---|
| 102-L | Solution filter |
| 109-L | Antifoam injection system |
| 115-L | Solution sump filter |
| 201-L | Air separation unit |

Refer to Section B.5.7.10 for the OSBL equipment list.

### B.4.2.7 Plot Space Requirement

The approximate area required for the ammonia plant is 4,500 $m^2$. The area required for the air separation unit is approximately 2,000 $m^2$.

## Preliminary Plot Plan – Ammonia

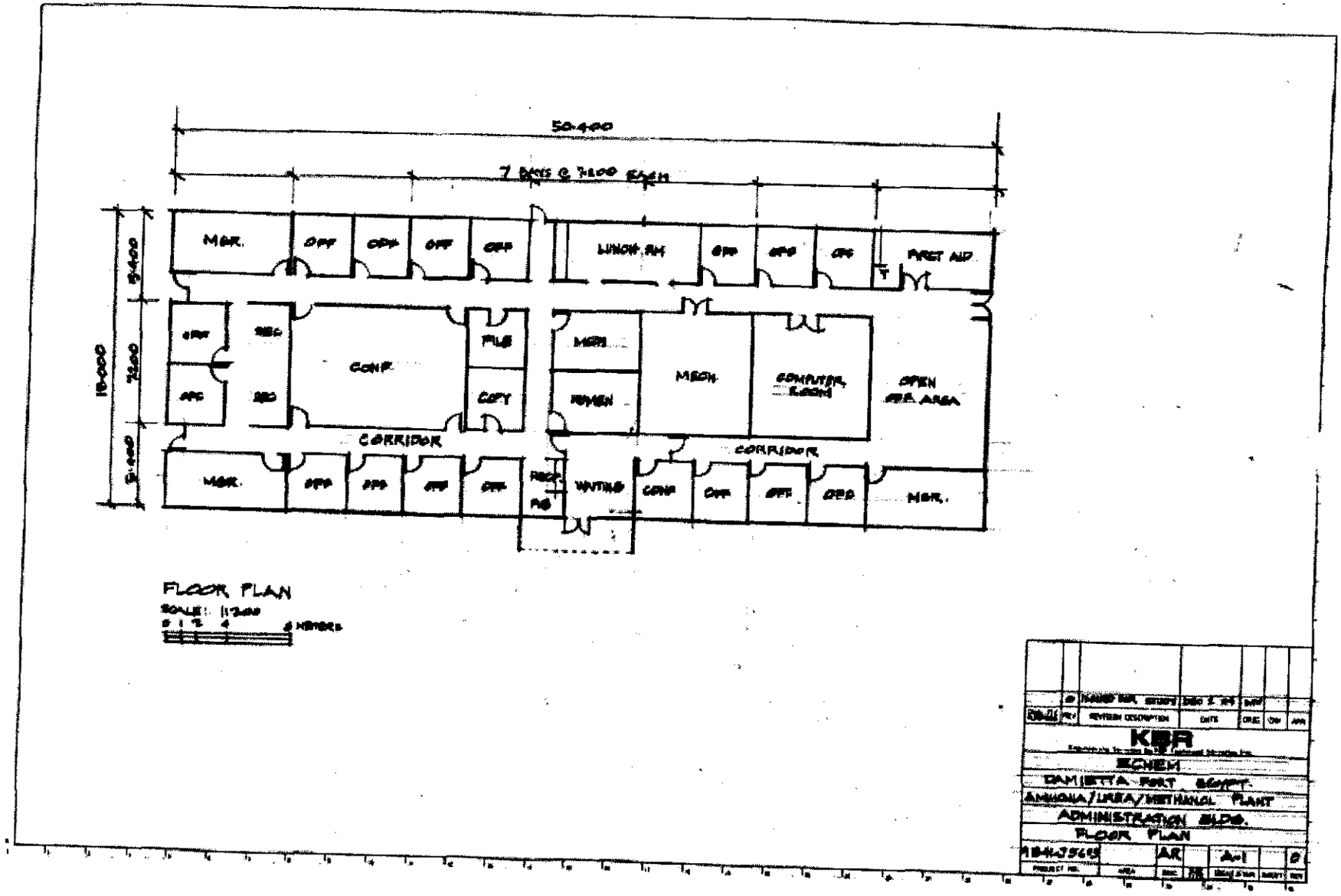


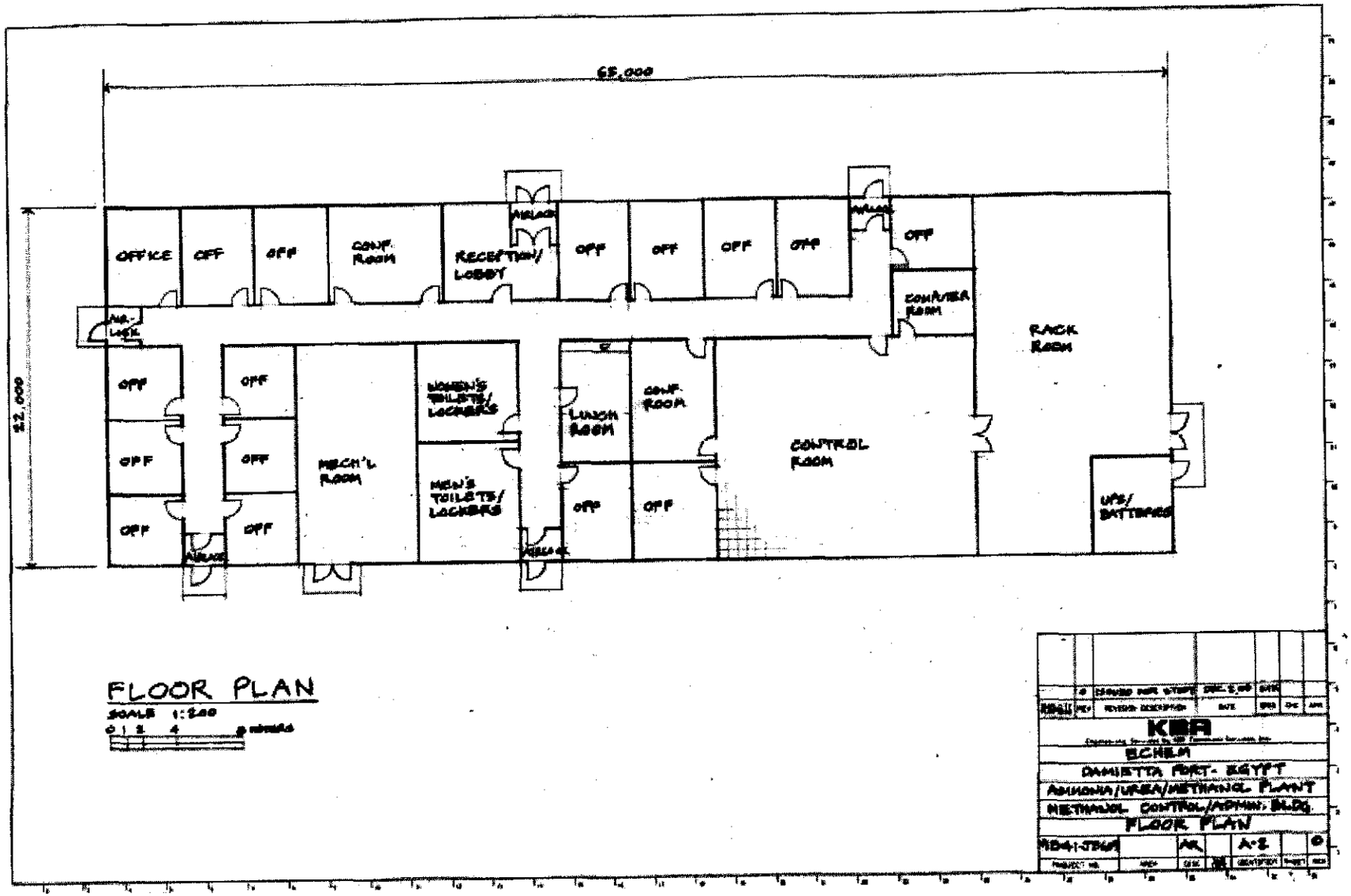
### B.5.1 Building Layouts

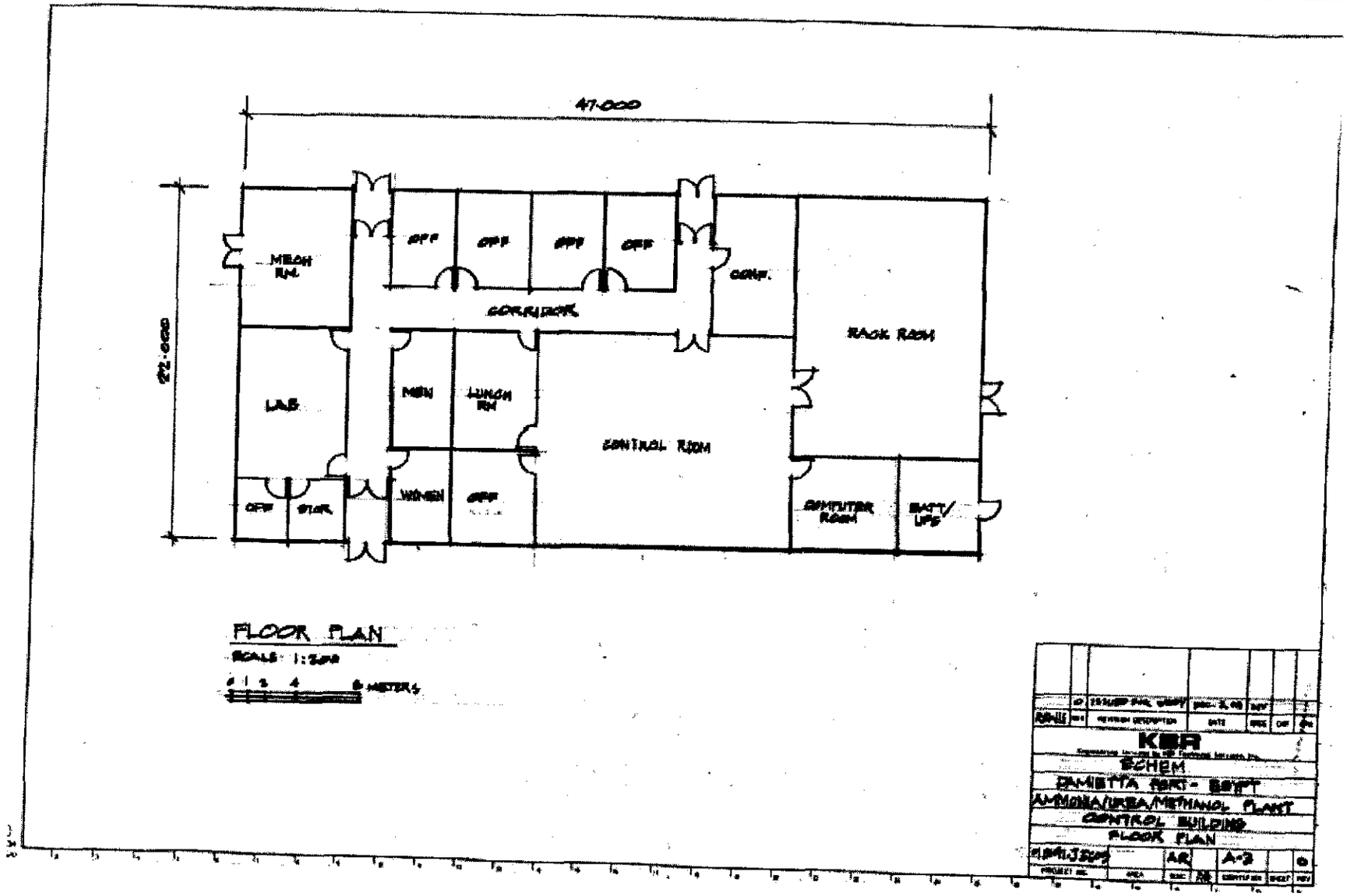
The principal buildings considered for this study are listed as follows:

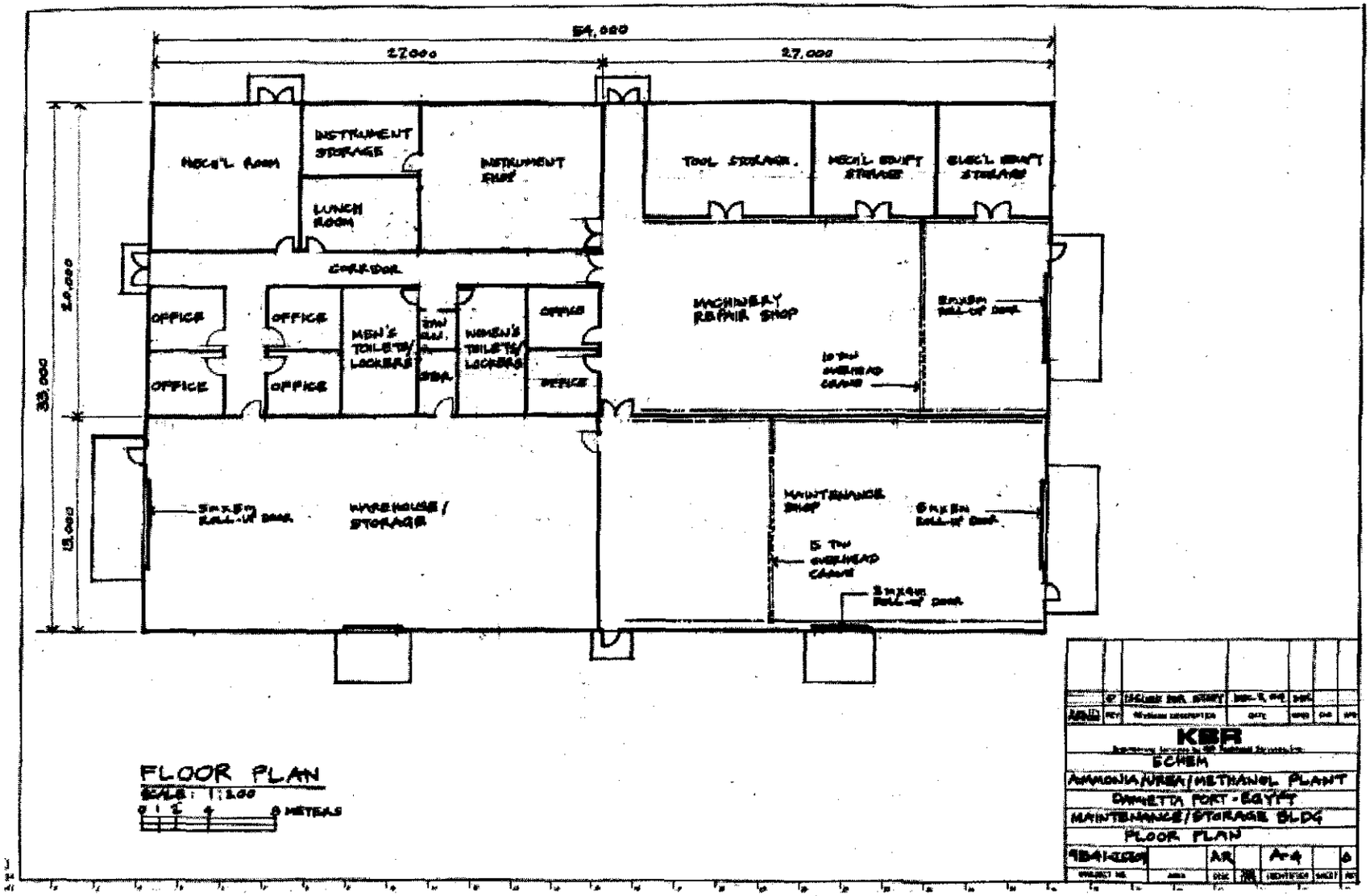
- **Administration Building.** This is a two story building to separately accommodate the management and administration of the methanol and ammonia administration staff.
- **Control Room and Site Offices.** There will be one control room, housing control panels for the methanol, ammonia and utilities/offsite equipment. This building also includes the site laboratory and offices for the site operation and records staff. A smaller building will be located in the ship loading area.
- **Ammonia Control Room and Site Offices** This is an alternate floor plan that would provide offices for the site operating and records personnel as well as the site laboratory.
- **Maintenance Workshops and Storage/Warehousing Building** The buildings will provide office accommodation for the maintenance and warehouse supervisory staff.
- **Substation and Motor Control Center (MCC) Building** The substation and motor control center will be placed centrally. There will be smaller buildings housing switchgear at the port loading area and the seawater pump basin area.
- **Fire Station** This is assumed to be a building that includes the plant security staff.

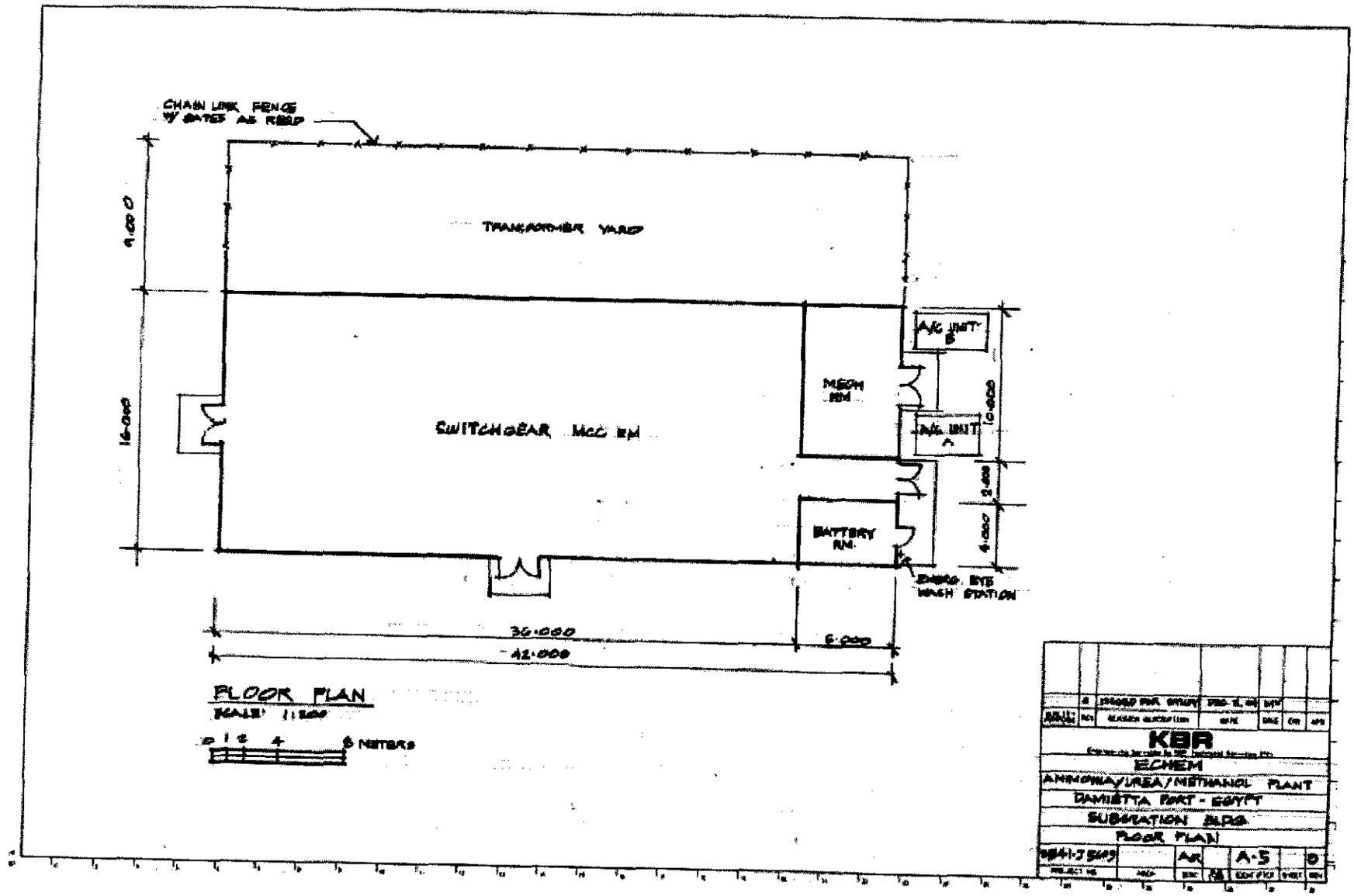
Copies of the provisional floor plans of these buildings are attached to this section

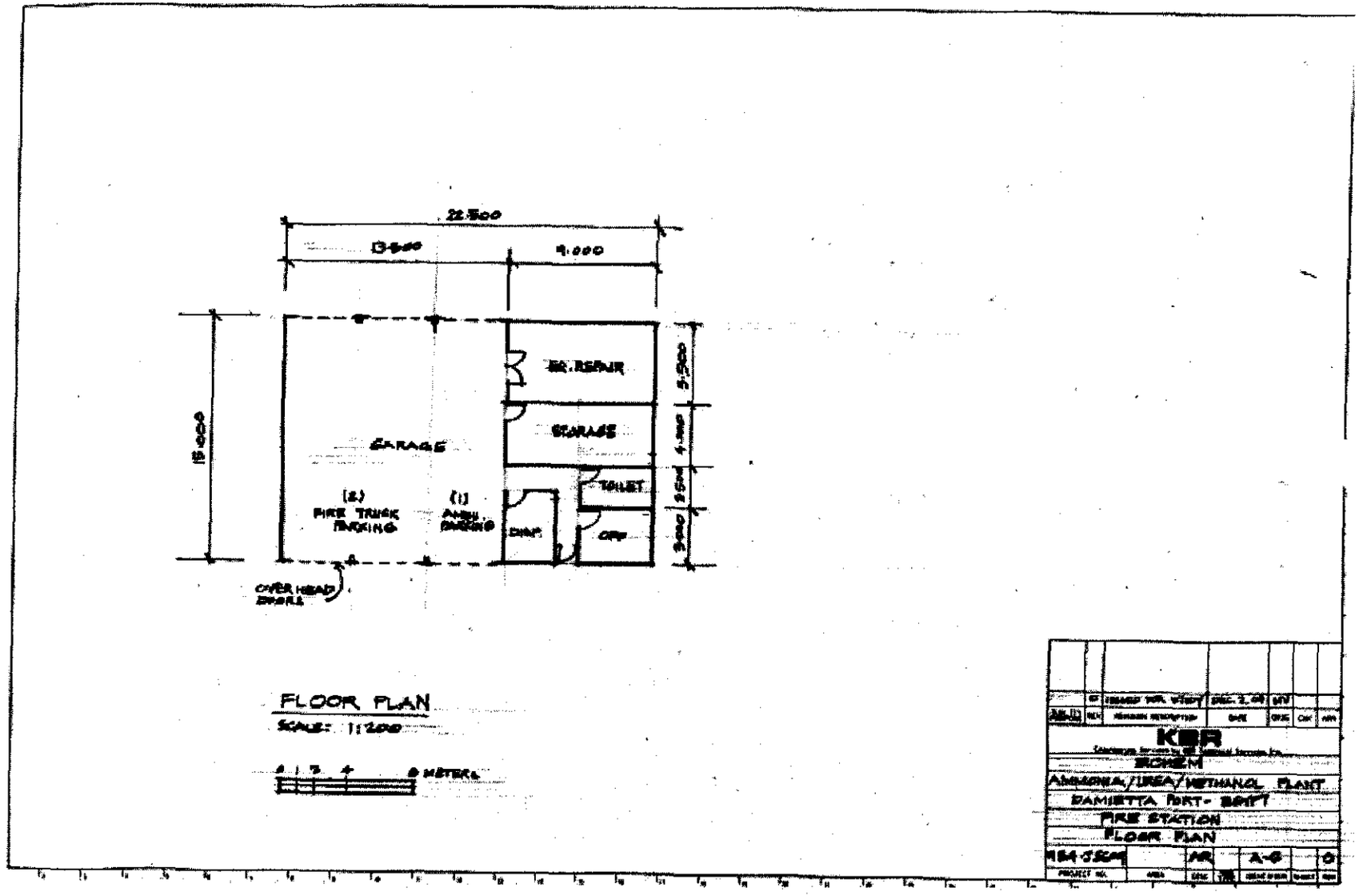

50.400
7 BAYS @ 7200 EACH
MGR.
OFF
CONF.
FILE
COPY
MECH.
COMPUTER ROOM
OPEN OFF. AREA
FIRST AID
CORRIDOR
CORRIDOR
MGR.
WAITING
CONF
MGR.
FLOOR PLAN
SCALE: 1:100
0 1 2 4 6 METERS
KBR
ECHEM
DAMIETTA PORT EGYPT
AMMONIA / UREA / METHANOL PLANT
ADMINISTRATION BLDG.
FLOOR PLAN


65,000
32,000
OFFICE
OFF
CONF. ROOM
RECEPTION/ LOBBY
AIR LOCK
COMPUTER ROOM
RACK ROOM
MECH'L ROOM
WOMEN'S TOILETS/ LOCKERS
MEN'S TOILETS/ LOCKERS
LUNCH ROOM
CONTROL ROOM
UPS/ BATTERIES
FLOOR PLAN
SCALE 1:200
KBR
ECHEM
DAMIETTA PORT - EGYPT
AMMONIA/UREA/METHANOL PLANT
METHANOL CONTROL/ADMIN. BLDG.
FLOOR PLAN


47-000
MECH RM.
OFF
OFF
OFF
OFF
CORRIDOR
CONF.
RACK ROOM
LAB
MEN
LUNCH RM
CONTROL ROOM
OFF
STAIR
WOMEN
OFF
COMPUTER ROOM
BATT/ UPS
FLOOR PLAN
SCALE 1:50
0 1 2 4 6 METERS
KBR
ECHEM
DAMIETTA PERT - EGYPT
AMMONIA/UREA/METHANOL PLANT
CONTROL BUILDING
FLOOR PLAN
AR
A-2


54,000
27000
27,000
33,000
INSTRUMENT STORAGE
INSTRUMENT REPAIR
TOOL STORAGE.
LUNCH ROOM
CORRIDOR
OFFICE
OFFICE
OFFICE
OFFICE
MEN'S TOILETS/ LOCKERS
WOMEN'S TOILETS/ LOCKERS
OFFICE
OFFICE
MACHINERY REPAIR SHOP
WAREHOUSE / STORAGE
MAINTENANCE SHOP
FLOOR PLAN
SCALE : 1:100
METERS
KBR
ECHEM
AMMONIA/UREA/METHANOL PLANT
DAMIETTA PORT - EGYPT
MAINTENANCE/STORAGE BLDG
FLOOR PLAN
AR
A-4


CHAIN LINK FENCE W/ GATES AS REQD
TRANSFORMER YARD
SWITCHGEAR MCC RM
MECH RM
A/C UNIT B
A/C UNIT A
BATTERY RM
EMERG. EYE WASH STATION
9.000
16.000
10.000
2.000
4.000
36.000
42.000
6.000
FLOOR PLAN
SCALE 1:200
0 1 2 4 8 METERS
KBR
ECHEM
AMMONIA/UREA/METHANOL PLANT
DAMIETTA PORT - EGYPT
SUBSTATION BLDG
FLOOR PLAN
A-5


22.500
13.500
9.000
15.000
EQ. REPAIR
STORAGE
GARAGE
TOILET
(2) FIRE TRUCK PARKING
(1) AMBU. PARKING
DISP.
OFF
OVER HEAD DOORS
FLOOR PLAN
SCALE: 1:200
METERS
KBR
ECHEM
AMMONIA/UREA/METHANOL PLANT
DAMIETTA PORT - EGYPT
FIRE STATION
FLOOR PLAN
A-6

## B.5.2 Preliminary Piling Drawings

### B.5.2.1 Soil Description

The soil stratigraphy and properties as given in Annex 3 of the SOR "Soil Investigation at East Dock of Damietta Port (Extension Project of Existing Basin)" have been used for developing the civil foundation design. The soil parameters given in this soils report are summarized below.

The site consists of 12 to 14 meters of medium dense to dense fine sands overlying 15 m of soft clays, which overlie very dense sands and stiff clays. The upper sands have reasonable bearing capacity. However, where foundation pressures from large heavily loaded or closely spaced smaller foundations combine to transmit bearing pressures to the clays, this will lead to significant settlements in the long term by consolidation of the clays.

The dense sand below the clays at elevation –30 m is suitable for end bearing piles. The thickness of the sand layer overlying stiff clays is important in determining the length of the piles.

### B.5.2.2 Site Fill

If the land in the site is raised to +2.5 m to 3.0 m as in other areas of the port, this will lead to considerable consolidation of the clays, which would give long term settlements in the range 100-200 mm. Two options were considered for the adjacent Segas LNG site for ground treatment:

a) Preloading with wick drains. This would enable most foundations to be constructed as spread footings and avoid the use of piles.

b) Using balanced cut and fill to reduce change in site levels to a minimum. This has the advantage of avoiding importing fill. Piling would be required where the surface loadings would lead to unacceptable differential settlements in areas with large diameter piping and heavy equipment, such as compressors casings, which are sensitive to any nozzle movements.

Option b) was selected because it is more economical and is not restricted by schedule.

### B.5.2.3 Pile Design

Preliminary pile design is based on precast driven piles with a working capacity of 600 kN after allowing for negative skin friction as well as a lateral capacity of 30 kN and a tension capacity where required of 180 kN. These would be driven to a founding level of approximate elevation of –32 m in the first dense sand level below the clay. This sand layer is sufficiently thick to provide adequate end bearing without overloading the underlying stiff clay. If the final site

investigation shows the elevation and thickness of the sand layers to be different, the length and type will be adjusted to ensure the necessary capacity.

The piling layout drawings can only be prepared at the time when the equipment is designed and the equipment manufacturers selected. The manufacturers will provide the necessary engineering data to enable the EPC contractor to design the foundations. A typical piling layout is shown in the drawings on the following pages. It is anticipated that approximately 1,500 piles will be required.

### B.5.2.4 Spread Foundations

The maximum bearing pressure for spread foundations is 300 kPa, where settlement is not a criterion. Spread foundations will be used where overall settlements from long-term consolidation of the soft clays is within allowable limits for the supported equipment.

The effect of this is that the methanol and ammonia/urea process trains and the Common Facilities areas will be piled. Other areas will not require piling.

A limiting differential settlement from consolidation of the clay, of 15 mm over a length of 20 m has been used for non-piled structures.

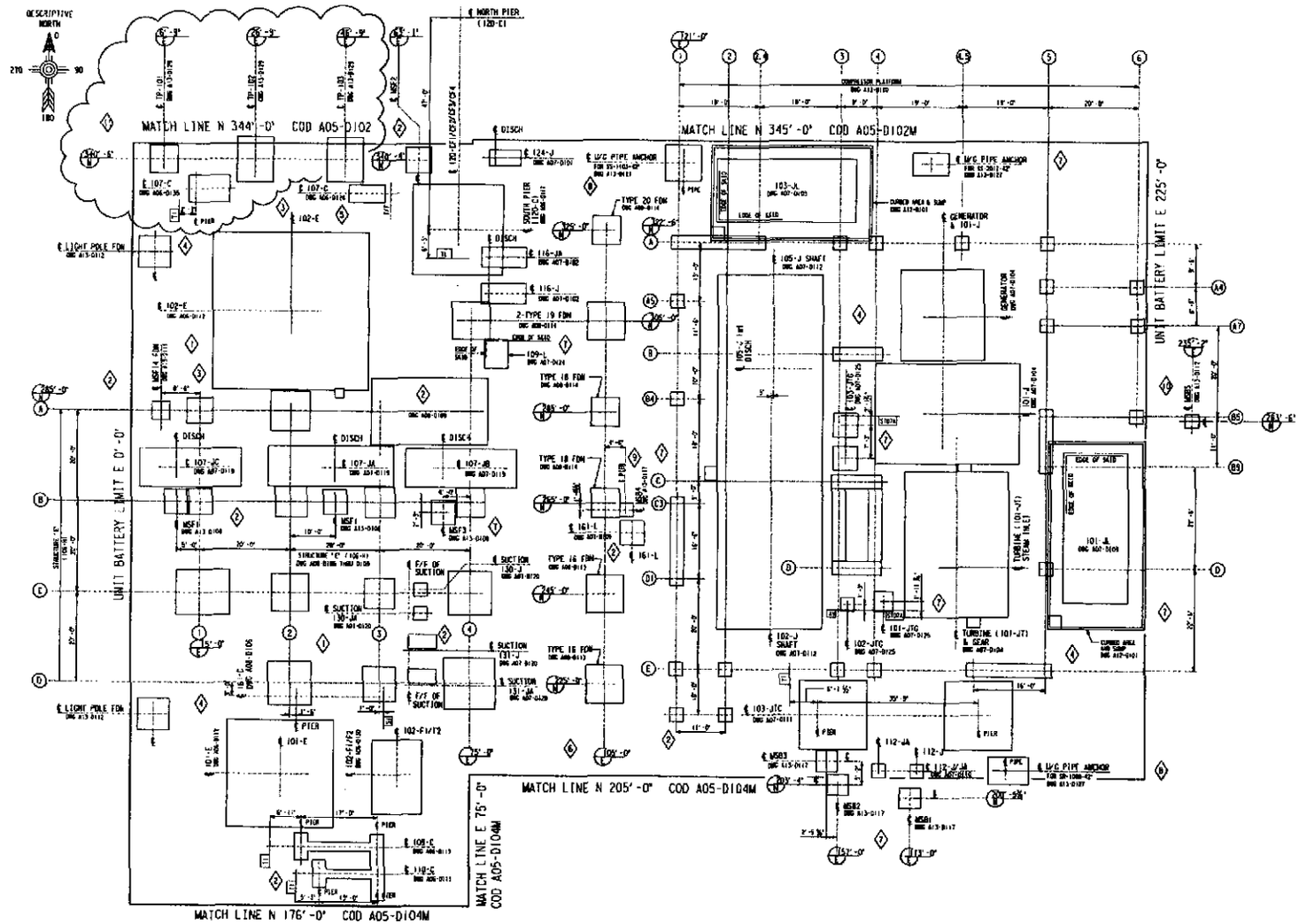
### B.5.2.5 Site Topography

Ground elevations measured in the very similar (and adjacent) Segas site varies from +2.368 m to +2.537 m (i.e., difference of 0.169 m in elevation) with an average of +2.38 m over the site. The ground surface at the site is thus almost plane.

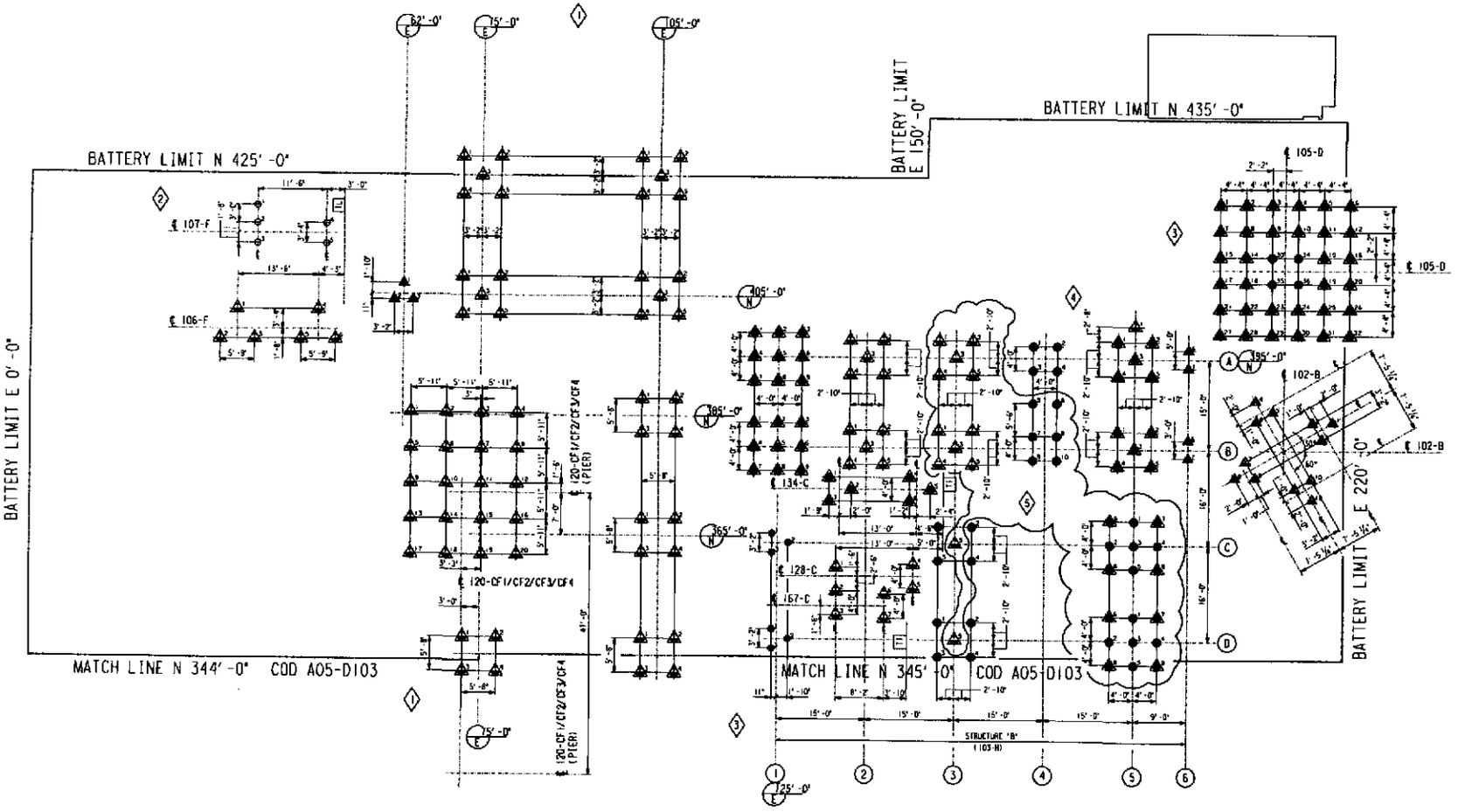
### B.5.2.6 Ground Water

The SEGAS site ran several boreholes and found that the average groundwater level was 1.75 to 1.90 meters below the surface.

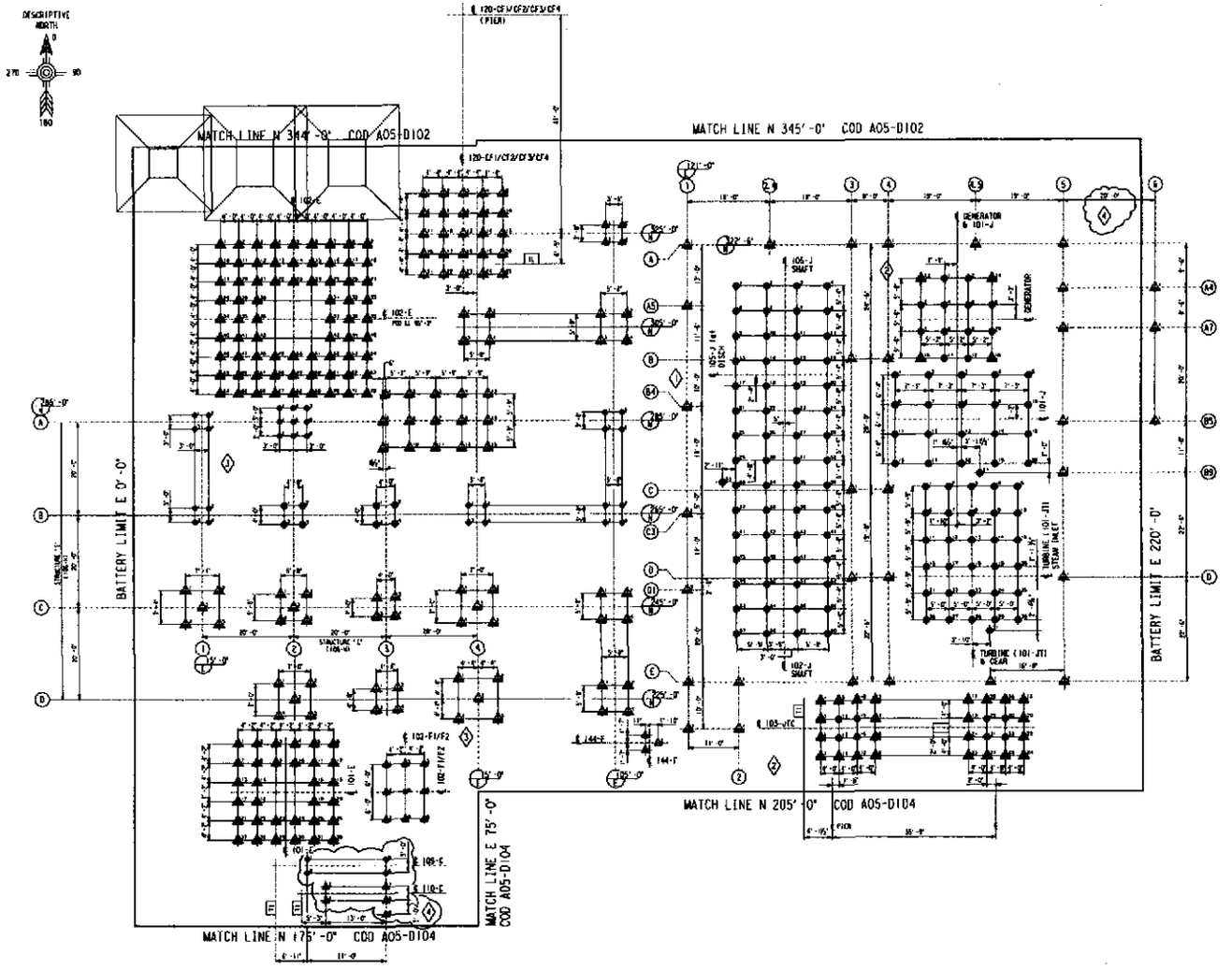
## TYPICAL PILING LAYOUTS – PROCESS AREA



## TYPICAL PILING PLAN – DETAILED CRITICAL FOUNDATIONS



## TYPICAL PILING PLAN- CRITICAL EQUIPMENT



## B.5.3 Site Drawings

Of the four sites investigated, Damietta Port Site is considered the optimum. The site is approximately 1,000,000 $m^2$, is within the Damietta Industrial Free Trade Zone, and partly fronts the Damietta Port harbor basin.

### B.5.3.1 Plot Plans

A preliminary site layout has been prepared showing the allocated plot areas for each of the three phases. Seawater cooling towers have been located at the downwind extremity of the plot, although excessive plumes of moisture are not expected from these improved designed towers.

Product storage has been located as close as practical to the ship loading area to reduce the cost of conveyor systems and export piping. Process units have been located as close as practical to the cooling towers to reduce the lengths and cost of the cooling water recirculation pipelines.

There is no rail loading foreseen at the project site. Any movement of product, other than that exported through the marine terminal, will be by road.

The dedicated ship berthing arrangement shows the berths to be used for Phase I and II while the location of the second berth for Phase III is also indicated.

Plot drawings showing preliminary information on piperacks, drainage, buried pipelines, paving and truck loading, and fire protection are enclosed:

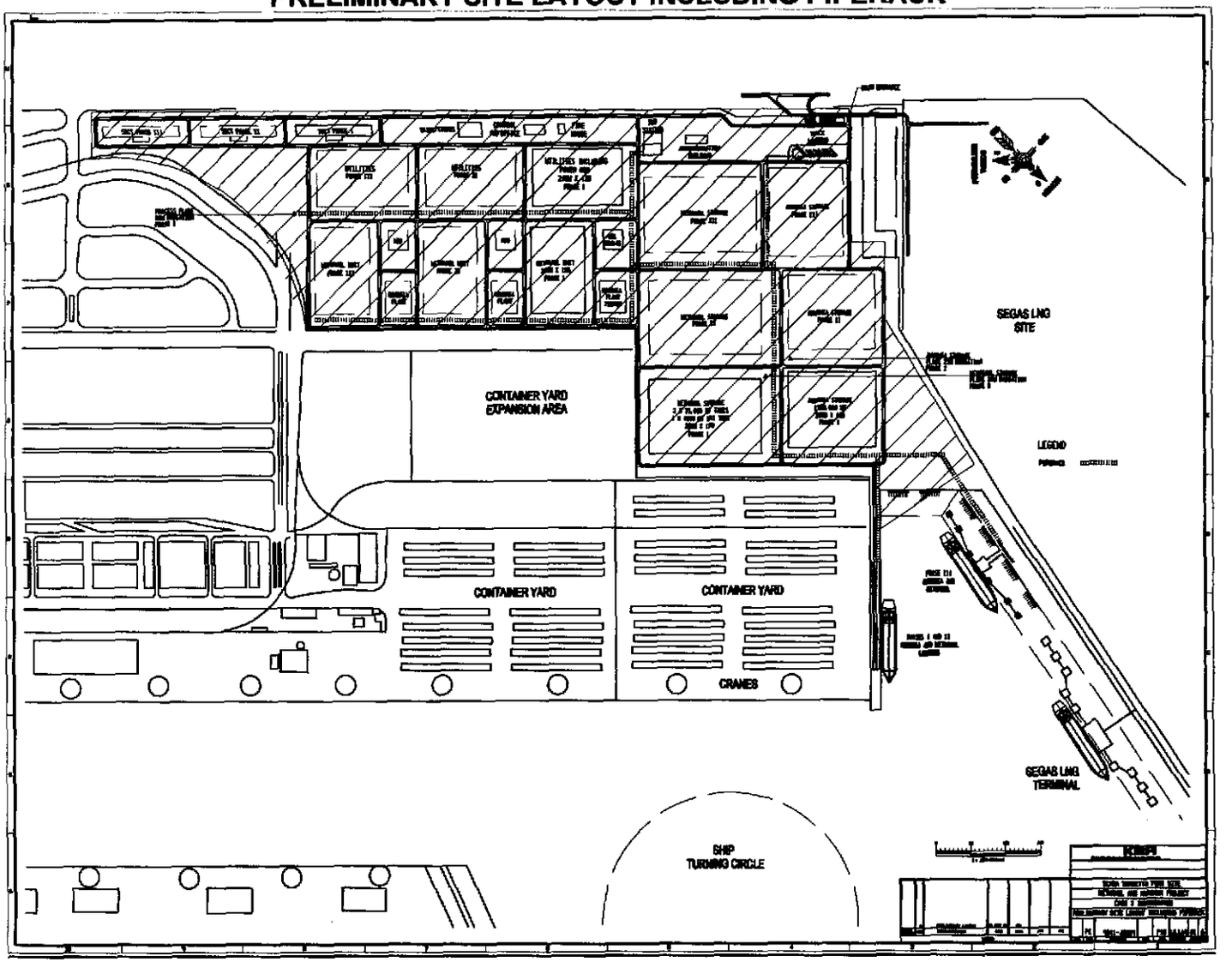
Drawing:

| | |
|---|---|
| 9B41-J5609-P10-B.5.3.1/1 | Preliminary Site Layout Including Piperack |
| 9B41-J5609-P10-B.5.3.1/2 | Preliminary Site Drainage Layout |
| 9B41-J5609-P10-B.5.3.1/3 | Preliminary Buried Pipeway Layout |
| 9B41-J5609-P10-B.5.3.1/4 | Preliminary Paving and Road/Truck Layout |
| 9B41-J5609-P10-B.5.3.1/5 | Preliminary Fire Protection/Treatment Layout |

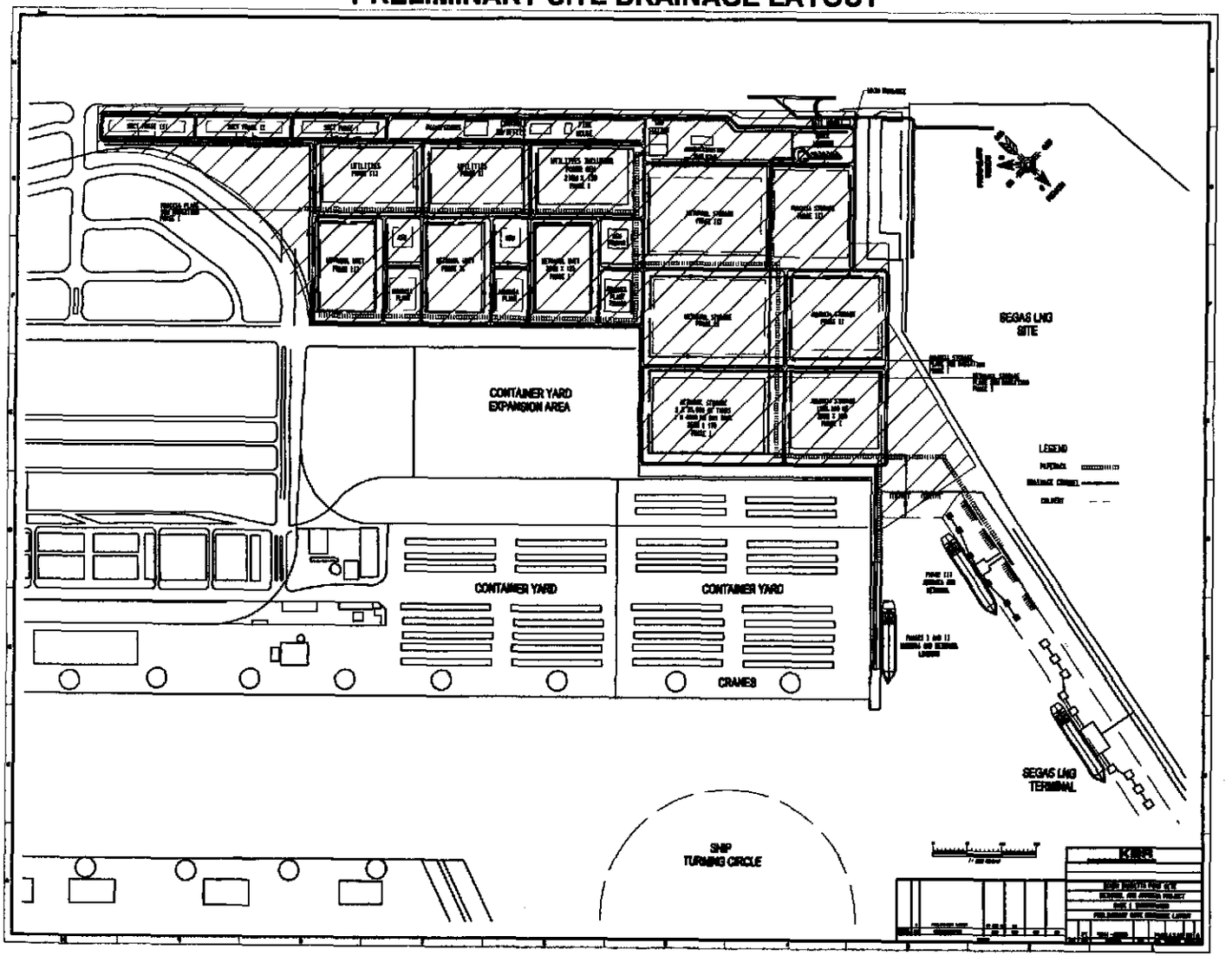
The seawater intake basin structure is approximately 2,000 meters away from the plot, in a north-west direction. A diagram of this structure is included in this report.

Larger scale versions of these drawings are included in Appendix 3 of this Study.

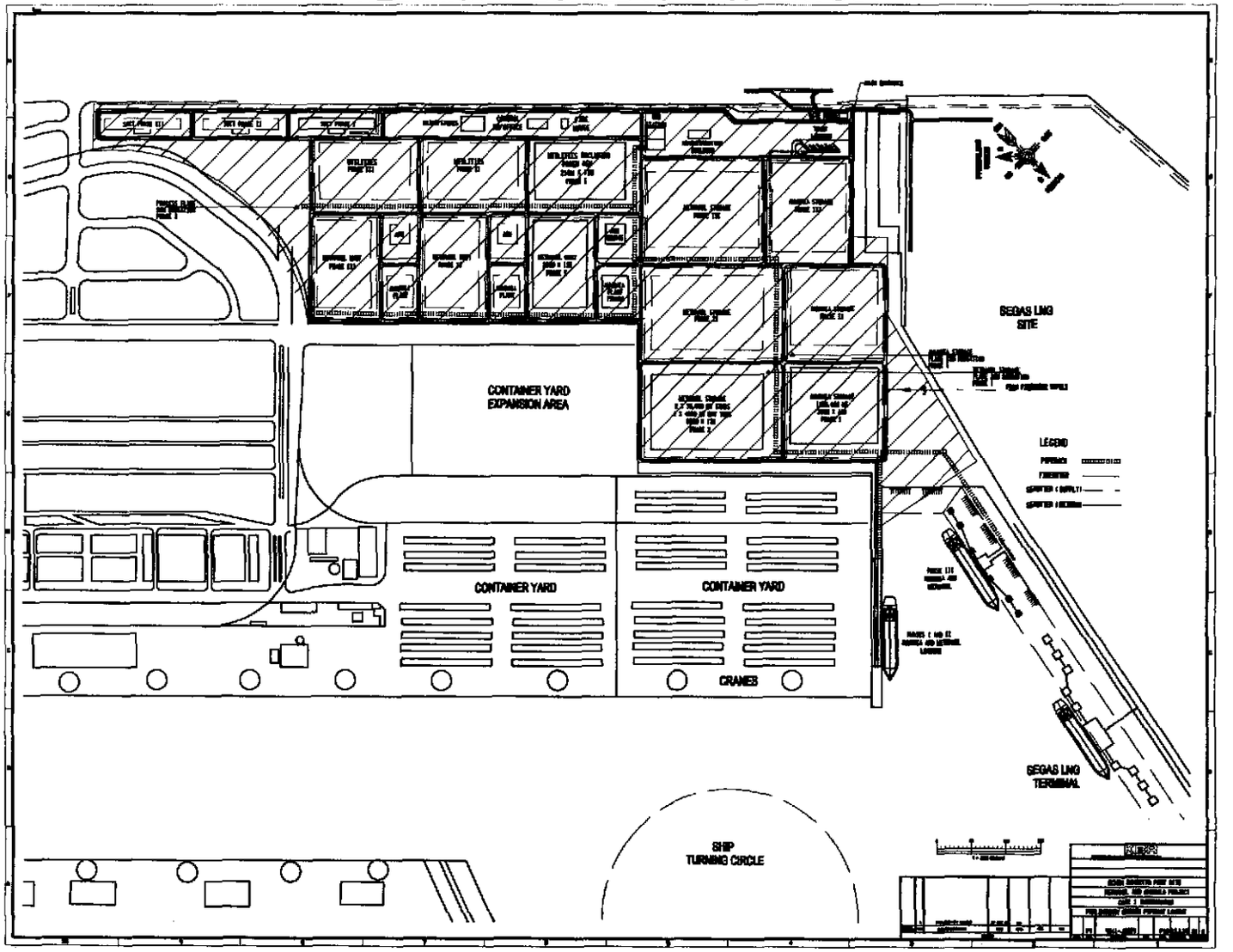
## PRELIMINARY SITE LAYOUT INCLUDING PIPERACK



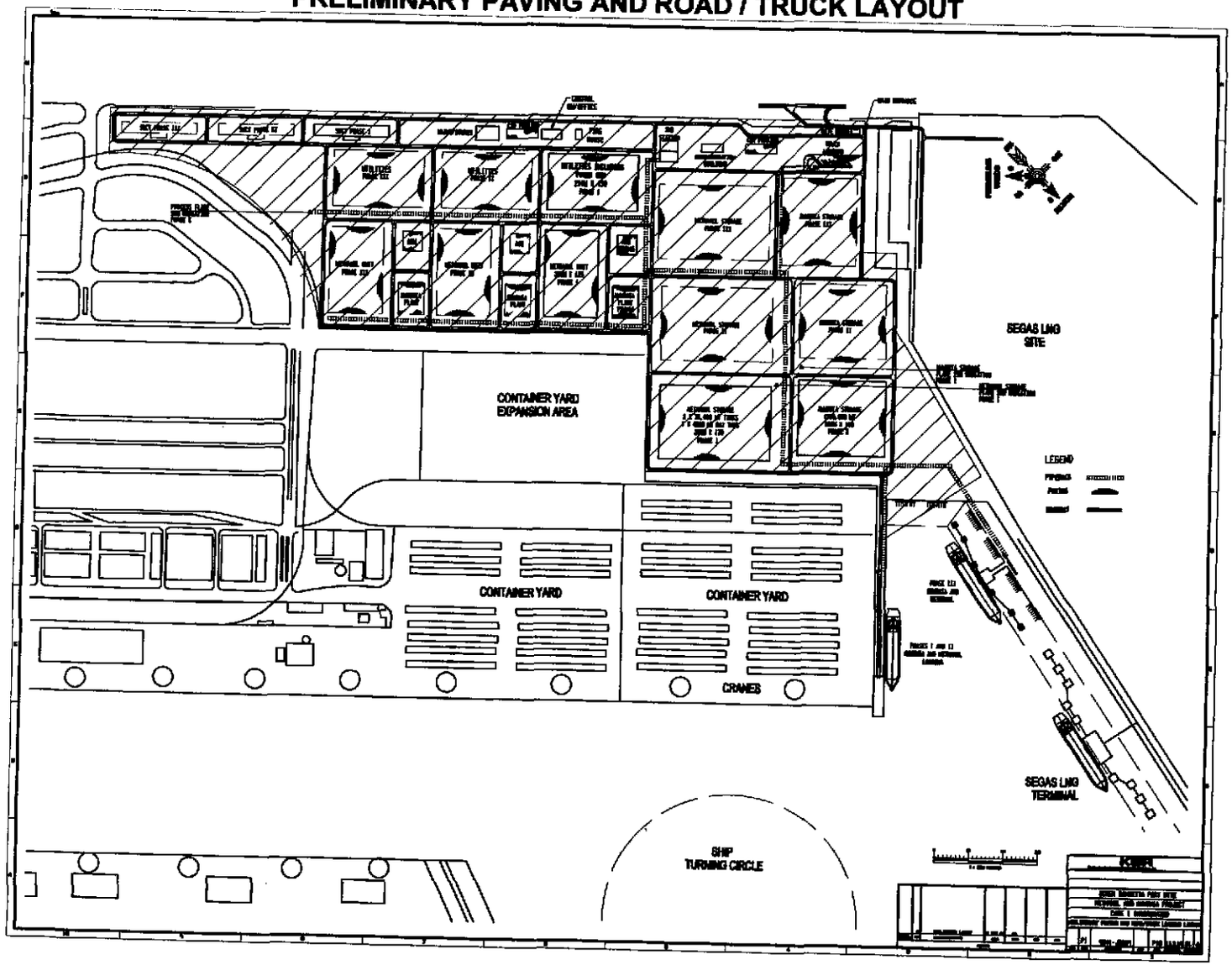
## PRELIMINARY SITE DRAINAGE LAYOUT



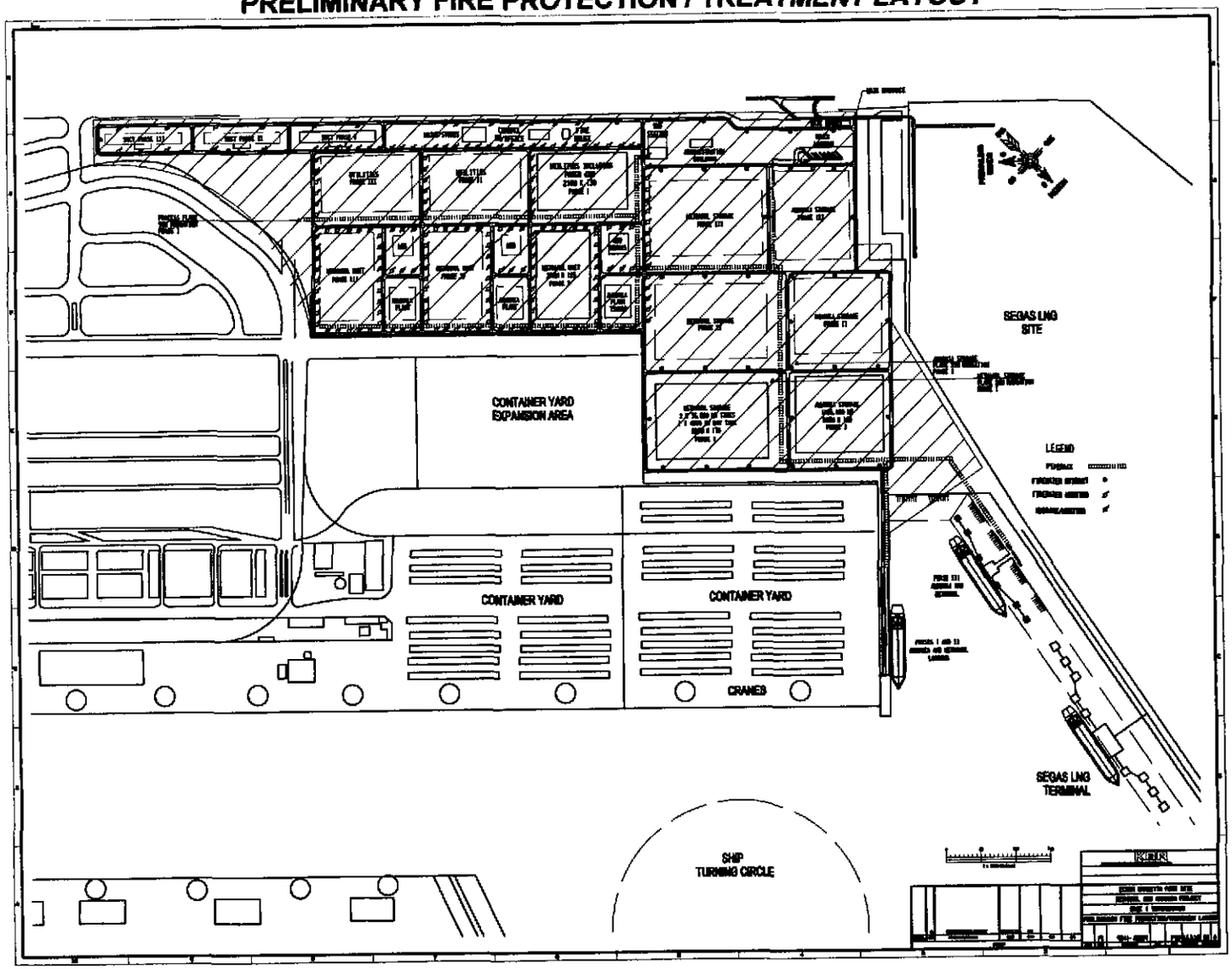
## PRELIMINARY BURIED PIPEWAY LAYOUT



## PRELIMINARY PAVING AND ROAD / TRUCK LAYOUT

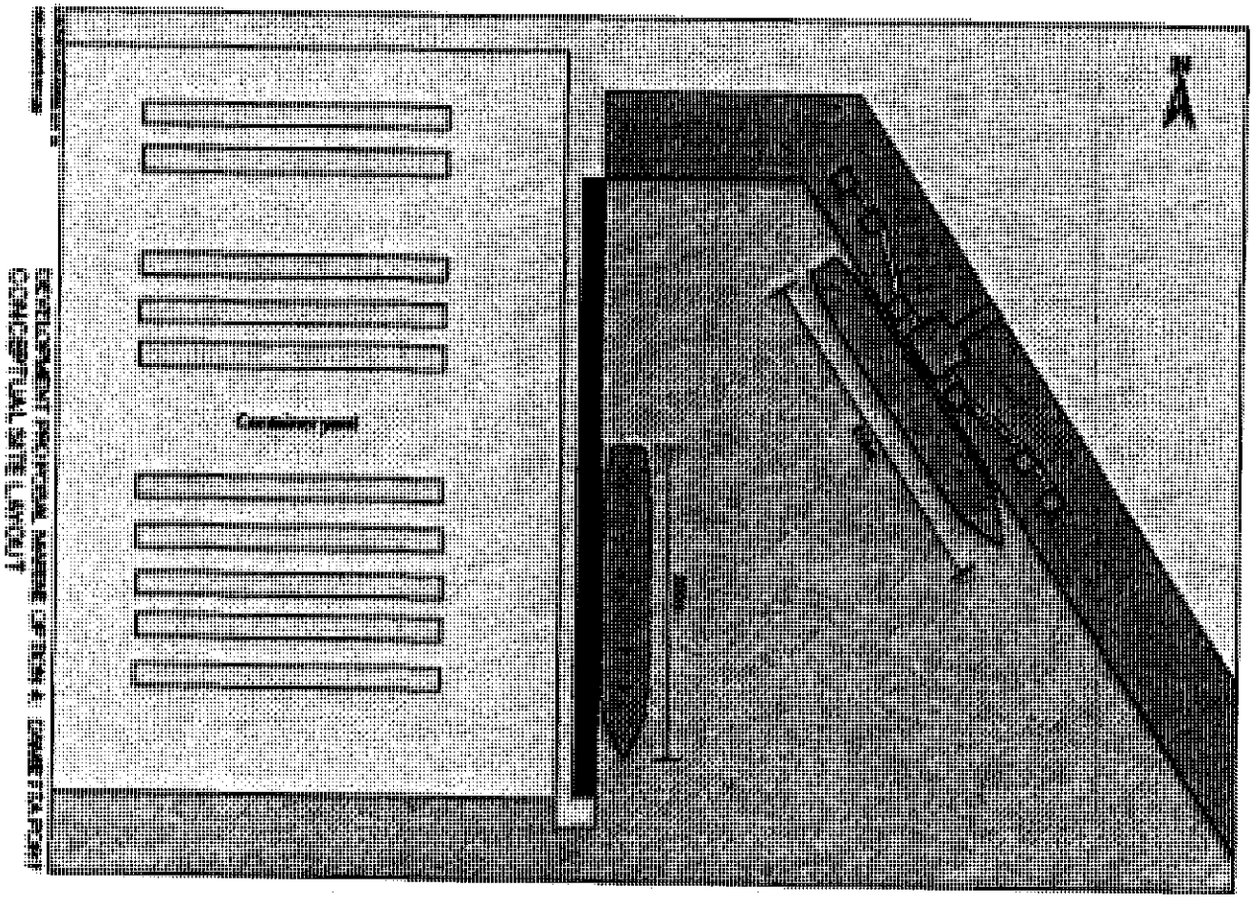


## PRELIMINARY FIRE PROTECTION / TREATMENT LAYOUT

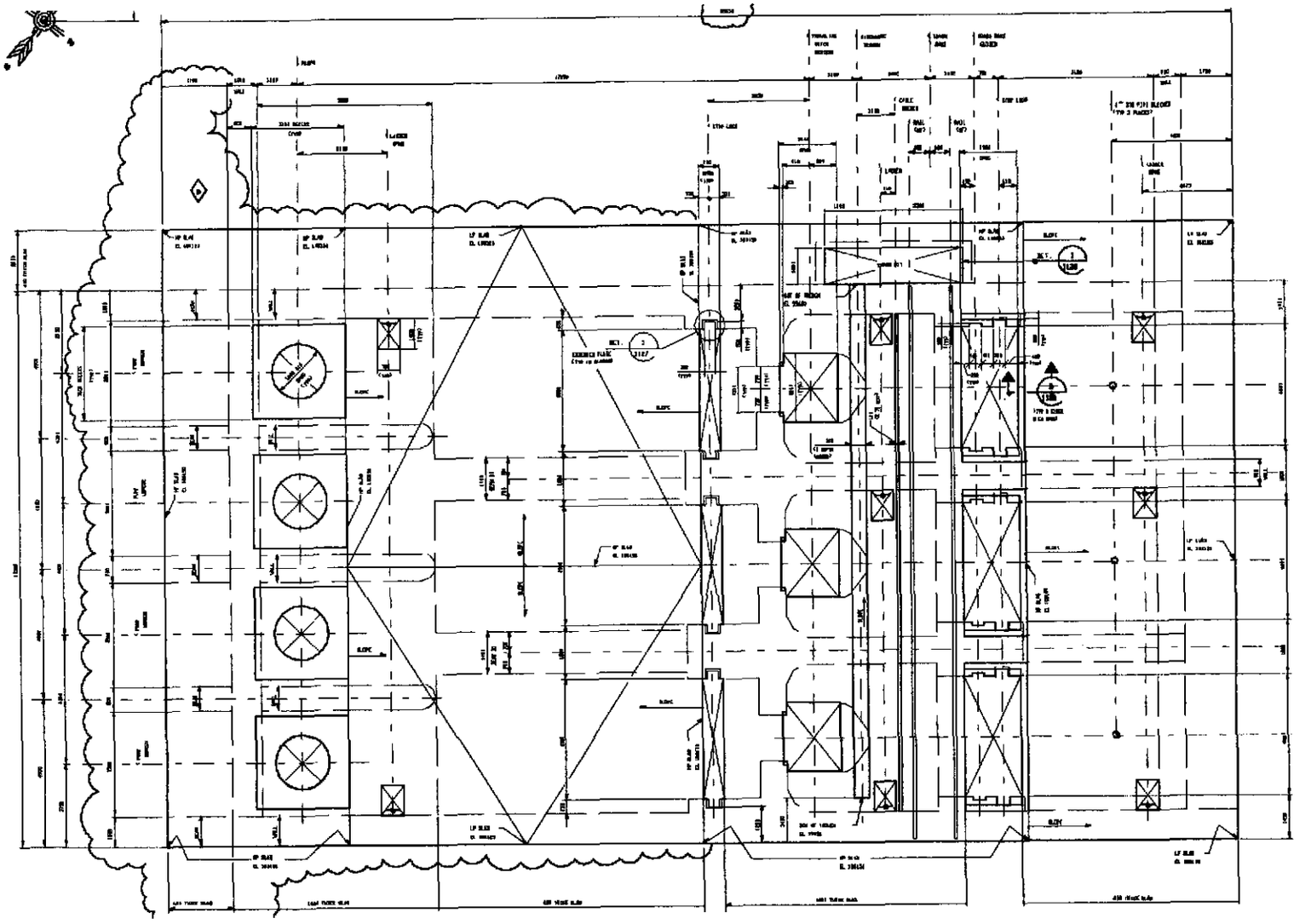


## PRELIMINARY LAYOUT OF THE DEDICATED SHIP BERTHS

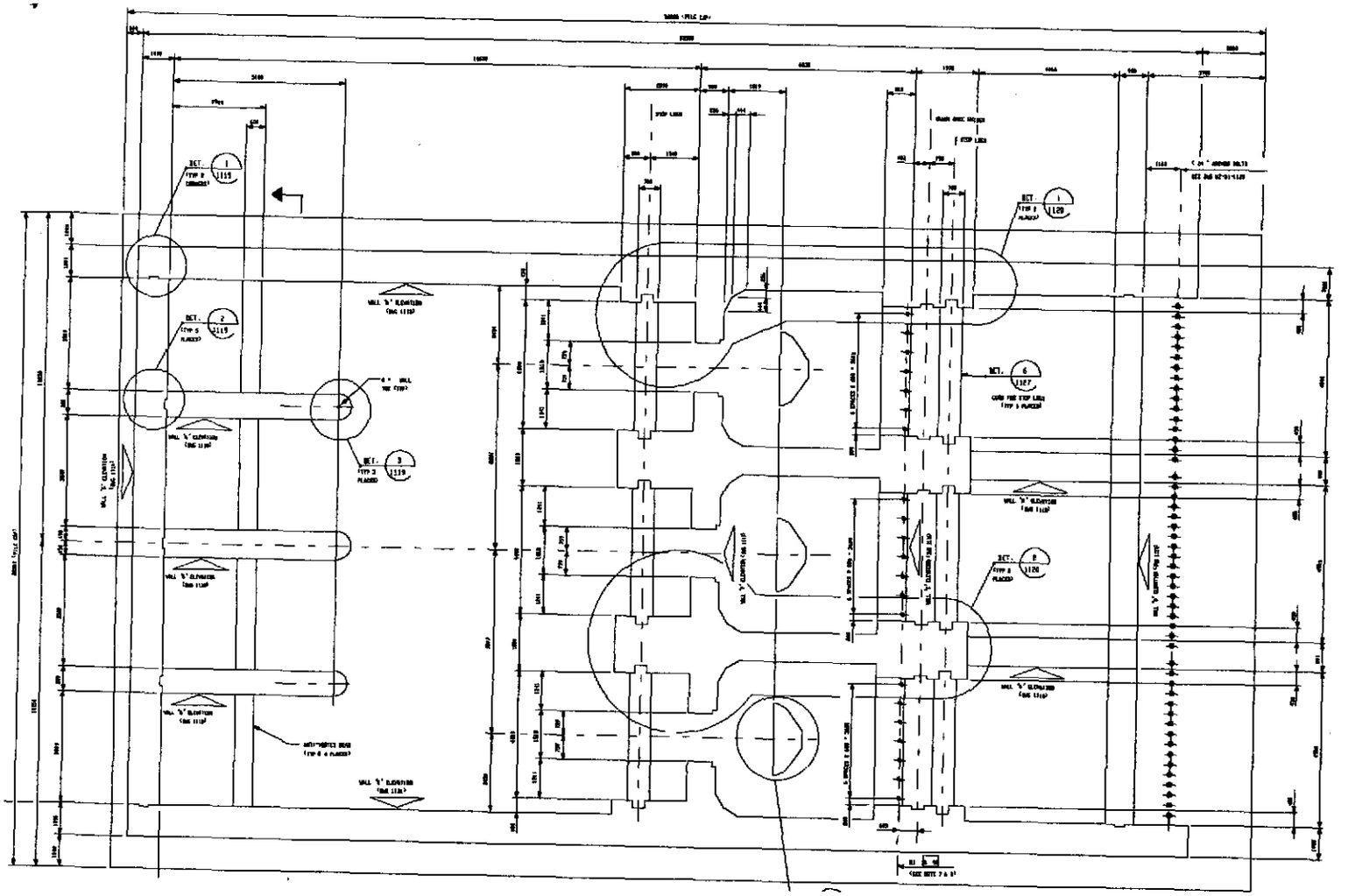
## (Phase I & II on left and Phase III on Right)



## TYPICAL ARRANGEMENT OF SEAWATER INLET BASIN – TOP SLAB



## TYPICAL ARRANGEMENT OF SEAWATER INLET BASIN – PLAN BELOW TOP SLAB



## B.5.4 Governing Codes and Standards

The Project will be designed in accordance with internationally accepted engineering and construction standards. Where Egyptian Standards related to the work are available, these standards shall govern, unless the Egyptian Standard can be amended following discussion and approval by the governing Egyptian codes, standards and regulatory authority.

### B.5.4.1 Project Engineering Design Codes and Standards

**INTERNATIONAL DESIGN CODES AND STANDARDS USED BY KBR TO DESIGN FERTILIZER PRODUCTION UNITS**

| CODE or STANDARD | APPLICATION |
|---|---|
| **American Concrete Institute (ACI)** | |
| ACI 308 | Standard Practice for Curing Concrete |
| ACI 506R | Guide to Shot-Crete |
| | |
| **American Society of Civil Engineers (ASCE)** | |
| ASCE | Design of Blast Resistant Buildings in Petrochemical Facilities, 1997 |
| ASCE 7-98 | Minimum Design Loads for Buildings and Other Structures |
| | |
| **Concrete Reinforcing Steel Institute (CRSI)** | |
| CRSI | Manual of Standard Practice |
| | |
| **American Institute of Steel Construction** | |
| AISC | Manual of Steel Construction, Allowable Stress Design |
| AISC | Specification of Structural Steel Buildings |
| AISC | Test Method to Determine the Slip Coefficient for Coatings Used in Bolted Joints |
| | |
| | |
| **American Society For Testing And Materials** | |
| ASTM A105/A105M | Carbon Steel Forgings for Piping Applications |
| ASTM A106/A106M | Seamless Carbon Steel Pipe for High-Temperature Service |
| ASTM A123 | Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products |
| ASTM A134 | Pipe, Steel, Electric-fusion (Arc)-Welded (Sizes NPS 16 and Over) |

| CODE or STANDARD | APPLICATION |
|---|---|
| ASTM A139 | Electric-Fusion (Arc)-Welded Steel Pipe (NPS 4 and over) |
| ASTM A143 | Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedures for Detecting Embrittlement |
| ASTM A153/153M | Zinc Coating (Hot-Dip) on Iron and Steel Hardware |
| ASTM A161 | Seamless Low-Carbon and Carbon-Molybdenum Steel Still Tubes for Refinery Service |
| ASTM A167 | Stainless and Heat-Resisting Chromium-Nickel Plate, Sheet and Strip |
| ASTM A179/A179M | Seamless Cold-Drawn Low-Carbon Steel Heat-Exchanger and Condenser Tubes |
| ASTM A182/A182M | Forged of Rolled Alloy-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service |
| ASTM A185 | Steel Wire Fabric, Plain, for Concrete Reinforcement |
| ASTM A193/193M | Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service |
| ASTM A194/194M | Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service |
| ASTM A200 | Seamless Intermediate Alloy-Steel Still Tubes for Refinery Service |
| ASTM A203/A203M | Pressure Vessel Plates, Alloy Steel, Nickel |
| ASTM A210/A210M | Seamless Medium-Carbon Steel Boiler and Superheater Tubes |
| ASTM A213/A213M | Seamless Ferritic and Austenitic Alloy-Steel Boiler, Superheater, and Heater-Exchanger Tubes |
| ASTM A214/214M | Electric-Resistance-Welded Carbon Steel Heat-Exchanger and Condenser Tubes |
| ASTM A216/A216M | Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service |
| ASTM A217 | Steel Castings, Martensitic Stainless Steel and Alloy, for Pressure-Containing Parts Suitable for High-Temperature Service |
| ASTM A234/234M | Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service |
| ASTM A240/A240M | Heat Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels |
| ASTM A249/A249M | Welded Austenitic Steel Boiler, Superheater, Heat-Exchange, and Condenser Tubes |
| ASTM A266 | Carbon Steel Forgings for Pressure Vessel Components |
| ASTM A271 | Seamless Austenitic Chromium-Nickel Steel Still Tubes for Refinery Service |
| ASTM A276 | Stainless Steel Bars and Shapes |

| CODE or STANDARD | APPLICATION |
|---|---|
| ASTM A283/A283M | Low and Intermediate Tensile Strength Carbon Steel Plates |
| ASTM A285 | Pressure Vessel Plates, Carbon Steel, Low-and Intermediate-Tensile Strength |
| ASTM A297/A297M | Steel Castings, Iron-Chromium and Iron-Chromium-Nickel, Heat Resistant, for General Application |
| ASTM A307 | Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength |
| ASTM A312/A312M | Seamless and Welded Austenitic Stainless Steel Pipes |
| ASTM A319 | Gray Iron Castings for Elevated Temperatures for Non-Pressure Containing Parts |
| ASTM A320/320M | Alloy Steel Bolting Materials for Low-Temperature Service |
| ASTM A325 | Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength |
| ASTM A333/A333M | Seamless and Welded Steel Pipes for Low-Temperature Service |
| ASTM A334/A334M | Seamless and Welded Carbon and Alloy-Steel Tubes for Low-Temperature Service |
| ASTM A335 | Seamless Ferritic Alloy-Steel Pipe for High-Temperature Service |
| ASTM A336/A336M | Alloy Steel Forgings for Pressure and High Temperature Parts |
| ASTM A350/A350M | Carbon and Low-Alloy Steel Forgings, Requiring Notch Toughness Testing for Piping Components |
| ASTM A351/A351M | Castings, Austenitic, Austenitic-Ferritic (Duplex), for Pressure-Containing Parts |
| ASTM A352/A352M | Steel Castings, Ferritic and Martensitic, for Pressure Containing Parts, Suitable for Temperature Service |
| ASTM A353/A353M | Pressure Vessel Plates, Alloy Steel, 9 Percent Nickel, Double-Normalized and Tempered |
| ASTM A358/A358M | Electric-Fusion-Welded Austenitic Chromium-Nickel Alloy Steel Pipe for High-Temperature Service |
| ASTM A36/A36M | Carbon Structural Steel |
| ASTM A385 | Providing High-Quality Zinc Coatings (Hot Dip) |
| ASTM A387/A387M | Pressure Vessel Plates, alloy Steel, Chromium-Molybdenum |
| ASTM A403/A403M | Wrought Austenitic Stainless Steel Piping Fittings |
| ASTM A420/A420M | Piping Fittings of Wrought Carbon Steel and Alloy Steel for Low-Temperature Service |
| ASTM A463/A463M | Steel Sheet, Aluminum-Coated by the Hot-Dip Process |
| ASTM A475 | Zinc-Coated Steel Wire Strand |
| ASTM A48 | Gray Iron Castings |

| CODE or STANDARD | APPLICATION |
|---|---|
| ASTM A488/488M | Standard Practice for Steel Castings, Welding, Qualifications of Procedures and Personnel |
| ASTM A516/A516M | Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service |
| ASTM A519 | Seamless Carbon and Allow Steel Mechanical Tubing |
| ASTM A522/A522M | Forged or Rolled 8 and 9% Nickel Alloy Steel Flanges, Fittings, Valves, and Parts for Low-Temperature Service |
| ASTM A53/A53M | Pipe, Steel, Black and Hot-Dipped, Zinc-coated, Welded and Seamless |
| ASTM A536 | Ductile Iron Castings |
| ASTM A537/A537M | Pressure Vessel Plates, Heat Treated, Carbon-Manganese-Silicon Steel |
| ASTM A541/A541M | Quenched and Tempered Carbon Treated Carbon and Alloy Steel Forgings, for Pressure Vessel Components |
| ASTM A553 | Pressure Vessel Plates, Alloy Steel, Quenched and Tempered 8 and 9% Nickel |
| ASTM A563 | Carbon and Alloy Steel Nuts |
| ASTM A572/A572M | High Strength Low Alloy columbium-Vanadium Structural Steel |
| ASTM A573/A573M | Structural Carbon Steel Plates of Improved Toughness |
| ASTM A6 | General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling |
| ASTM A633/A633M | Normalized High-Strength Low-Alloy Structural Steel Plates |
| ASTM A671 | Electric-Fusion -Welded Steel Pipe for Atmospheric and Lower Temperatures |
| ASTM A672 | Electric-Fusion -Welded Steel Pipe for High-Pressure Service at Moderate Temperatures |
| ASTM A673/A673M | Sampling Procedure for Impact Testing of Structural Steel |
| ASTM A691 | Carbon and Alloy-Steel Pipe, Electric-Fusion-Welded for High-Pressure Service at High Temperatures |
| ASTM A743/A743M | Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion-Resistant, for General Application |
| ASTM A744/A744M | Castings, Iron-Chromium, Corrosion Resistant for Severe Services |
| ASTM A765/A765M | Carbon Steel and Low Alloy Steel Pressure-Vessel Component Forgings with Mandatory Toughness Requirements |
| ASTM A780 | Repair of Damaged and Uncoated Areas Hot-Dip Galvanized Coatings |
| ASTM A792/A792M | Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot Dip Process |

| CODE or STANDARD | APPLICATION |
|---|---|
| ASTM A992 | Steel for Structural Shapes for Use in Building Framing |
| ASTM B209 | Aluminum and Aluminum Alloy Sheet and Plate |
| ASTM B695 | Coatings of Zinc Mechanically Deposited on Iron and Steel |
| ASTM C1086 | Glass Fiber Felt Thermal Insulation |
| ASTM C1335 | Measuring Non-Fibrous Content of Man-Made Rock and Slag Mineral Fiber Insulation |
| ASTM C150 | Portland Cement |
| ASTM C33 | Concrete Aggregates |
| ASTM C518 | Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus |
| ASTM C533 | Calcium Silicate Block and Pipe Thermal Insulation |
| ASTM C547 | Mineral Fiber Pipe Insulation |
| ASTM C552 | Cellular Glass Thermal Insulation |
| ASTM C591 | Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation |
| ASTM C592 | Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type) |
| ASTM C610 | Molded Expanded Perlite Block and Pipe Thermal Insulation |
| ASTM C612 | Mineral Fiber Block and Board Thermal Insulation |
| ASTM D4285 | Indicating Oil or Water in Compressed Air |
| ASTM D4417 | Field Measurement of Surface Profile of Blast Cleaned Steel |
| ASTM D56 | Test Method for Flash Point by Tag Closed Tester |
| ASTM D93 | Test Methods for Flash Point by Pensky-Martens Closed Cup Tester |
| ASTM E112 | Determining Average Grain Size |
| ASTM E165 | Liquid Penetrant Examination |
| | |
| ASTM E741 | Method for Determining Air Changes in a Single Zone By Means of a Tracer Gas Dilution |
| ASTM E90 | Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements |
| ASTM F436 | Hardened Steel Washers |
| | |
| **American Society of Mechanical Engineers** | |
| ASME A17.1 | Safety Code for Elevators and Escalators |
| ASME B1.20.1 | Pipe Threads, General Purpose |
| ASME B16.11 | Forged Fittings, Socket-Welding and Threaded |
| ASME B16.20 | Metallic Gaskets for Pipe Flanges - Ring-Joint, Spiral- |

| CODE or STANDARD | APPLICATION |
|---|---|
| | Wound, and Jacketed |
| ASME B16.21 | Nonmetallic Flat Gaskets for Pipe Flanges |
| ASME B16.47 | Large Diameter Steel Flanges NPS 26 Through NPS 60 |
| ASME B16.5 | Pipe Flanges and Flanged Fittings NPS 1/2 through NPS 24 |
| ASME B18.2.2 | Square and Hex Nuts |
| ASME B18.2.22.1 | Plain Washers |
| ASME B31.1 | Power Piping |
| ASME B31.3 | Process Piping |
| ASME B46.1 | Surface Texture (Surface Roughness, Waviness and Lay) |
| ASME Section I | Power Boilers |
| ASME Section II | Material Specifications |
| ASME Section II Part A | Ferrous Materials |
| ASME Section II Part B | Nonferrous Materials |
| ASME Section II Part C | Welding Rods, Electrodes and Filler Metals |
| ASME Section II Part D | Material Properties |
| ASME Section IX | Welding and Brazing Qualifications |
| ASME Section V | Nondestructive Examination |
| ASME Section VIII | Boiler and Pressure Vessel Code |
| ASME Section VIII Division 1 | Pressure Vessels |
| ASME Section VIII Division 2 | Alternate Rules |
| | |
| **Welding Research Council (WRC)** | |
| Bulletin Number 107-79 | Local Stresses in Spherical and Cylindrical Shells Due to External Loadings |
| Bulletin Number 297-84 | Local Stresses in Cylindrical Shells Due to External Loadings on Nozzles |
| **American Welding Society (AWS)** | |
| AWS A4.2/A4.2M | Calibrating Magnetic Instruments to Measure the Delta Ferrite Content of Austenitic And Duplex Austenitic-Ferritic Stainless Steel Weld Metal |
| | |
| **American Petroleum Institute** | |
| API 2000 | Venting Atmospheric and Low-Pressure Storage Tanks (Nonrefrigerated and Refrigerated) |
| API 526 | Flanged Steel Pressure Relief Valves |
| API 527 | Seat Tightness of Pressure Relief Valves |
| API 5L | Line Pipe |
| API 617 | Centrifugal Compressors for Petroleum, Chemical and Gas Service Industries |
| API 620 | Design and Construction of Large, Welded, Low- |

| CODE or STANDARD | APPLICATION |
|---|---|
| | Pressure Storage Tanks |
| API 650 | Welded Steel Tanks for Oil Storage |
| API MPMS Ch. 2.2A | Measurement and Calibration of Upright Cylindrical Tanks by the Manual Strapping Method |
| API RP 520 | Sizing, Selection, and Installation of Pressure-Relieving Devices in Refineries |
| API RP 520 Part I | Sizing and Selection |
| API RP 520 Part II | Installation |
| API RP 521 | Guide for Pressure Relieving and Depressuring Systems |
| API STD 530 | Calculation of Heater-Tube Thickness in Petroleum Refineries |
| | |
| **AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)** | |
| AISC | Manual of Steel Construction, Allowable Stress Design |
| AISC | Specification for Structural Steel Buildings |
| | |
| **American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)** | |
| | |
| **National Fire Protection Association (NFPA)** | |
| NFPA 13 | Sprinkler System Installation |
| NFPA 14 | Standpipe and Hose System |
| NFPA 1496 | Electrical Equipment, for Purged and Pressurized Enclosure |
| NFPA 15 | Water Spray Fixed System |
| NFPA 2001 | Fire Extinguishing Systems, Clean Agents |
| NFPA 30 | Flammable and Combustible Liquids Codes |
| NFPA 496 | Purged and Pressurized Enclosures for Electrical Equipment |
| NFPA 497 | Classification of Flammable Liquids, Gases, or Vapors and of Hazardous (Classified) Location for Electrical Installation in Chemical Process Areas |
| NFPA 497A | Classification of Class I Hazardous (Classified) Locations for Electrical Installations in Chemical Plants |
| NFPA 70 | Electric Code, National |
| NFPA 78 | Lightning Protection Code |
| | |
| **National Association of Corrosion Engineers (NACE)** | |
| NACE RP0178 | Fabrication Details, Surface Finish Requirements, and Proper Design Considerations for Tanks and Vessels to be Lined for Immersion Service |
| | |

| CODE or STANDARD | APPLICATION |
|---|---|
| **Rubber Manufacturer's Association (RMA)** | |
| RMA Technical Bulletins Numbers 1 & 2 | Protective Linings |
| | |
| **Steel Joist Institute (SJI)** | |
| | |
| Wozinak, R.S. and Mitchell, V.W. "Basis of Seismic Design Provisions for Welded Steel Storage Tanks" | |
| (Ref" API 1978 Proceedings - Refinery Department) | |
| | |
| **Steel Structures Painting Council (SSPC)** | |
| SSPC-PA 1 | Shop, Field, and Maintenance Painting |
| SSPC-PA 2 | Guide to Safety in Paint Application |
| SSPC-Vis 1 | Visual Standard for Abrasive Blast Cleaned Steel |
| SSPC-SP 1 | Solvent Cleaning |
| SSPC-SP 2 | Hand Tool Cleaning |
| SSPC-SP 3 | Power Tool Cleaning |
| SSPC-SP 10 | Near-White Blast Cleaning |
| SSPC-SP 11 | Power Tool Cleaning to Bare Metal |
| | |
| **American National Standards Institute (ANSI)** | |
| ANSI C2 | National Electrical Safety Code |
| | |
| **Institute of Electrical and Electronic Engineers (IEEE)** | |
| IEEE 80 | Guide for Safety in AC Substation Grounding |
| IEEE 141 | Recommended Practice for Electric Power Distribution for Industrial Plants |
| IEEE 142 | Recommended Practice for Grounding of Industrial and Commercial Power System |
| IEEE 446 | Recommended Practice for Emergency and Standby Power Systems for Industrial and Commercial Applications |
| | |
| **National Electrical Manufacturers Association (NEMA)** | |
| NEMA MG-1 | Motors and Generators |
| NEMA ICS-1 | General Standards for Industrial Controls and Systems |
| NEMA/ANSI Various | Current Editions of Equipment Standards equally adopted by the American National Standards Institute |
| | |
| **Engineering Equipment and Material Users Association (EEMUA)** | |
| | |
| EEMUA Publication No. 104 | Noise; A Guide to Information Required from Equipment Vendors |
| EEMUA Publication No. 140 | Noise Procedure Specification |

| CODE or STANDARD | APPLICATION |
|---|---|
| EEMUA Publication No. 141 | Guide to the Use of the Noise Procedure Specification |
| EEMUA Publication No. 161 | Guide to the Selection and Assessment of Silencers and Acoustic Enclosures |
| | |
| **Conservation of Clean Air and Water - Europe (CONCAWE)** | |
| CONCAWE Report 4/81 | The Propagation of Noise from Petroleum and Petrochemical Complexes to Neighbouring Communities |
| CONCAWE Report 87/59 | The Prediction of Noise Radiated from Pipe Systems - An Engineering Procedure for Plant Design |

B.5.4.2 Egyptian Codes and Regulations

The following is a list of the known and applicable Egyptian codes and regulations pertaining to the onshore and marine design and construction.

B.5.4.2.1 Egyptian Marine Construction Codes and Regulations [1]

**Policy and Regulations**

The environmental policy and regulations likely to apply to the design, construction, and operation of the marine terminal, which will be constructed in the coastal zone. The coastal zone in Egypt had been defined (EEAA, 1996) as, *"The coastal zone is the domain of land-sea interface. It encompasses the territorial water and extending to areas of active interactions with the marine environment for at least 30 kilometers in the desert areas, unless major topographic features interrupt this stretch, while in the lower Nile delta region the terrestrial part would be extended up to contour +3.00 meters*".

License for any development (including in the coastal area) is obtained from the Competent Administrative Authority (CAA). In the case of Urea/Ammonia/Methanol terminal the CAA would be the Ministry of Petroleum and Mineral Resources represented by ECHEM. License is granted for construction and operation after approvals are obtained mainly;

From the Egyptian Environmental Affairs Agency (EEAA) on the EIA according to law 4/94,

The Shore Protection Authority (SPA) according to law 12/84, and

The Port Authority according to Law 1/96 (specially if a new port or terminal is developed).

Military approval must also be obtained before starting the construction, steps for granting this approval is also beyond the scope of this study. However, application usually includes submission of maps to the Military authorities through the Competent Administrative Authority (ECHEM).

The potential implications of the above national policies and regulations on the project are summarized below

**Egyptian Law 4 of 1994, "Law for the Environment"**

This is the primary piece of Egyptian Environmental Legislation and deals with protection of the Land/water/air environment from pollution. It comprises two documents, the Environmental law number 4/1994 and its Executive Regulations number 335/1995.

The law and Regulations indicate that the marine project will be considered a Black list project (C list), requiring a full EIA, on four counts:

a) It concerns the processing, storage and transport of hydrocarbons.

b) It involves the construction of apart capable of handling vessels in excess of 25 DWT.

c) It is proposed in a location that is classified for tourism.

d) It will involve construction within the coastal zone.

[1] *With acknowledgement to Halcrow Inc and CMAI.*

**Requirements/Measures**

1. Environmental Impact Assessment (EIA) will be required as part of the approvals process. A marine terminal in the coastal area is defined as Category C in the EEAA guidelines and would require a full-fledged EIA. Guidelines for conducting EIA for ports, harbors, and Marinas are issued by the EEAA in 1999. The EIA is submitted to the EIA for review and decision-making ONLY through the CAA. According to law 4/94, the EEAA is given a period of 60 days to make their decision. Experience had shown that the EEAA send comments within this duration and usually a six months period is considered adequate to obtain the approval on the EIA by the EEAA. It is strongly recommended that an EIA is submitted early enough in the project design cycle and also to involve the EEAA staff in the procedure during the preparation of the EIA. EEAA approval usually issued with construction and operation conditions which must be considered later in the project.

2. Describe procedures for the storage and handling of hazardous substances and the licensing procedure.

3. Prohibits the discharge of oil and oily mixtures (above 15 ppm) in Egyptian waters.

4. Prescribe the statutory requirements for protection of the water (liquid emission limits) and air environment (gaseous and noise emission limits).

5. Defines administrative procedures for dealing with spills.

6. Prohibits vessels from the discharge of polluted wastewater into Egyptian waters. In order to dispose of the wastewater the ship must:

   - hold a valid international certificate for pollution prevention .
   - discharge treated wastewater at a distance greater than 4nm from shore .
   - discharge untreated wastewater at a distance of greater than 12nm form shore
   - discharge at moderate rates whilst maintaining a speed of greater than 4 knots.

7. Requires the marine terminal to be fitted out with adequate facilities to receive polluted wastewater and garbage from ships and that the Port Authority disposes of this in a location in accordance with Environmental and Public Hygienic laws.

8. Prohibits the construction of any establishment within two hundred metered of the Egyptian Coastline, or to take any measures that may affect the natural coastline without the specific permission from the Shore Protection Authority (SPA) and a specific SIA made for this establishment (as discussed later). Specific issues of concern are the impact of the project on erosion, sedimentation, coastal currents and pollution. These specifics must be addressed clearly in the SIA through the use of physical and hydrodynamic models.

9. Related articles to the development in the coastal area in law 4/94 are; Articles 73, 74, 75 and 98 of law 4 of 1994 states that:

***Article 73***: *"It is prohibited to construct any establishment within 200 m of the Egyptian shorelines without the permission of the competent administrative authority in co-ordination with the EEAA. The executive regulations of this Law shall lay down the procedures and conditions to be followed in this connection."*

***Article 74***: *"It is prohibited to take any measures that may affect the natural coast line or alter its configuration either inwards or outwards, without the approval of the competent authority in coordination with EEAA. The executive regulations of this law shall regulate the procedures and conditions to be followed in this connection."*

***Article 75***: *"The representative of the concerned administrative authorities shall be entitled, each within its scope of competence and in coordination with the EEAA, to enter the exclusion zones referred to in articles 73 and 74 of this Law in order to inspect works being carried out therein. If they discover that the works contrary to the foregoing provisions are being executed or are intended to be executed, the violator shall be ordered to restore matters to their original state otherwise the works will be halted administratively and matters restored to their original*

*state at the expense of the violator and the beneficiary jointly. Payment shall be collected by means of administrative attachment."*

***Articles 98*** *"Penalties for violating the provisions of articles 73 and 74 of this Law shall be imprisonment for a period of not more than six months and/or a fine of not less than one thousand Egyptian Pounds and not more than twenty thousand Egyptian Pounds.*

*The court may not order a stay of execution of the fine, and in all cases, the violating works must be halted and removed by administrative means at the expense of the violator and the machinery, equipment and materials used in these works shall be seized without awaiting a court sentence. In case of conviction, such machinery and equipment shall be confiscated."*

Articles 59 and 60 of the executive regulations of law 4/94, states that:

***Articles 59*** *"It is prohibited to issue building permits for the construction of any establishment on the seashores of the Arab Republic of Egypt at a distance of 200 metres inland from the shoreline, except after obtaining the approval of the Egyptian General Shore Protection Authority in co-ordination with the EEAA.*

*The following procedures shall be followed in respect of permits for the construction of these establishments:*

*The application shall be submitted in writing to the coastal governorate concerned (the licensing authority), indicating the type of establishment to be constructed within the prohibited zone, together with an attached study assessing the environmental impact of the project or of new works requiring to be carried out, including their effect on the environmental balance of the coastal area, and on the shoreline, and in particular on the following factors:*

*Erosion*

*Sedimentation*

*Coastal currents*

*Pollution resulting from the project or works*

*The application shall include a detailed statement of precautions proposed to avoid or treat these effects, if any.*

*The coastal governorate shall forward the application to the Egyptian General Shore Protection Authority to express its technical opinion on the project, in co-ordination with the EEAA. The coastal governorate shall also forward the study assessing the environmental impact of the project to the EEAA to review same and render its opinion thereon within sixty days from the date of receiving the said study.*

*The Egyptian General Shore Protection Authority may charge the applicant with the costs of the surveys and studies it carries out.*

*The Minister for Environmental Affairs, after consulting the competent administrative authorities and the governorates concerned, shall issue the conditions for granting a building permit to construct the establishment within the prohibited zone, or to modify the shoreline.*

***Article 60**: It is prohibited to authorize the carrying out of any works that may affect the natural shoreline of the beach or alter its configuration either inwards or outwards, except after obtaining the approval of the Egyptian General Shore Protection Authority in co-ordination with the EEAA. With regard to applications that may affect the natural shoreline or modify, the same procedures and conditions prescribed in the preceding Article shall be applied."*

**Egyptian Law 12 of 1984**

According to the Presidential Decree no. 261 of 1981, the responsibilities of the Egyptian General Shore Protection Authority (SPA) are given as:

Laying a coordinated and inclusive planning of the shore protection projects to match the socio-economic development projects to be executed on the shores and requiring a complete survey of the Egyptian shores to identify the projects needed for its protection

Laying a general plan to protect the shores including priorities to protection projects

Surveying the projects being executed and the required completion

Conducting experimental projects that serves the SPA goals

Certifying the designs of the suggested projects

Laying the necessary foundations for buildings on shores without conflicting with the protection designed for them

Implementing necessary works for shore protection by SPA or through specialized companies

Supervising the implementing works according to the plan and time schedule designed for it

Follow-up of regular maintenance works of the shores

Contacting authorities, departments, Egyptian and Foreign Universities to exchange research and information on shore protection

Cooperating with Scientific Organizations and experienced consulting offices to benefit of their experience in the field of shore protection

Participating in organizations, international and local conventions in the field of shore protection and development

Suggesting the necessary legislation to protect and maintain the shores

Supplying the African, Arab, and friendly nations with advice and technical assistance.

**Related articles in law 12/84**

***Article 86**: It is forbidden to construct any structure on the Northern coast of the country in front of the Mediterranean Sea between the Western and Eastern borders for a distance of 200 meters inland from the shoreline.*

***Article 87**: The Egyptian General Shore Protection Authority has to specify the final demarcation line according to its studies. This line will be, after it is specified, the final demarcation line which should not be over crossed by any construction*

*The indication mentioned in Article 86 lasts until the final line has been specified by the authority and after notifying all concerned Authorities, and after that the line mentioned in Article 86 will be cancelled.*

***Article 88**: In urgent cases needing to construct special constructions in the restricted limited areas mentioned in Article 86, it is stipulated to previously acquire the approval of the Egyptian General Shore Protection Authority has to include in its approval about the construction, the determination of the protection works.*

***Article 97**: The Irrigation and drainage engineers assigned by the Minister of Justice, after the agreement with the Minister of Irrigation, have the right of legal reporting about crimes mentioned in this law lying within their specialization. Engineers of the SPA are also given these rights concerning Articles 86, 87 and 88 of this law.*

***Article 99**: Identifies the punishments for crossing the Articles 86, 87 and 88 of this law.*

Legal Framework

According to Law 12/84, the SPA is the Competent Administrative Authority (CAA) within the set back zone or the 200 m set-back area. It is requested to submit a Shoreline Impact Assessment study (SIA) to the SPA through the licensing authority (ECHEM or the Governorate in Charge).

Shoreline Impact Assessment (SIA) is a systematic examination of the possible impacts on the shoreline of a project to be implemented within the setback zone (Abul-Azm and Anderskov, 2003) The SIA also includes an analysis of the possible measures, which can reduce or mitigate negative consequences on the shoreline and maximize on positive ones. The purpose of the

SIA is to justify the project with regard to acceptable impacts on the shoreline, and to optimize design, location and mitigating measures in order to minimize these effects.

The SIA are dealing with morphology and coastal engineering problems and the Guidelines are fairly detailed with respect to description of the application procedures and formulation of SIA. The high degree of detail makes it easier for an applicant to get an idea of the requirements he is facing when planning to implement a project in the setback zone. The Guidelines describe the application procedure and the SIA form itself, but are also outlining the benefits for the applicant making an early contact to SPA in order to avoid unnecessary studies or project implementations in areas not suitable for the project.

**Generic Content for a Typical SIA**

Cover letter with reference to legislation under which SPA approval is applied for.

SIA report comprising – but not limited to:

Identification of owner and neighbors

Description of type and purpose of project

Location maps (e.g., in 1:5 000 or 1:2 500) in national co-ordinate system

Survey maps in a suitable scale (bathymetric and topographic as appropriate)

Geometric design, alignment of project

Layout of project

Structural design for project elements

Description of construction method

Description of alternatives considered (location, layout, designs, construction methods, etc.)

Input data for SIA: Meteo-marine, waves, wind, morphological, etc.

Modelling: model selection, verification and calibration

Modelling results for all alternatives including the "do-nothing" option

Impact assessment

Proposed mitigating measures to minimize negative impacts

Proposed post-construction activities: Clearance of temporary construction features, monitoring program, maintenance of mitigating measures, etc

Estimated Cost for Works

10 LE – study dues to be paid directly to SPA treasury or by post transfer

Law 12/84 does not specify certain duration for SPA to grant approval. Experience shows that a period of three to four months is usually needed to get this approval, provided that the SIA study is complete and include enough results through the use of numerical or physical models for the project. After review of the SIA, the SPA grants a temporary approval to start construction. The SPA also charges a percentage (about 1% and depending on the size of the project) of the project cost to cover their supervision during construction. Final SPA approval is granted after the completion of the marine terminal and after assessing the shoreline impacts as described in the SIA study, the final approval includes conditions for managing the shore structures and a monitoring program.

**Egyptian Law 1 of 1996 relates to Ports**

***Article 1:*** *This law is concerned with ports related to fishing, oil and gas, mineral resources, tourism and specialized harbors locate on the Egyptian coast line. A presidential decree must be issued for such ports based on a memo presented by the Minister of Transportation in coordination with concerned authorities.*

***Article 2:*** *Any authority requires to construct a specialized port should submit an application to the Ministry of Transportation. The application must include the construction plan and the Ministry of Transportation should conduct the necessary technical studies to assess the suitability of the required port from location and the land facilities and the navigation aids provided for this port. The Ministry of transportation informs the authority with the decision of constructing this port and it will supervise this port during construction.*

***Article 3****: The specialized ports that will be constructed in the future on the Egyptian coastline will be under the supervision the Ministry of Transportation to ensure its safety and its continuity to operate with safe regulations and in a fashion to protect the aquatic environment. The Ministry of Transportation licenses the operation, management, and maintenance of these specialized ports and for the reason it was constructed.*

***Article 4****: The Minster in charge under whose authority the Port is functioning, issue the tariffs for the service boats used in the Port and his decree shall be made in view of law 24/83 and indicates how to pay those tariffs and the cases of exemptions, if any.*

***Article 5****: The Minister of Transportation will issue the executive regulations for this law.*

***Article 6****: This law should not contradict with the pertinent international laws and agreements.*

The Minister of Transportation Decree, Executive Regulations number 81/99 had indicated that in order to construct the specialized Port or to develop an existing Port an application should be submitted to the Naval Transport Sector under the Ministry of Transportation including the followings:

- Data on the applicant and the function of the Port.
- Detailed data on the required Port
- Capital for construction and operation
- List of technical staff and equipment including navigation aids used in the approach navigable channel that will be used in the operation of the Port.
- Detailed drawings and design calculations of the Port project including dimensions, directions, navigable channels and fairways, depths and location. A registered engineering office must stamp the drawings.
- Preliminary approvals from concerned authorities.
- Construction and operation plan.

A study should be submitted (in Arabic) with this application which include:

- Bathymetric survey for the location of the Port indicating the dredging depths required and the type of berth planned.
- Results of the site visit and inspection of the shoreline, and results of the geo-technical survey and the suitability to construct the Port in this area.
- Results of the met-marine conditions and tidal ranges in the area.
- Results of the studies made including but not limited to the studies on the Port Planning, studies on the coastal processes and shoreline erosion, numerical or physical model tests, and durability of the construction material.
- Copy of the Environmental Impact Assessment (EIA).
- The study should also include the entrance channel, direction, water depth, side slopes, location and specification of the fixed and floating navigation aids used.
- The breakwaters type, width, cross-sections, direction, depths, and navigation aids built on the breakwaters.
- Water area including dimensions, depths, and permanent or floating structures.

- Berths and quay walls including lengths, direction, depths, permanent structures, and mechanical equipment used, fenders, bollards and lighting posts
- Roads and railways leading to the Port with a master plan showing the internal transportation roads inside the Port.
- Back areas, custom fences, planning and engineered cross-sections.
- Location of the different buildings inside the Port, function, and footprint area.
- Slipways, docks and lifts used with locations and capacity.
- Construction phases and time schedule and who will be in charge.

The Naval Transport Sector will review the study and give its opinion within 2 months from the date the study is complete. Decision is made indicating the required time to construct the terminal (Port), the location, the land area, and the necessary navigation support units. Their report is sent to the Minster of Transportation as a memo to issue the required license.

The applicant must put a letter of guarantee (L/G) to ensure his seriousness in constructing this terminal; the Head of the Naval Transport Sector specifies the amount of the L/G. A fee of 0.01% of the total construction cost is paid to the Naval Transport Sector for their supervision during construction.

For more details refer to the executive regulation number 81/99 of Law 1/96.

**Summary**

This chapter presented the required permissions and licenses needed to work in the coastal zone in Egypt and to construct a specialized marine terminal (or quay wall inside an existing Port). All applications should be made through the Ministry of Petroleum and Mineral Resources.

(1) Military approval (this was not discussed in details in this study)

(2) An Environmental Impact Assessment Study. The approval of the Egyptian Environmental Affairs Agency (EEAA) is pre-requisite for all licenses. This approval is required if work will be done inside or outside an existing port.

(3) A Shoreline Impact Assessment Study (SIA). The approval is obtained from the General Shore Protection Authority (SPA). This approval to work in the setback area of 200-m inland from the shoreline. This approval is not required in case the work will take place inside an existing Port.

(4) A license to construct and operate the terminal obtained from the Ministry of Transportation through the Naval Transport Sector according to Law 1/96.

B.5.4.2.2. Egyptian Onshore Construction Consents, Permits and Approvals

The Contractor will be responsible for obtaining the following permits and all others not indicated that could be required for the Performance of Works:

- Materials registration, testing, and approval
- Permits for transportation of materials by _____(barge)
- Electrical equipment certification
- Permits for radiography
- Egypt Police permit
- Hazardous and non-hazardous waste management areas for construction
- Permits for radio _____
- Civil aviation permits for tall structures
- Import and certification permits for construction equipment
- Permits related to disposal of construction wastes
- Permits related to the opening and operations of _____
- Permits related to temporary facilities
- Civil Defense permits related to fire fighting equipment and_____ for temporary works
- Permits for offshore dredging and trenching
- Import permits for materials

The following permits apply solely to Owner activities and are not considered the Contractor's responsibility.

Contractor will prepare all necessary drawings and other documentation/information is _____ the following permits in accordance with the Project Specification and technical documentation specified in the Contract

- Overall Licensee for import and use by Owner of the Materials (if required)
- _____ Construction Permit and _____ Jetty construction [1]
- Civil Defense permits related to firefighting equipment and facilities for the Plant [1]
- Safety and Hazard Civil Defense [1]
- Environmental Impact Assessment [1]
- Hazardous and non-hazardous waste management areas for plant operation
- Plant Operation Permits

- Permits related to marine facilities operation such as navigation aid, berth monitoring system, etc.

(1) Main Permits

The following permits are not applicable to the project:

- Permits for rock blasting and for transport to and from site of associated explosives.

B.5.4.2.3. Egyptian Environmental Consents, Permits and Approvals (1)

**Relevant Laws and Regulations**

Law No. 4 is the main Environmental Law in Egypt concerning the environment and was passed in 1994. The Executive Statutes of this law were set out in 1995. This law established an Egyptian Environmental Affairs Agency (EEAA). The EEAA has the power to set criteria and conditions, monitor compliance and to take procedures against violators of these criteria and conditions. Various decrees have also been passed dealing with drainage of liquid wastes, and protection of the River Nile and other waterways from pollution.

The law dictates that the licensing authority must assess the environmental impacts of proposed facilities, Article 10, Decree 338 (A10/D338). The license application must include data to be entered in Form A12/D338, which shall be maintained as a register of the facility's impact on the environment during operation (A17/D338).

Form A12/D338 is to contain the following information:

- Emissions emanating or draining from the facility;
- The efficiency of treatment processes and specification of any residual material from the treatment process;
- Details of environmental safety procedures applied in the facility;
- The results of periodic tests and measurements necessary to demonstrate compliance with emission, discharge and health and safety requirements; and,
- The name of the officer in charge of maintaining the register.

The EEAA can visit the facility and take samples to ensure conformity. The EEAA must be notified of any deviation from the criteria by registered letter. The letter must also outline the procedures taken to correct the problem. If a violation occurs and the establishment fails to comply within 60 days the facility could be closed, the violating activity suspended and/or court action could be taken (A18/D338).

Any expansions or renewals to the existing facility or any work, which might result in an adverse impact on the environment or workers, are subject to the preceding articles (A19/D338).

**Conditions in the Workplace**

The facility must operate such that leakage or emission of air pollutants inside the workplace will not affect worker's health and safety (A45/D338). The facility must operate such that humidity and temperature will be maintained within the set limits for workers (A46/D338) and suitable Personal Protective Equipment (PPE) are to be provided as required for workers in the facility.

(1) Acknowledgement to KOMEX

**Use of Dangerous Materials and Wastes**

The production of dangerous materials and wastes is prohibited without a licence. The license is issued for a fixed time interval. The required information to be submitted when applying for a license is summarized in A26/D338. Management of dangerous wastes is subject to rules and procedures, which are set out in A28/D338.

**Air/Odor Emissions**

The facility must demonstrate that it will meet air/odor emission standards, taking into account not only the facility's emissions, but also those of existing industries in the same area (A34 - 36/D338).

The location of the facility must take into account suitability with respect to distance from urban areas and wind direction (A34/D338).

The release of noxious and harmful smoke, gases and fumes resulting from burning fuel at a facility is regulated by A42/D338. This article covers precautions and permissible limits as well as specifications of chimneys in burning any kind of fuel.

**Noise Emissions**

The facility must meet noise regulations for within the workplace, outside the facility and for the area as a whole (A44/D338).

**Disposal of Liquid Wastes**

A license is required to discharge industrial liquid wastes into the public sewer system (A7/Law 93 update and Decree 44/2000). There are existing discharges criteria (A11/D649) to which the liquid wastes must adhere (A8/Law 93). Routine analyses of the liquid wastes should be carried out periodically to ensure compliance with Law 4/94. The Authority in charge of sewerage has the right to obligate the owner to undertake treatment or purification (A4/D649).

Surface drainage of liquid wastes is not allowed except with a license. The criteria for drainage will be set by the Minister of Housing and Utilities (A14/Law 94).

Oily discharges are required to pass through an oil/water separator prior to being discharged (A3/D649).

***Additional Relevant Egyptian Laws/Regulations***

Additional relevant laws and regulations include:

- Egyptian Decree: Prime Minister's Decree No. 338 of the year 1995 (Executive Regulations of the Law Number 4, 1994).
- Minister of Housing and Infrastructure - Decree No. 44 for 2000 – Modifying the Executive Regulations of Law No. 93 for 1962) – maximum limits for reusing treated sewage for irrigation.
- EEAA: 1999. Guidelines for development of Ports, Harbors and Marinas. Environmental Impact Assessment.
- EEAA. Guidelines for Egyptian Environmental Impact Assessment. Environmental Management Sector.
- Egyptian Standard ES1109 (1971). Aggregates from Natural Sources.

**Environmental Register Requirements**

According to the Law of the Environment, all facilities must keep an environmental register. The format of the environmental register is provided in Appendix I.

**Relevant Conventions, Standards and International Regulations**

The design of the plant shall be in accordance to good engineering practice and shall be based on the latest issue of the following standards and/or codes.

**International Conventions**

- MARPOL (1978).
- UN Convention on the Law of the Sea 1982.
- Barcelona Convention.
- Basel Convention on Tran boundary Movements of Waste.

**Standards/Regulations**

- General Guidelines for Full Environmental Impact Assessment, EGPC[1] EH&S General Division, January 1997.
- Standard Methods for examination of Water and Wastewater - Amer. Public Health Assoc.
- Handbook for Sampling and Sample Preservation of water & Wastewater - US EPA.
- Handbook for Analytical Quality Control in Water and Wastewater Laboratories - US EPA.
- International Maritime Organization Dangerous Goods Code.

## B.5.5 Battery Limit Conditions for Feeds and Products (Case 1 Integrated Plant)

**Methanol Plant**

| | | SOR | EOR | |
|---|---|---|---|---|
| | Natural gas | Purge gas | Purge gas | Methanol |
| Specific gravity | 0.584-0.693 | 0.162 | 0.198 | See B.2.1.4 |
| HHV, Btu/scf | 980 -1180 | | | N/A |
| LHV, Btu/scf | | 337 | 335 | 766 |
| B.L. temperature, °C | 38 | 40 | 40 | 40 |
| B.L. pressure, barg | min.35 | 66 | 66 | 5 |

**Ammonia Plant**

| | SOR | EOR | |
|---|---|---|---|
| | Purge gas | Purge gas | Ammonia |
| Specific gravity | 0.162 | 0.198 | 0.684 (-33°C) |
| LHV, Btu/scf | 337 | 335 | N/A |
| B.L. temperature, °C | 40 | 40 | -33°C |
| B.L. pressure, barg | 66 | 66 | 5 |

[1] Egyptian General Petroleum Corporation

**Utilities**

| | |
|---|---|
| Seawater Cooling | Supply temperature 29°C |
| | Return temperature 39°C (not more than + 10°C above supply temperature) |

## B.5.6 Preliminary Product Storage Drawings and Specifications

### B.5.6.1 Ammonia Tank Storage

A 50,000 MT ammonia will be installed for each Phase of the planned methanol/ammonia production expansion. Each of the ammonia units produces 1,200 MTPD of anhydrous ammonia. Although most of the product is anticipated to be exported using bulk ammonia tankers of 43,350 kdwt capacity, truck loading equipment has been included for approximately 15% domestic sales.

The ammonia storage tank is described as follows.

**Description of Ammonia Storage Tank**

Each 50,000 MT Dome Roof Tank (DRT) ammonia tank includes an internal suspended deck and is insulated externally, internally and on the bottom. The tank is installed on an elevated concrete slab with a piled foundation. A typical ammonia storage tank drawing is provided at the end of this section.

**Description of Ammonia Loading**

The jetty head for Phase I shipping will share installed but separate liquid loading arms for Methanol (2 arms) and Ammonia (1 arm). The ammonia loading rate is 750 MTPH.

The ammonia loading arm approximate size is 10-in. x 70 ft. with a 6-in. piggyback vapor return line for operation at 750 MTPH capacity. The loading arm will be designed for loading bulk ammonia ships of 43,350 MTDWAT (57,000 $m^3$, 215.7 m length, 32.3 m beam, 11.48 m draft).

### B.5.6.2 Methanol Storage Tanks

Two methanol storage tanks, each of 35,000 MT capacities, are planned for each phase of the project. Each methanol process unit produces 3,000 MTPD, and the product is stored in the on-site tankage. Most of the product will be exported by ships using 30 kdwt and 40 kdwt capacity bulk ship tankers. Truck loading facilities are also included to handle up to 15% of the product for distribution to the domestic market.

**Description of Methanol Storage Tanks**

Each 35,000 MT DRT methanol tank is installed on an elevated concrete slab with piled foundations. The tanks, which incorporate an internal floating roof, are not insulated. A typical methanol storage tank drawing is provided at the end of this section.

**Description of Methanol Loading**

Two loading arms will be provided for loading of methanol. Their approximate size is 12-in. dia. x 70 ft. with an 8-in. piggyback vapor return line for operation at 1,500 MTPH capacity each. The loading arms will be designed for loading bulk sea carriers of 48,000 MTDWAT (186 m length, 32.2 m beam, 12.22 m draft) and 30,000 MTDWAT (175 m length, 27.7 m beam, 10.02 m draft).

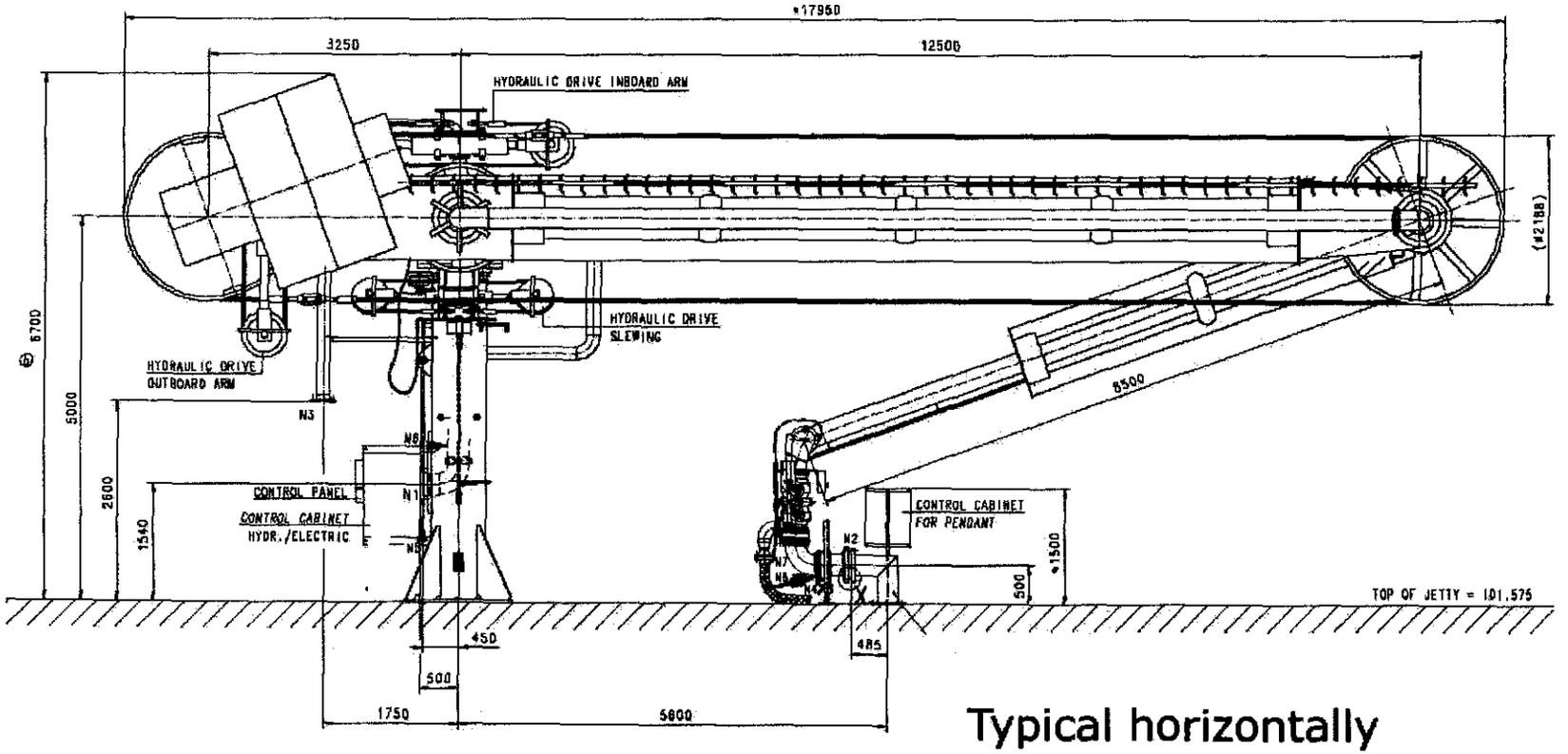
**Ship Loading of Ammonia and Methanol Liquid Products**

During Phases I and II, the single berth will share liquid loading arms for Methanol (2) and Ammonia (1). The second ship berth will be made available for Phase III loading requirements.

Two loading arms will be provided for loading of Methanol. Their approximate size is 12-in. diameter x 70 ft. with an 8-in. piggyback vapor return line for operation at 1,500 MTPH capacity each. The loading arms will be designed for loading sea carriers of 48,000 MTDWAT (186 m length, 32.2 m beam, 12.22 m draft) and 30,000 MTDWAT (175 m length, 27.7 m beam, 10.02 m draft).

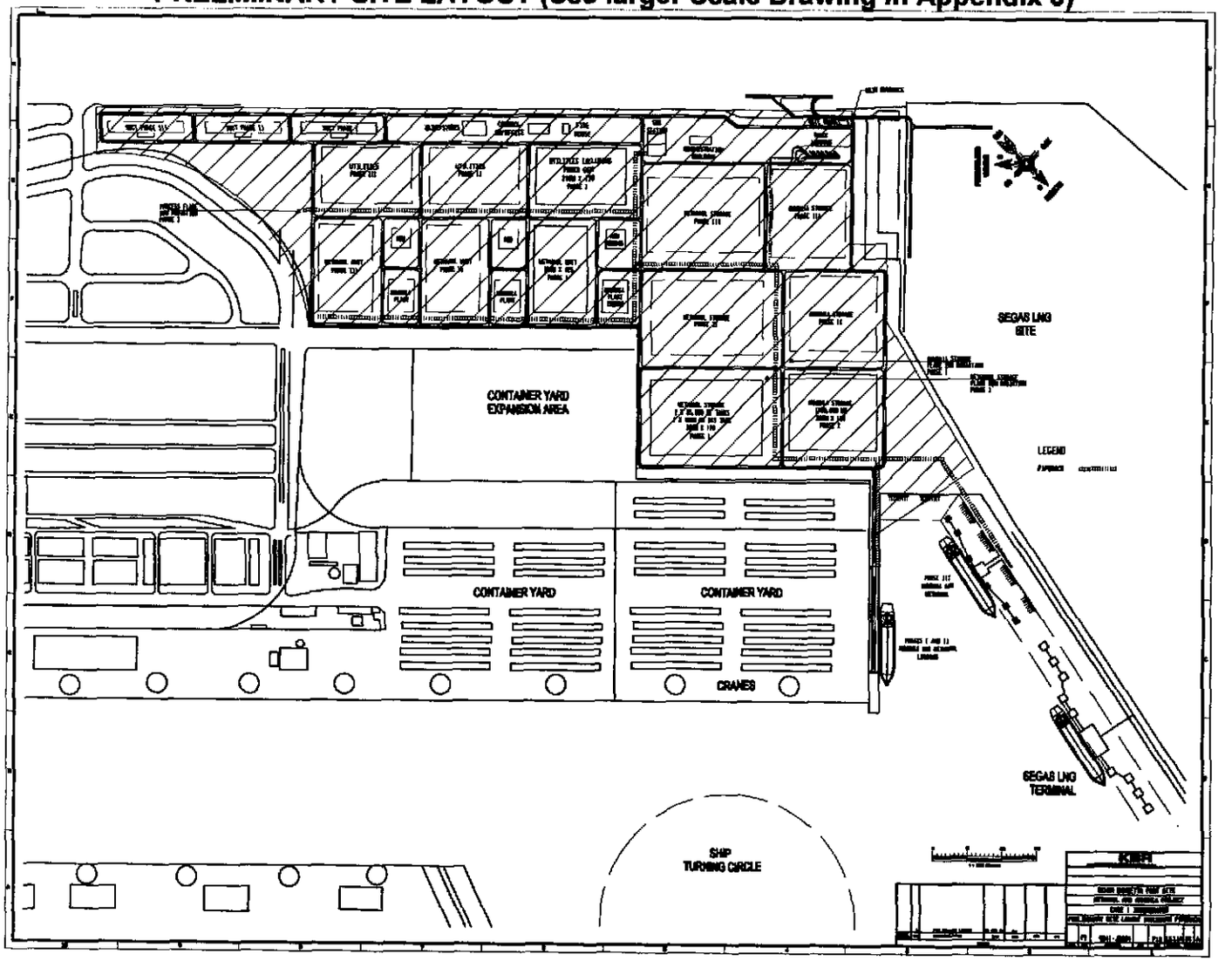
One loading arm will be provided for loading of Ammonia. Its approximate size is 10-in. x 70 ft. with 6-in. piggyback vapor return line for operation at 750 MTPH capacity. The loading arm will be designed for loading sea carriers of 43,350 MTDWAT (57,000 $m^3$, 215.7 m length, 32.3 m beam, 11.48 m draft).

## TYPICAL AMMONIA LOADING ARM

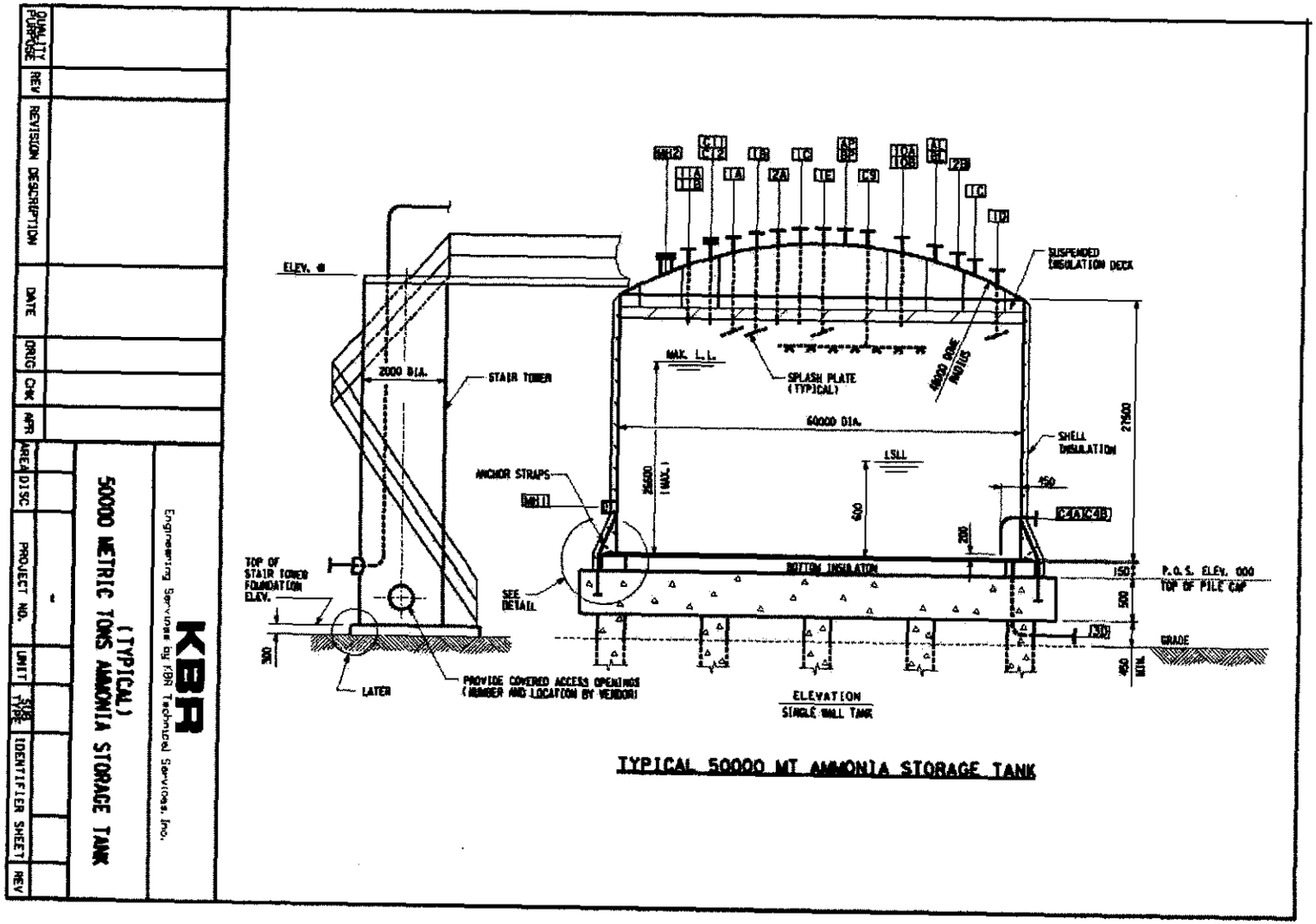



Typical horizontally parked Marine Arm

## PRELIMINARY SITE LAYOUT (See larger Scale Drawing in Appendix 3)

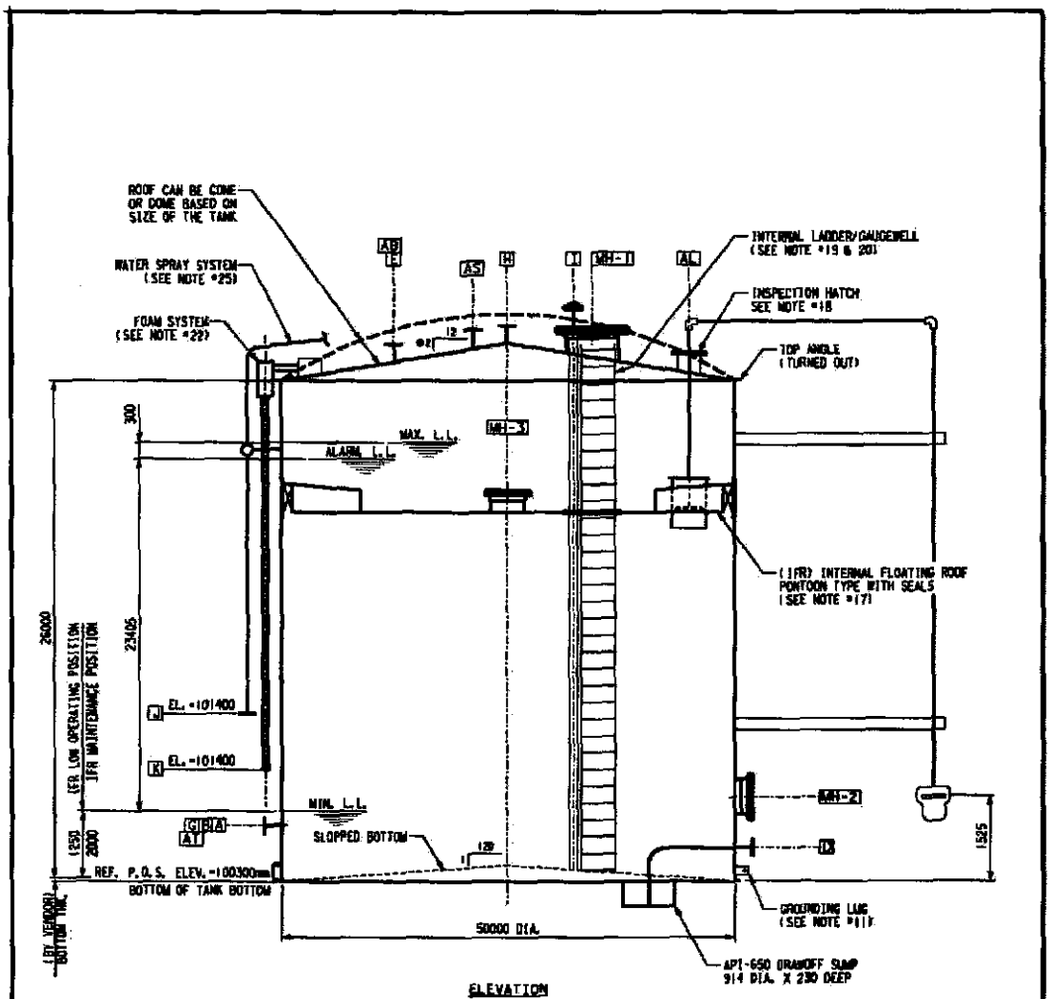


# PRELIMINARY AMMONIA STORAGE TANK DRAWING




TYPICAL 50000 MT AMMONIA STORAGE TANK

# PRELIMINARY METHANOL STORAGE TANK DRAWING



## B.5.7 Project Design Basis - Utility and Offsite Systems

### B.5.7.1 Primary Water Treatment System

Please refer to Figure 9.

#### Seawater

The source of all water used in the proposed facility is seawater taken from the Mediterranean Sea through a submerged intake culvert that extends from the 5 meter depth contour located 850 meters offshore to a seawater intake basin located at the shoreline. The seawater intake basin has a single intake approach channel, four isolatable screen trains with coarse bar screens and traveling band screens, a single pump forebay, and four pump bays. Stop logs allow isolation of each individual screen train's channel to permit maintenance or installation of equipment. The first phase of the project would require two band screens and two pumps to be located at the intake basin. One screen train and one pump could be added as required by each later phase of the project. Seawater is pumped from the basin through a single header to the various users in the plant. Chlorinated seawater, generated by an electro-chlorination unit, is piped to the inlet of the intake culvert to reduce bio-fouling of the raw seawater system.

The major users of raw seawater are the seawater cooling tower as makeup, the desalination unit and several heat exchangers. Used seawater (slightly warmed and concentrated) is returned by culvert to the 5 meter depth contour. The seawater intake culvert, intake basin and outfall are sized for three times the flow rate required by the initial installation in anticipation of two similar plants to be constructed at the site later.

#### Desalination

The desalination unit utilizes multi-stage flash (MSF) evaporation to produce fresh water from raw seawater. Low pressure steam is the heat source for the MSF equipment. Medium pressure steam drives the unit's ejectors Concentrate (brine) is directed to the seawater discharge header. Desalinated water is collected in the Desalinated Water Storage Tank and is used for service, fire, potable, and boiler feedwater. The elevation of the storage tank's discharge nozzles for water users, other than the firewater system, will be sufficiently high to ensure that there is an adequate supply of fire water in the lower portion of the storage tank at all times.

#### Potable Water

The potable water system consists of a dedicated, atmospheric storage tank with electro-chemical chlorination unit, two 100% supply pumps, and the potable water distribution system. Desalinated water is directly transferred to the potable water tank where the water is chlorinated

in a continuously circulating loop using the potable water pumps. This potable water will supply the safety showers, drinking water and sanitary water.

Service Water

Service water is desalinated water that is used for general plant fresh water needs such as clean-up. Desalinated water is fed from the desalinated water storage tank to two 100% pumps that provide water to the service water distribution system.

Desalinated Water as Condensate Polisher Make-up

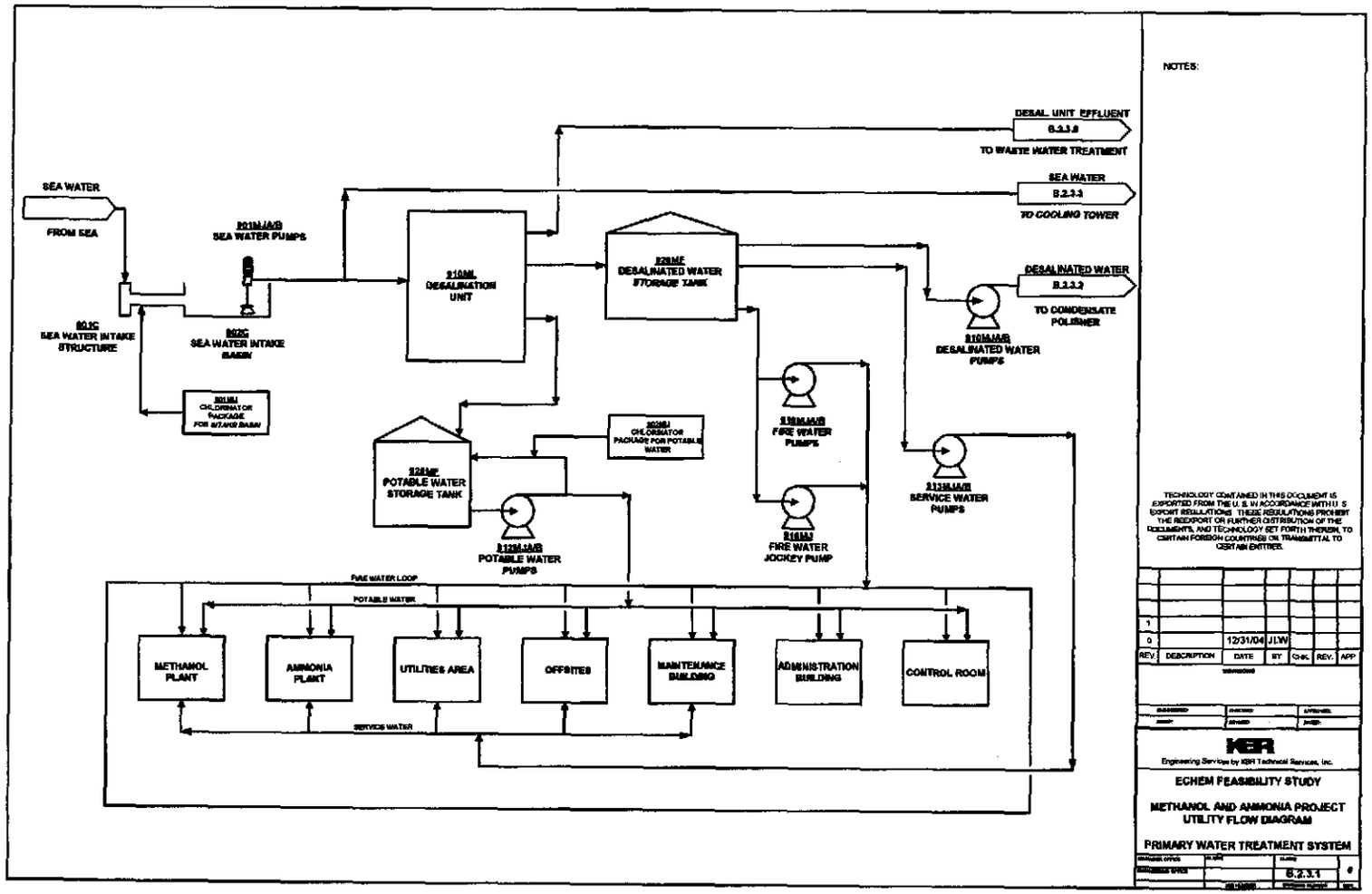
To compensate for steam losses, additional fresh water is needed as make-up to the condensate treating system. To provide this make-up, desalinated water is pumped from the desalinated water storage tank to the Condensate Polisher Unit by one of two 100% pumps.

Fire Water

There are two 100% fire water pumps; one driven by an electric motor and one driven by a diesel engine. A small jockey pump will maintain the system pressure when fire water is not in demand. The Desalinated Water Storage Tank will have reserve capacity to allow firefighting activities to continue for two hours without resupply. Raw seawater will be piped to the service/fire water storage tank to permit fire fighting with seawater if the supply of fresh water is depleted. The seawater connection to the fresh water tank will have sufficient safeguards, such as blinds or removable spools, to prevent accidental addition of seawater to the fresh water system.

An underground firewater distribution loop will supply all areas of the plant. The firewater distribution piping will be arranged to ensure redundancy in piping with sufficient accessible valving so that a single break may be isolated and not significantly affect the functionality of the system. The firewater design is based on only one fire source at a time. Aboveground hydrants are provided on the firewater ring and have a hydrant spacing of 60 m. Water monitors are installed close to high towers, process buildings or structures. The service range of the monitors is a minimum of 60 m.

## FIGURE 9 – PRIMARY WATER TREATMENT SYSTEM



### B.5.7.2 Boiler Feedwater, Steam, and Condensate

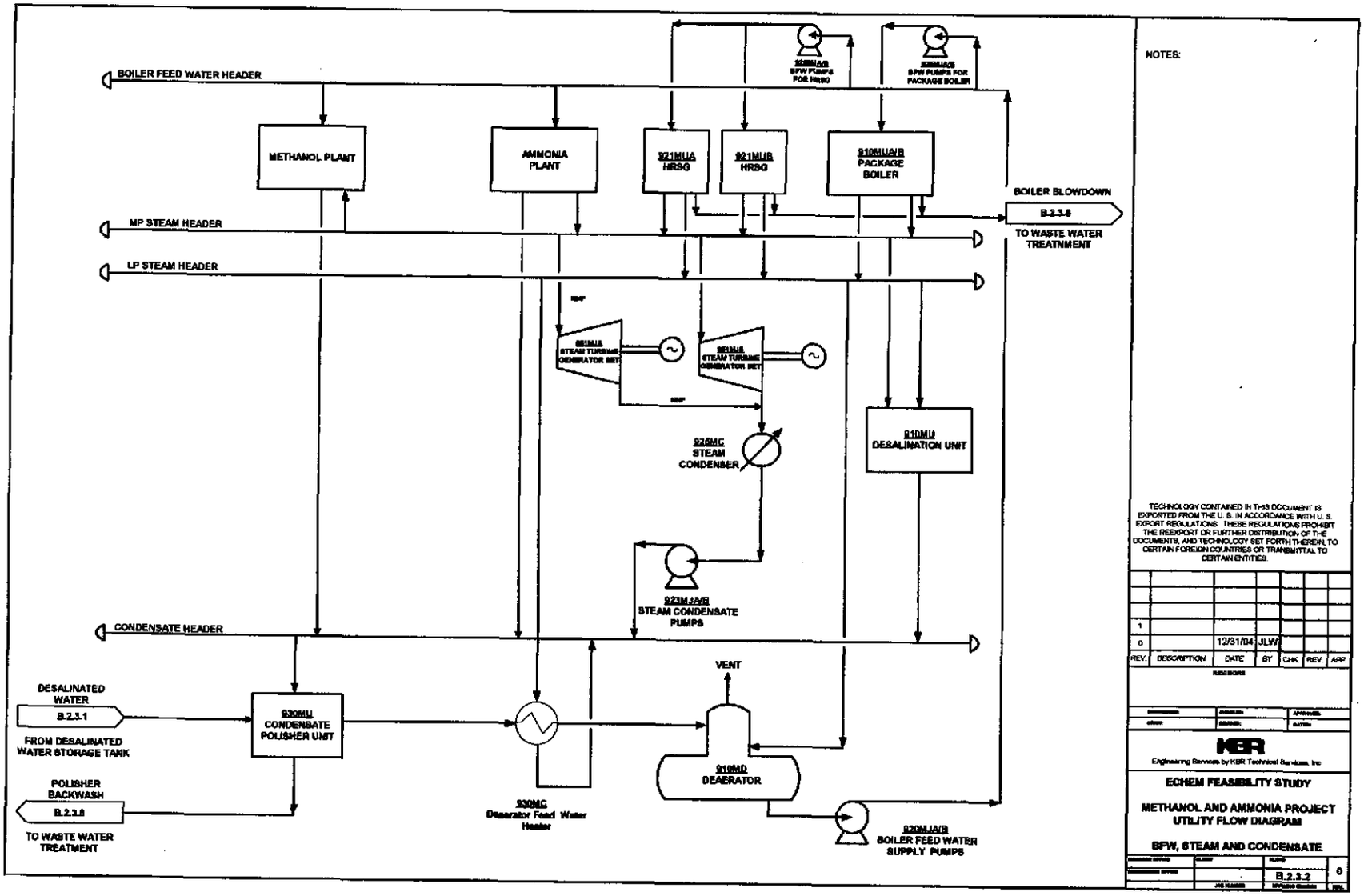
Please refer to Figure 10.

There are two levels of steam utilized, medium pressure superheated (MP, 45.5 barg and 387°C) and low pressure saturated (LP, 3.5 barg sat.) The ammonia plant is a net producer of MP steam. MP steam is also produced by the package boiler and by the heat recovery steam generators (HRSG) coupled to the gas turbine - generator sets. The turbine generator uses MP steam to generate power. The package boiler is also used for startup.

All condensate from major steam users is returned to the Condensate Polisher Unit, cooled to 49°C and combined with desalinated water as makeup. Cooling is required to prevent degradation of the anion resin in the mixed bed polisher. The desalinated water is sufficient quality for use as makeup without demineralization. The polisher unit will protect the steam system from contaminated condensate and minor upsets in the desalination unit.

Polished condensate is sent to the Deaerator that is located off-site. In the deaerator, a purge of low pressure steam strips out dissolved gases to help reduce corrosion. The boiler feedwater (BFW) exiting the deaerator is pumped to the package boilers and HRSGs in the utility area and to BFW users in the methanol and ammonia plants.

## Figure 10 – BFW STEAM AND CONDENSATE



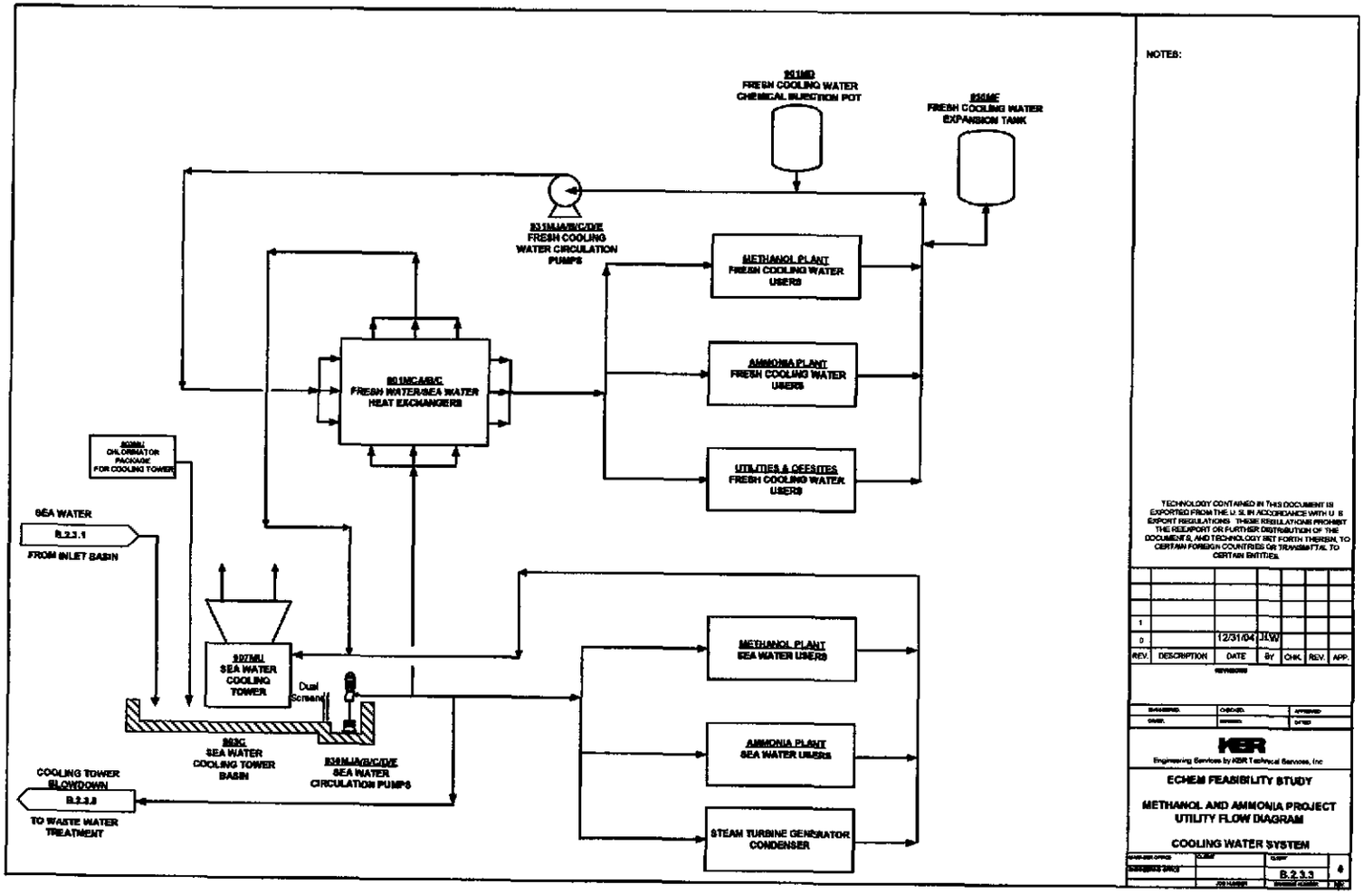
### B.5.7.3 Cooling Water System

Please refer to Figure 11.

The plant uses fresh water and seawater coolers to remove heat from most process equipment. The primary cooling system consists of a seawater cooling tower with five 25% circulation pumps and supply and return lines to and from the fresh water/seawater plate exchangers. This closed loop system also includes a chemical addition pot and an elevated expansion tank. The seawater cooling tower operates with 1.2 cycles of concentration and requires facilities for chemical treatment to control scaling. Biological treatment is provided by an electrochemical chlorination unit. Cooling tower makeup is raw seawater. Blow down from the cooling tower is sent to the seawater discharge header.

For certain applications based on special needs, such as the steam turbine generator condenser, direct seawater cooling is used. Some air-cooling is also used where specifically warranted.

## Figure 11 – CLOSED LOOP COOLING WATER SYSTEM



B.5.7.4 Power Generation

Please refer to Figure 12, Figure 13, and Figure 14.

Electrical power is supplied by two gas turbine generator (GTG) sets with Heat Recovery Steam Generators (HRSG) and two steam turbine generators (STG); each sized at 19 MW and for 33% of load. All power demands can be met with two gas turbine generator sets and one turbo generator or if necessary, one gas turbine generator set and two turbo generators. The choice of providing four machines, each of 19 MW, is driven by the economics for machines of this power range. It is recognized that there is excess capacity built in, but this will be offset in not having to add a spare machine for the Phase II expansion. Steam for the turbine generators is provided by the ammonia plant, HRSG(s) and package boiler.

A preliminary version of the power distribution system design is shown by one-line diagram 703-D100 (following Utility Flow Diagram B.2.3.4). The load of the plant is estimated to be 46 MW under normal operating conditions with a peak load of 57 MW. The primary distribution voltage within the plant will be 33 kV. The utilization voltages within the plant will be 11 kV for large motors, 6.6 kV for medium voltage loads and 400 V or 220 V for low voltage loads. The use of the 220 V level will generally be limited to supplemental lighting, convenience receptacles, heat tracing and other small power circuits.

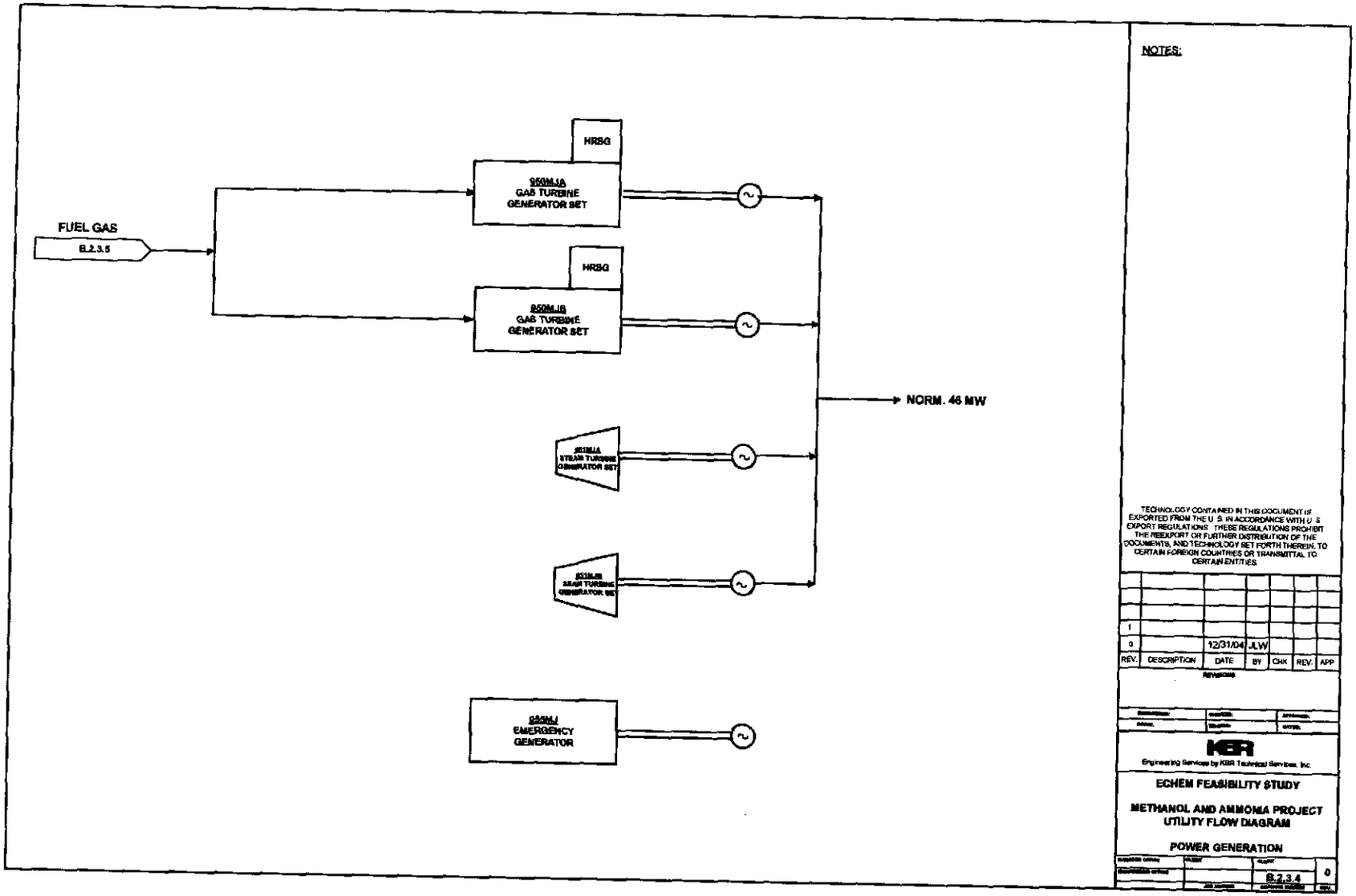
Substations located within the plant will be a prefabricated building type or integrated into the buildings that they service. Transformers will generally be an outdoor, sealed, oil-filled type. The power and control wiring will be generally be routed above ground in cable trays. The main 33 kV power distribution and the 6.6 kV stand-by power distribution will be installed underground as direct buried cable in trenches. The plant will have 33 kV metal-clad, 11 kV metal-clad, 6.6 kV metal-clad and 400 V metal-enclosed switchgear lineups. The switchgear lineups that are used for the normal power distribution will be generally be configured in a secondary selective arrangement to provide a high level of reliability of the supply system. A 125 VDC system including batteries and charger will be provided for reliable switchgear control power.

Motors that are larger than 3,000 kW will be rated 11 kV, 3 phase and motors rated from 200-3000 kW be rated 6 kV, 3-phase. Motors rated less than 200 kW will generally have a rated voltage of 400 V. Motors rated 6 kV would generally be controlled by fused vacuum contactor type starters. Switchgear circuit breakers type starters will be utilized for all 11 kV motors and 6 kV motors rated over 1,800 kW. Motors rated 400 V would be controlled by combination motor starters using molded-case motor circuit protectors or molded-case motor circuit breakers. High-pressure sodium lighting will be provided for all outdoor locations via floodlights and local fixtures.

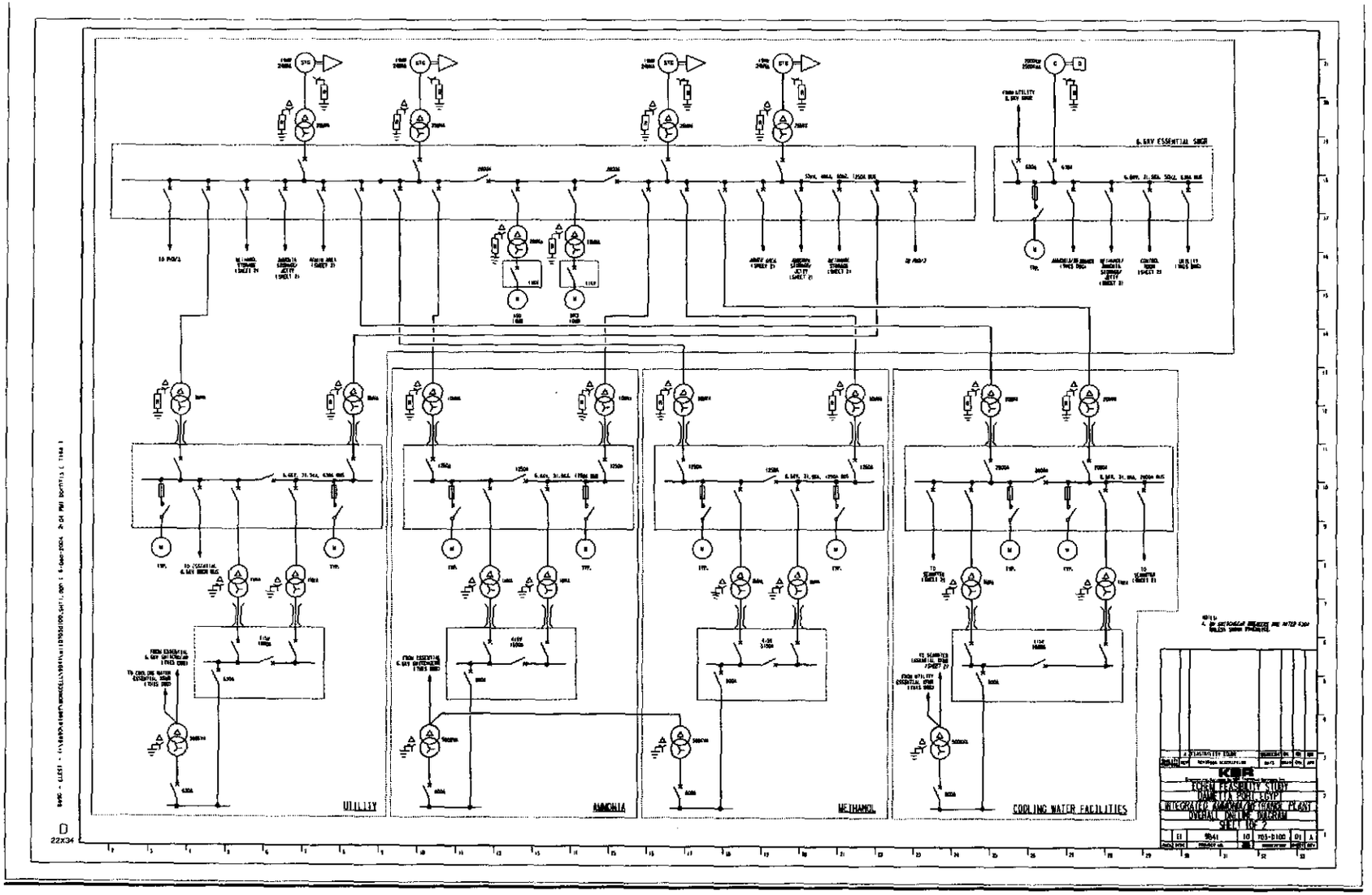
A UPS system will be provided for critical instrumentation and controls. The UPS system consists of an inverter/converter with static transfer switch, batteries, maintenance bypass switch, and power distribution panels. Loads served by the UPS systems include critical instrumentation and control system circuits, DCS, SIS, and associated I/Os.

Standby power would be supplied by a diesel engine generator with a rated capacity of 2,000 kW and a rated output voltage of 6.6 kV. The standby power supply system will provide a safe, orderly shut down of the plant in the event of a complete loss of the normal power supply system. Loads that could receive standby power include uninterruptible power supply feeders, lube oil pumps, firewater jockey pump motors, loading arm hydraulic pump units, standby lighting, motor operated valves and other loads essential for a safe shutdown. The standby power system will also be designed to provide black startup of the plant.

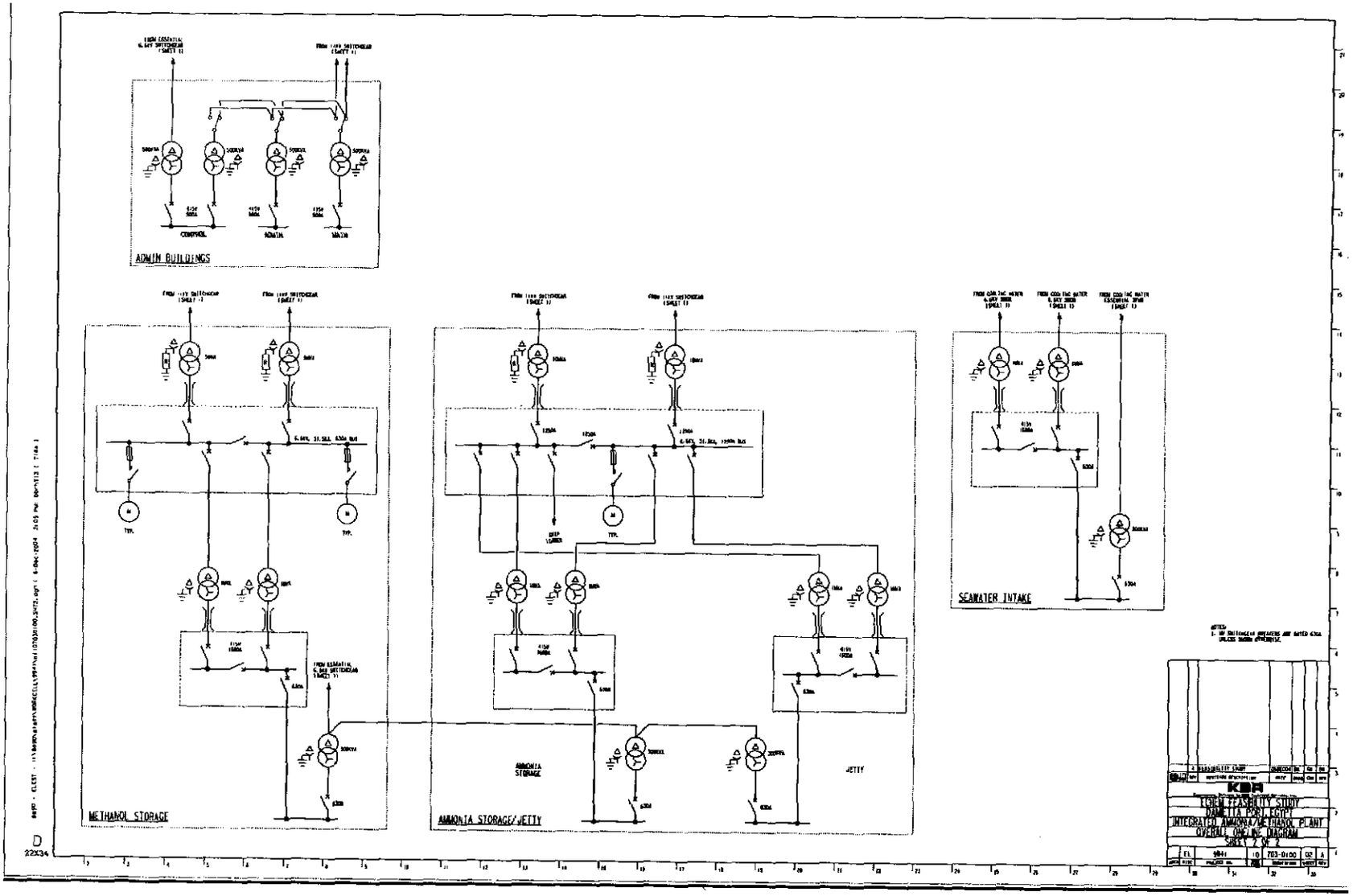
## Figure 12 – POWER GENERATION UFD



## Figure 13 – POWER GENERATION ONE LINE DIAGRAM (SHEET 1 of 2)



## Figure 14 – POWER GENERATION ONE LINE DIAGRAM (SHEET 2 of 2)



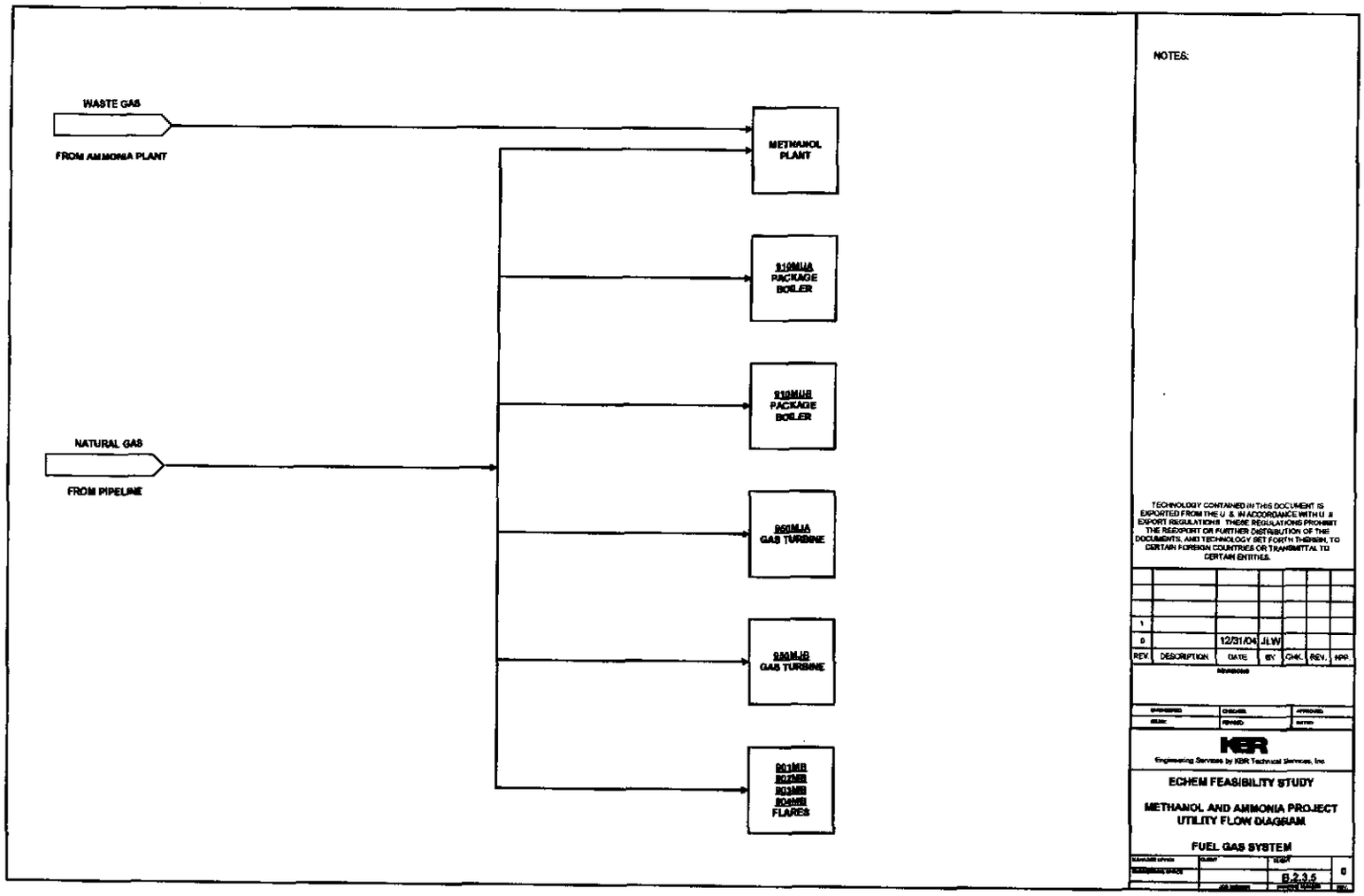
### B.5.7.5 Fuel Gas System

Please refer to Figure 15.

Natural gas is supplied to the plant from the main natural gas distribution trunkline at 35 barg for use as feedstock and fuel. It is distributed directly to the project natural gas users - the methanol plant, two gas turbine generators, two package boilers and to the flare system.

Waste gas from the ammonia plant is used as fuel in the methanol plant.

## Figure 15 – NATURAL GAS DISTRIBUTION



B.5.7.6 Air Systems

Please refer to Figure 16.

Instrument Air

Compressed air for instrumentation and utility use is normally supplied by the ammonia plant's process air compressor. Wet air from the process air compressor flows to the Plant Air Receiver where any free water is removed. Wet air then flows to the Instrument Air Dryer Package. The dry air leaving the dryer enters the instrument air distribution header and is provided to the methanol plant, the ammonia plant, and offsite users.

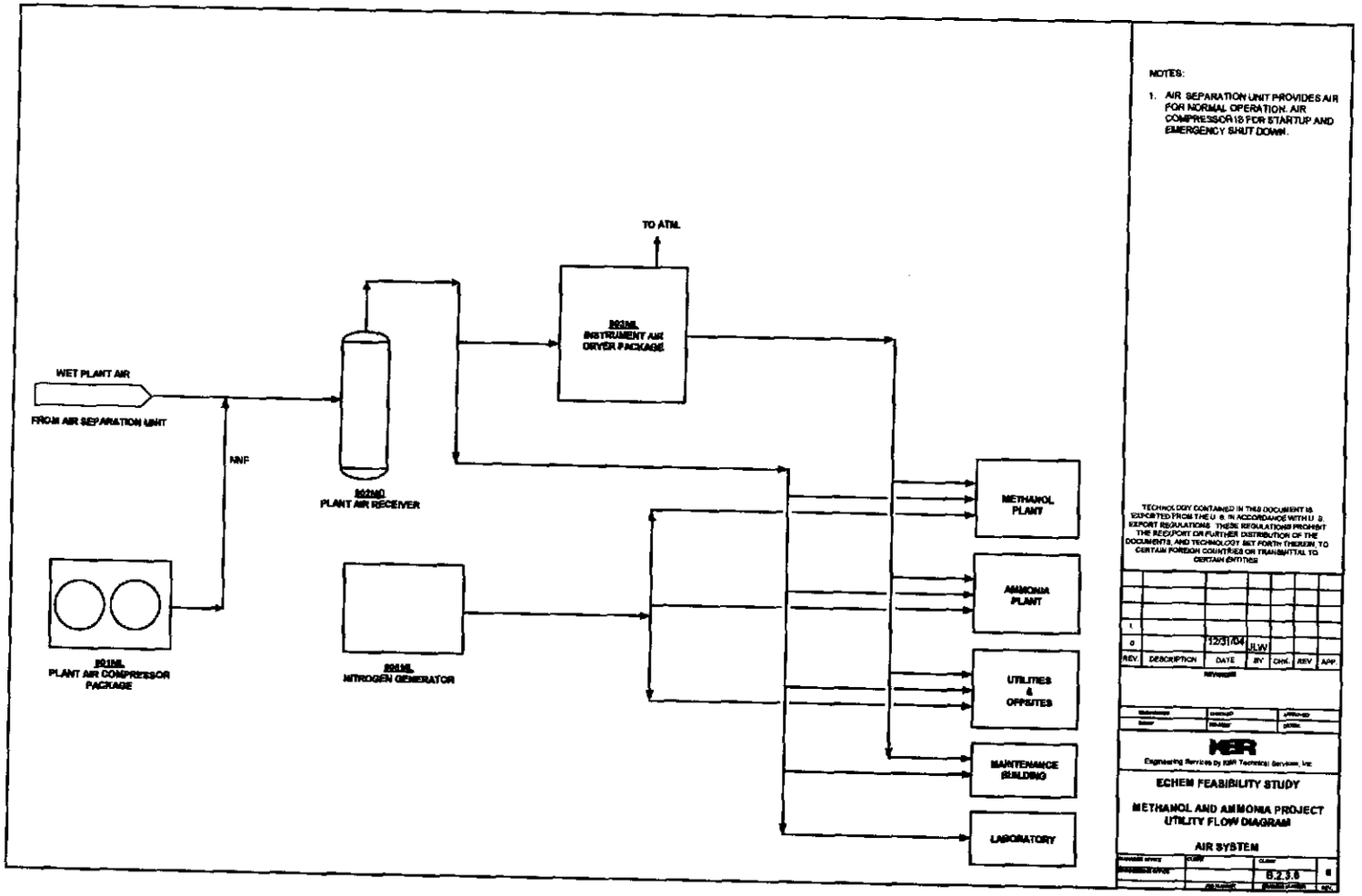
Plant Air

General plant air, used throughout the plant for maintenance and other sundry uses is distributed throughout the plant. Air is received into the Plant Air system directly downstream of the plant air receiver. The wet process air is fed into the Plant Air distribution system. A control valve is provided which shuts off the supply of plant air to the complex if the instrument air header pressure falls below 6 barg. A single, back-up air compressor package is provided for emergency situations and startup.

Nitrogen

Nitrogen for use in the complex is produced from atmospheric air by a nitrogen generation package and is directed throughout the complex through separate nitrogen piping.

## Figure 16 – AIR SYSTEMS



### B.5.7.7 Flare System

Please refer to Figure 17.

Vapors from the methanol plant and methanol storage tanks are burned by a flare for the methanol process area and a flare for the methanol storage tanks.

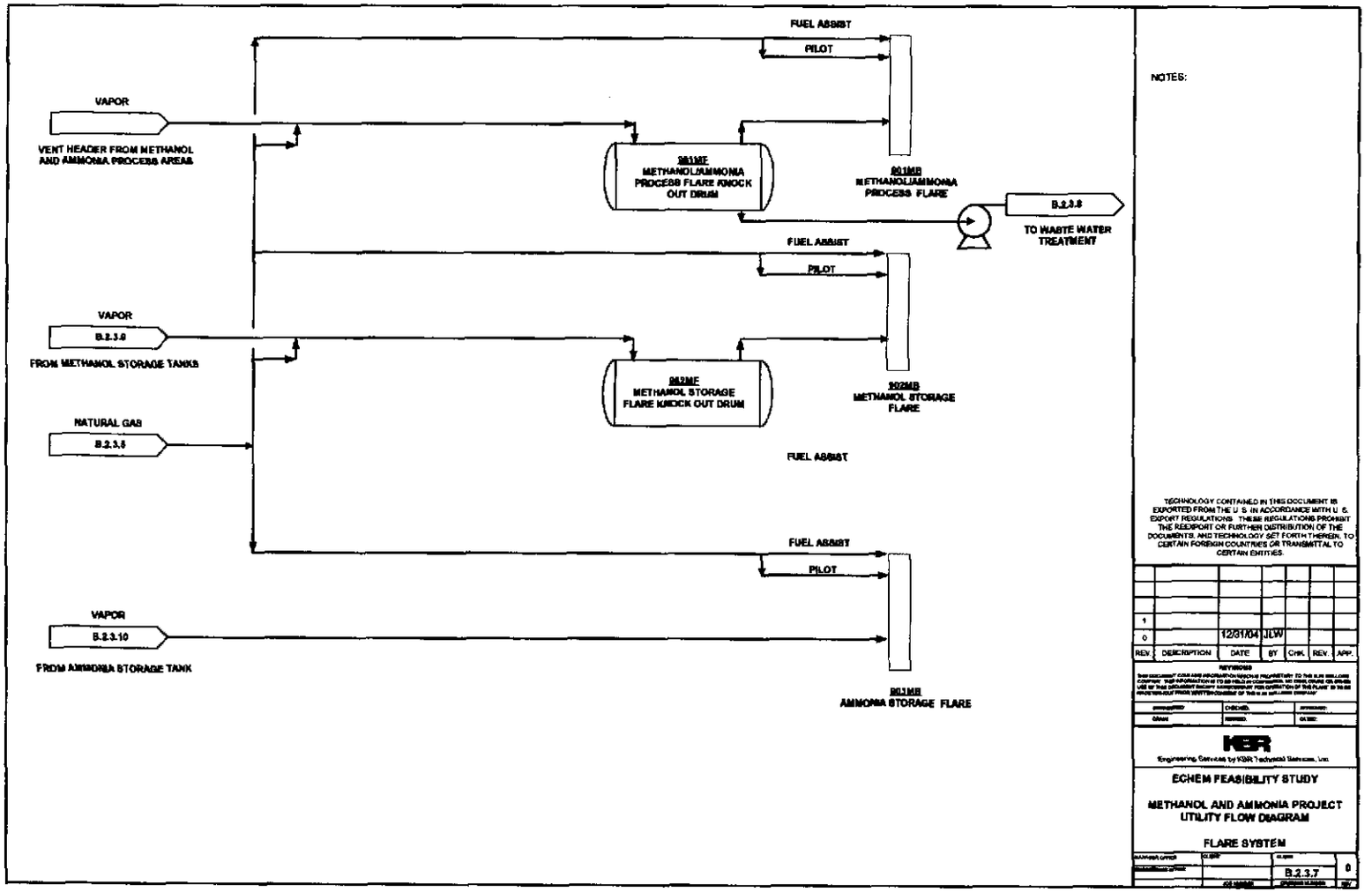
Vapors from the methanol plant relief header are directed to the Methanol Process Flare Knockout Drum where entrained liquids are removed. Vapor from the knockout drum goes to the Methanol Process Flare. The Methanol Process Flare is sized to handle any releases from the methanol plant. Normally there would be no flow except for the continuous natural gas purge into the flare header piping system. The flare tip is equipped with a continuous pilot and has an electronic ignition system for relighting when necessary. It is also equipped with fuel assist.

The Methanol Storage Tank Flare only receives vapor from the storage tanks. The storage flare system is designed to prevent over pressurization of the storage tank under fire conditions.

The flare for the ammonia storage tank will receive uncondensed vapors. The storage flare system is designed to prevent over pressurization of the storage tank under fire conditions. The flare is mounted directly onto the ammonia storage tank. It is equipped with electronic ignition and fuel assist to aid in the combustion of ammonia when necessary.

Separate flares are provided for each Phase of the project.

## Figure 17 – FLARE SYSTEM



### B.5.7.8 Wastewater Treatment

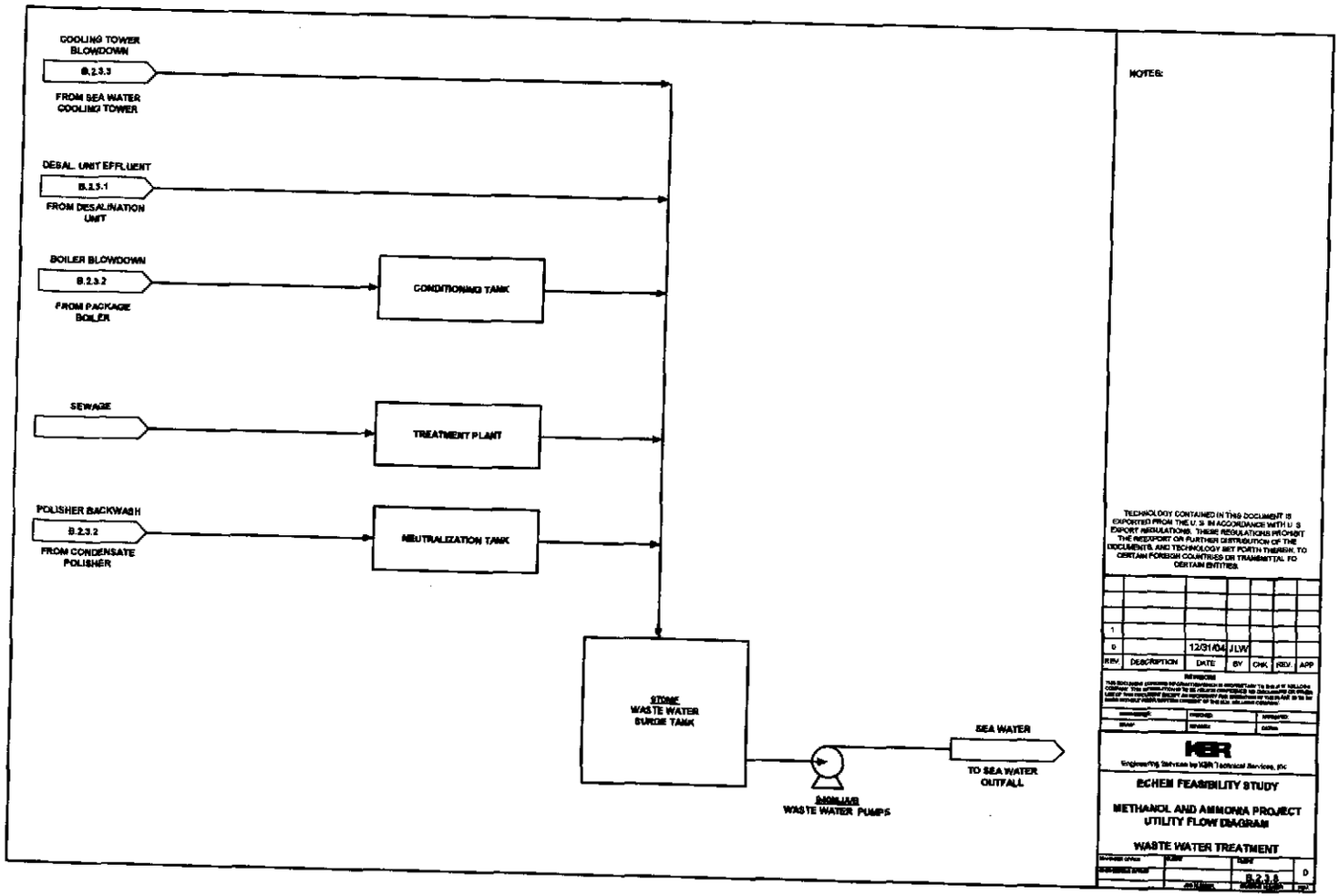
Please refer to Figure 18.

Continuously discharged wastewater is a combination of cooling tower blowdown (65%), brine from the desalination unit (34.6%), boiler blowdown (0.25%), sanitary wastewater (0.14%) and saturator blowdown from the methanol plant (0.01%). The cooling tower blowdown and brine have a salt content 14% greater than raw seawater and is released untreated. Solids are allowed to settle from the boiler blowdown before it is released. Sanitary wastewater is processed in a standard treatment unit. Saturator blowdown is slightly contaminated with methanol but will not require treatment.

An intermittent wastewater effluent is the chemical regenerants and backwash from the polisher unit. This waste stream will require neutralization before it is released. A special neutralization tank and facilities are provided to handle this stream.

All effluents will be combined and discharged into the sea at the 5 meter contour.

## Figure 18 - WATER TREATMENT



B.5.7.9 Product Storage and Loading

Please refer to Figures 19 and 20.

Methanol

Product methanol is transferred from the process area to a single day tank where it is held until batch testing. After approval, the loading pumps are use to transfer the methanol to either of two 35,000 mt, storage tanks located in separate, diked areas near the loading berth. Both storage tanks and the day tank have external domed roofs and internal floating roofs and are nitrogen-blanketed. Packaged refrigeration units receive vapors from each tank, recondense the methanol and return the liquid to the tank. Uncondensed vapors are sent to the Methanol Storage Tank Flare.

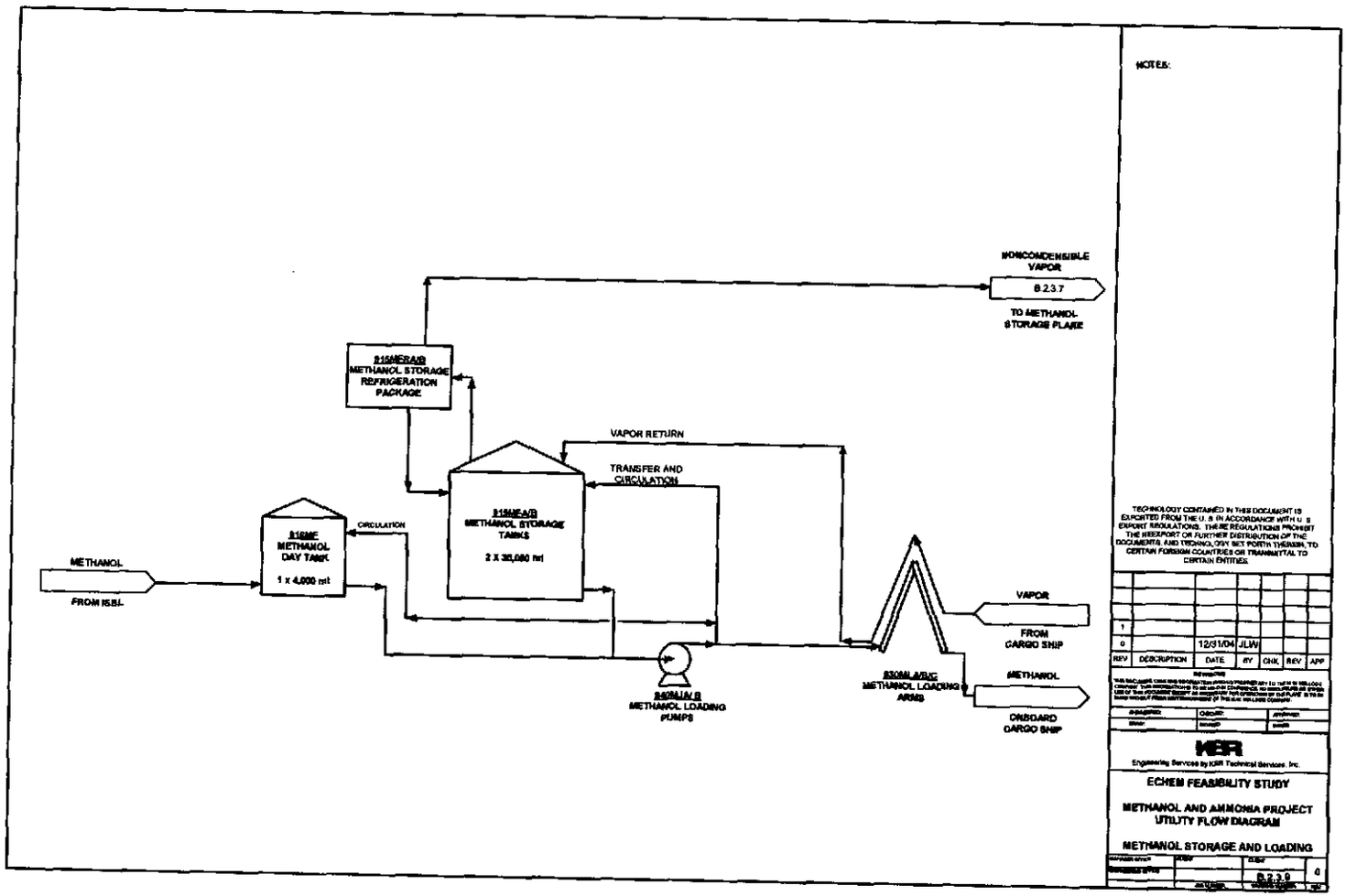
Either of two methanol loading pumps are used to transfer methanol from one storage tank to the other storage tank or the day tank to main storage, to circulate the storage tanks for homogenization, or to transfer methanol to a ship at the berth. The methanol loading rate is 2,750 mtph. Dedicated loading arms are used to carry methanol onboard and receive displaced vapor from the ship. Vapor from the ship is directed to the methanol storage tanks.

Ammonia

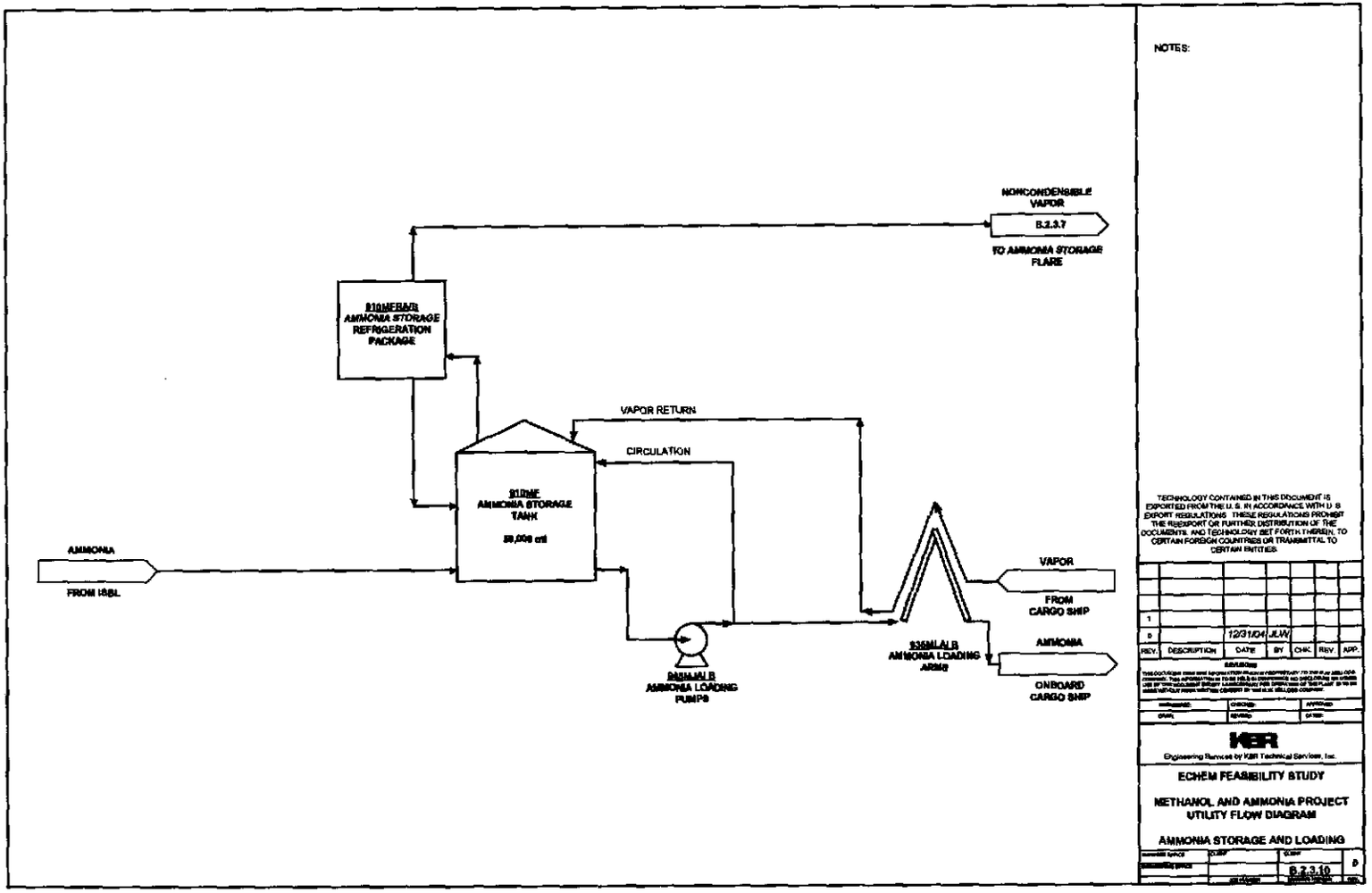
Product ammonia is transferred from the process area to a 50,000 mt, storage tank located near the loading berth. The ammonia storage tank has a domed-style roof and an internal suspended deck. It has external, internal and bottom insulation. Ammonia is stored at -33°C and at near atmospheric pressure. Vapor from the storage tank is routed to a two-stage refrigeration package that compresses the ammonia vapor and recovers liquid ammonia. Uncondensed vapor from the refrigeration unit is sent to the ammonia storage tank flare that is mounted directly onto the ammonia storage tank.

Loading pumps are used to transfer ammonia from the storage tank to a ship at the berth at 750 mtph. Dedicated loading arms are used to carry ammonia onboard and receive displaced ammonia vapor from the ship. Vapor from the ship is directed to the ammonia storage tank.

## Figure 19 – METHANOL STORAGE TANKS



## Figure 20 – AMMONIA STORAGE TANK



B.5.7.10 Utility and Offsite Equipment List

| ITEM NO. | DESCRIPTION |
|---|---|
| CLASS A: BUILDINGS | |
| 901A | Central Control Room Building |
| 902A | Water Treatment Building |
| 903A | Motor Control Center Building |
| 905A | Administration Building |
| 906A | Laboratory |
| 907A | Guardhouse |
| 908A | Maintenance Building |
| 909A | Warehouse |
| 910A | Fire station |
| 911A | Dock office |
| **Class C:** | **Civil** |
| 901C | Seawater Intake Structure |
| 902C | Seawater Intake Basin |
| 903C | Seawater Cooling Tower Basin |
| **Class MB:** | **Flares** |
| 901MB | Methanol Process Flare |
| 902MB | Methanol Storage Flare |
| 903MB | Ammonia Process Flare |
| **Class MC:** | **Heat Exchangers** |
| 901MCA/B/C | Fresh Water/Seawater Heat Exchangers |
| 925MC | Steam Condenser |
| 930MC | Deaerator Feedwater Heater |
| **Class MD:** | **Pressure Vessels** |
| 901MD | Fresh Cooling Water Chemical Injection Pot |
| 902MD | Plant Air Receiver |
| 910MD | Deaerator |
| **Class MF:** | **Drums/Tanks** |
| 910MF | Ammonia Storage Tank |
| 910MFRA/B | Refrigeration Packages for Ammonia Storage Tank |
| 915MFA/B | Methanol Storage Tanks |
| 915MFRA/B | Refrigeration Packages for Methanol Storage Tanks |
| 916MF | Methanol Day Tank |
| 920MF | Desalinated Water Storage Tank |

| | |
|---|---|
| 925MF | Potable Water Storage Tank |
| 930MF | Fresh Cooling Water Expansion Tank |
| 935MF | Sulfuric Acid Tank |
| 950MF | Diesel Storage Tank for Firewater System |
| 955MF | Diesel Storage Tank for Emergency Generator |
| 961MF | Methanol Process Flare Knock Out Drum |
| 962MF | Methanol Storage Flare Knock Out Drum |
| 963MF | Ammonia Process Flare Knock Out Drum |
| 970MF | Wastewater Surge Tank |

**Class J: Rotating Equipment**

| | |
|---|---|
| 901MJA/B | Seawater Pumps |
| 901MJA/B | Motors for Seawater Pumps |
| 910MJA/B | Desalinated Water Pumps |
| 910MJA/B | Motors for Desalinated Water Pumps |
| 912MJA/B | Potable Water Pumps |
| 912JA/B | Motors for Potable Water Pumps |
| 913MJA/B | Service Water Pumps |
| 913MJA/B | Motors for Service Water Pumps |
| 915MJA/B | Fire Water Pumps |
| 915MJA | Motor for Fire Water Pump |
| 915MJDE | Diesel Engine for Fire Water Pump |
| 916MJ | Fire Water Jockey Pump |
| 916MJA | Motor for Jockey Pump. |
| 920MJA/B | Boiler Feedwater Supply Pumps |
| 920MJA/B | Motors for Boiler Feedwater Supply Pumps |
| 923MJA/B | Steam Condensate Pumps |
| 923MJA/B | Motors for Steam Condensate Pumps |
| 925MJA/B | BFW Pumps for Package Boiler |
| 925MJA/B | Motors for BFW Pumps for Package Boiler |
| 926MJA/B | BFW Pumps for HRSG |
| 926MJA/B | Motors for BFW Pumps for HRSG |
| 930MJA/B/C/D/E | Seawater Circulation Pumps |
| 930MJA/B/C/D/E | Motors for Seawater Circulation Pump |
| 931MJA/B/C/D/E | Fresh Cooling Water Circulation Pumps |
| 931MJA/B/C/D/E | Motors for Fresh Cooling Water Circulation Pumps |
| 932MJA/B | Sulfuric Acid Pumps |
| 932MJA/B | Motors for Sulfuric Acid Pumps |
| 940MJA/B | Methanol Loading Pumps |
| 940MJA/B | Motors for Methanol Loading Pumps |
| 945MJA/B | Ammonia Loading Pumps |
| 945MJA/B | Motors for Ammonia Loading Pumps |
| 940MJA/B | Wastewater Pumps |
| 940MJA/B | Motors for Wastewater Pumps |
| 950MJA/B | Gas Turbine Generator Set |
| 951MJA/B | Steam Turbine Generator Set |
| 955MJ | Emergency Generator |

**Class ML: Special Equipment**

| | |
|---|---|
| 901ML | Plant Air Compressor Package |
| 901MLM | Motor for Plant Air Compressor Package |
| 903ML | Instrument Air Dryer Package |
| 905ML | Nitrogen Generator |
| 910ML | Desalination Unit |
| 930MLA/B/C | Methanol Loading Arms |
| 935MLA/B | Ammonia Loading Arms |

**Class MU: Utility Equipment**

| | |
|---|---|
| 901MU | Chlorinator Package for Intake Basin |
| 902MU | Chlorinator Package for Potable Water |
| 903MU | Chlorinator Package Cooling Tower |
| 907MU | Seawater Cooling Tower |
| 910MUA/B | Package Boilers |
| 921MUA/B | HRSG's |
| 930MU | Condensate Polisher Unit |

B.5.7.11 Project Design Basis – Overall Plant

- Utility Summary

The following page shows a utility summary for the methanol and ammonia complex. It is seen that the demands for most utilities are provided by the on-site utility systems. The only normal imports are natural gas and seawater. Backup power is provided from the public grid.

## Utility Summary – Integrated Methanol/Ammonia

| | Natural gas | Sea water makeup | Desali-nated water | Boiler feed water from polisher | 40 bar steam | 3.5 bar steam | Conden-sate to polisher | Cooling water | Drinking/ service water | Waste water | Instrument Air | Electrical Power |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $Nm^3/hr$ | $m^3/hr$ | t/hr | t/hr | t/hr | t/hr | t/hr | $m^3/hr$ | t/hr | t/hr | Nm3/h | kW |
| Methanol plant | 149,500 | | | 422 | 28 | | -356 | 18,000 | 5 | -6 | 350 | 5,000 |
| Ammonia plant | -13,500 | | 60 | 43 | -7 | 0.4 | -36 | 6,498 | 5 | -0.4 | -550 | 23,348 |
| Utilities | | | | | | | | | | | 150 | |
| Sea water desalination | | 1,453 | -172 | | 2 | 23 | -23 | | -10 | -1,271 | | 908 |
| Drinking, fire, service water | | | 10 | | | | | | | | | 17 |
| Condensate Polisher | | | 100 | -590 | | | 490 | | | | | 189 |
| Deaerator and inlet HE | | | | | | 39 | -39 | | | | | |
| Package boiler | 2,993 | | | 31 | 0 | -30 | | | | -1 | | 438 |
| Power generation | 12,022 | | | 94 | -23 | -32 | -37 | 2,020 | | -2 | | -45,350 |
| Cooling water system | | 2,864 | 2.0 | | | | | -26,518 | | -2,360 | | 13,593 |
| Plant & instrument air | | | | | | | | | | | | 0 |
| Offsites | | | | | | | | | | | 50 | |
| Methanol storage | | | | | | | | | | | | 40 |
| Methanol loading | | | | | | | | | | | | 0 |
| Ammonia storage | | | | | | | | | | | | 125 |
| Ammonia loading | | | | | | | | | | | | 0 |
| Waste water treatment | | | | | | | | | | | | 693 |
| Flare | 455 | | | | | | | | | | | |
| Light/AC & Misc. | | | | | | | | | | | | 1,000 |
| Total | 151,471 | 4,317 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -3,640 | 0 | 0 |

NOTES:

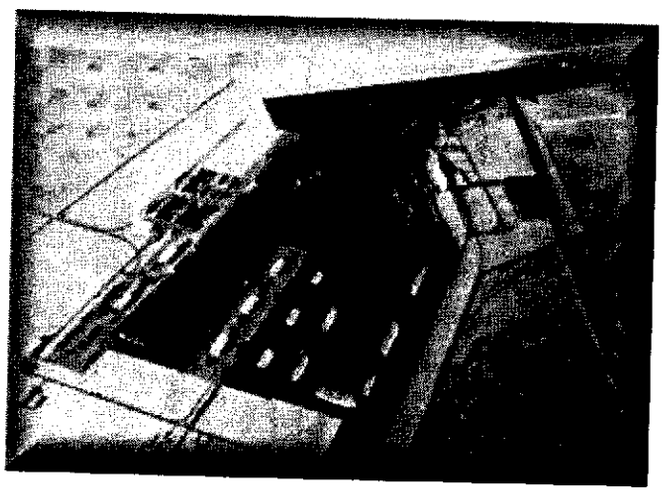
1. Power generation by two 19 MW gas turbine-generator set with heat recovery steam generator and two 19MW steam turbine generators.
2. A negative number indicates export.
3. "Natural gas" from ammonia plant is vent gas as equivalent natural gas.

## B.5.8 Site Data and Environmental Requirements

The following sections pertain to engineering and environmental data that directly affect the engineering basis for the project. This data is expanded in the Project Design Data (PDD) document in Appendix 5 of this Report.

### B.5.8.1 Damietta Port Site Description

The site is located within the Industrial Free Trade Port, a few kilometers to the west of the Damietta Branch of the river Nile.



The proposed site for the Methanol and Ammonia/Urea production complex is located with in the Damietta Port Authority premises. The Damietta port is situated on the Mediterranean coast (Longitude 31° 45' E; and, Latitude 31° 28' N), approximately 8.5 Km west of the Nile's Eastern branch and about 70 Km west of the Port-Said port. The port covers a total area of approximately 9.3 $Km^2$, of which 6.2 $Km^2$ is land area and 3.1 $Km^2$ is water area. It includes an 11.3 Km long, 300 m wide approach area dredged to 15 m, with two sheltering breakwaters: one to the west at a length of 1.640 Km (140 m in land and 1,500 m in water) and the other to the east, 738 m long (238 m in land and 500 m in water). The approach area provides access to a barge channel consisting of two ports, one (1.35 Km long) links the barges dock to the sea and the other (3.75 Km long) links the Dock to the Nile Branch. The barge dock occupies an area of 62,500 $m^2$ and is equipped with a 250 m long berth with a water depth of 5 m. The rotation dock is 500 m in diameter and varies in depth from 14.5 m in front of the containers broth to 12 m in front of the general cargo berths.

As illustrated above, the site (A) is bounded by SEGAS LNG facility (B) from the northwestern boundary, port container yard expansion area (C) from the eastern boundary and administration buildings area (D) from the southern boundary.

The plot plans developed for the proposed site show a dedicated main entrance for access to the site. The site is characterized as coastal sand plains, with almost no vegetation, and no dominant dune system.

Currently, the site is heavily impacted by large quantities of accumulated construction/demolition and dredged sediment wastes. Upper soil layer, of un-impacted areas, consisted of fine, silty sands with traces of broken shells. Ongoing construction activities were observed to the south east of the proposed site. However, no activities were observed on site during site visits.

The proposed outfall will use the same corridor/route as the existing SEGAS outfall, where the outfall site falls within a restricted area where fishing is prohibited, thus meeting the EEAA criteria for discharge conditions. The major features in the study area are the breakwaters to the east and west of the Port entrance and the dredged channel (approximately 15 m deep) approach, which cuts through the shallow, near-shore, waters. Routine maintenance dredging (annual) is conducted within the channel. A ship wreck is identified (Admiralty Chart No. 2578 amendment, 2000) on the eastern approach to the main shipping channel entrance to Damietta Port in the vicinity of navigational buoy Fl. R.2.5s No 12.

The western breakwater is in the vicinity of an existing outfall. The western breakwater is 1,300 m long at an angle of 10° (from N) and is constructed of large concrete rip-rap. A walkway exists along the entire breakwater.

### B.5.8.2 Metrological Data

#### Temperature

The Damietta Governorate, proposed site area, exhibits typical Mediterranean region temperatures where the average annual minimum air temperature is 17.5°C and the average maximum air temperature is 22.5°C.

Table 5.8-1 and Table 5.8-2, respectively, show the number of days with maximum or minimum (other than average) temperatures in an average climatic year in Damietta. Table 5.8-3 provides details of the meteorological parameters for Damietta and Appendix III provides 30 years of meteorological data for Damietta.

**Table 5.8-1: Minimum Temperatures in Damietta Port**

| Minimum Temperature | No. of Days |
|---|---|
| 0°C | 0 – 5 Days |
| 5°C | 0 - 5 Days |
| 10°C | 60-90 Days |

**Table 5.8-2: Maximum Temperatures in Damietta Port**

| Maximum Temperature | No. of Days |
|---|---|
| 35°C | 0 –5 Days |
| 40°C | 0 –5 Days |
| 45°C | 0 –5 Days |

Winds

During summer season moderate NW or N winds are most prevalent; however, occasional increases to fresh or strong may be exhibited.

During the winter season, no wind direction predominates; however, N and W winds are often more frequent. During spring (April and May), sea breeze predominates, and winds from between NW and NE exceed all others. It is during this season that the Khamasin winds, a variety of the Sirocco, are most prevalent. Although Khamasin winds are usually moderate to strong they occasionally reach gale force.

Land and sea breezes are less marked in the winter months but may occur in places during settled weather. Near the Egyptian coast, gales are mainly confined to the period of October to May, and are most frequent from December to February.

## Table 5.8-3: Regional Meteorological Parameters, Mean Values

| Month<br>Meteorological Element | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Maximum Air Temperature (°C) | 18.2 | 18.5 | 20.3 | 23.1 | 26.4 | 29.2 | 30.6 | 30.9 | 29.3 | 27.3 | 23.6 | 19.7 |
| Highest maximum air temperature (°C) | 26.5 | 31.9 | 35.8 | 38.8 | 45.6 | 40.8 | 39.5 | 38.6 | 37.9 | 36.1 | 35.4 | 28.5 |
| Date (yy/dd) | 87/18 | 52/28 | 31/16 | 93/17 | 41/10 | 33/30 | 34/16 | 36/15 | 39/29 | 51/6 | 41/7 | 62/3 |
| Lowest Maximum air temperature (°C) | 10.6 | 8.8 | 10.3 | 15.3 | 19.5 | 23.8 | 26.0 | 27.0 | 23.5 | 20.3 | 15.1 | 11.9 |
| Date (yy/dd) | 74/23 | 92/24 | 83/6 | 94/3 | 87/1 | 90/4 | 69/15 | 68/24 | 70/30 | 65/30 | 94/29 | 71/22 |
| Minimum air temperature (°C) | 8.6 | 9.0 | 11.0 | 13.6 | 16.8 | 20.0 | 21.4 | 21.6 | 20.2 | 18.4 | 15.1 | 10.7 |
| Highest minimum air temperature (°C) | 17.0 | 15.6 | 17.6 | 21.7 | 23.4 | 24.8 | 25.8 | 26.4 | 25.0 | 24.4 | 23.2 | 17.7 |
| Date (yy/dd) | 85/14 | 68/29 | 61/17 | 94/20 | 64/30 | 65/13 | 89/16 | 78/3 | 86/24 | 63/18 | 66/4 | 71/2 |
| Lowest minimum air temperature (°C) | 1.5 | 0.7 | 3.8 | 4.6 | 9.5 | 7.0 | 16.9 | 16.3 | 14.7 | 11.4 | 6.8 | 3.7 |
| Date (yy/dd) | 53/14 | 34/17 | 49/5 | 49/19 | 65/5 | 93/3 | 49/26 | 49/22 | 49/30 | 59/21 | 48/28 | 31/31 |
| Relative humidity (%) | 76 | 75 | 73 | 71 | 71 | 71 | 72 | 76 | 75 | 75 | 76 | 76 |
| Highest relative humidity (%) | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| Date (yy/dd) | s.d | s.d | s.d | s.d | s.d | s.d | s.d | s.d | s.d | s.d | s.d | s.d |
| Lowest relative humidity (%) | 26 | 24 | 20 | 16 | 13 | 21 | 24 | 25 | 31 | 29 | 25 | 31 |
| Date (yy/dd) | 85/1 | 71/28 | 75/22 | 66/14 | 65/26 | 95/7 | 94/3 | 63/18 | 66/22 | 77/10 | 95/5 | 80/4 |
| Amount of Rainfall (mm/month) | 26 | 19.7 | 13.0 | 4.6 | 1.5 | 0.2 | Trace | Trace | 0.4 | 7.1 | 15.7 | 24.0 |
| Highest amount of Rainfall (mm/month) | 37.0 | 29.0 | 44.3 | 31.8 | 15.8 | 8.5 | Trace | Trace | 18.0 | 35.0 | 55.0 | 40.1 |
| Date (yy/dd) | 32/28 | 93/13 | 91/22 | 86/1 | 61/6 | 79/4 | 34/21 | 42819 | 57/30 | 37/27 | 53/5 | 93/22 |
| Dry temperature (°C) | 12.9 | 13.4 | 15.3 | 18.1 | 21.0 | 24.5 | 25.8 | 26.0 | 24.5 | 22.4 | 18.4 | 14.6 |
| Highest dry temperature (°C) | 17.1 | 17.5 | 19.4 | 22.0 | 25.1 | 28.2 | 29.2 | 29.9 | 28.4 | 26.2 | 22.6 | 18.8 |
| Lowest dry temperature (°C) | 9.8 | 9.9 | 11.3 | 14.0 | 16.5 | 19.9 | 21.3 | 21.4 | 20.2 | 18.4 | 15.3 | 11.5 |
| Pressure on mean level sea | 1018.5 | 1017.0 | 1015.3 | 1013.6 | 1021.6 | 1011.2 | 1008.4 | 1008.5 | 1012.5 | 1015.6 | 1015.4 | 1018.2 |
| Highest pressure on mean sea level | 1032.5 | 1029.9 | 1028.8 | 1026.3 | 1024.4 | 1019.4 | 1016.4 | 1016.3 | 1028.3 | 1024.8 | 1028.4 | 1028.8 |
| Date (yy/dd) | 92/4 | 89/3 | 923 | 83/20 | 95/8 | 90/5 | 79/11 | 72/24 | 92/28 | 91/27 | 88/14 | 63/26 |
| Lowest pressure on mean sea level | 929.9 | 997.9 | 1000.8 | 993.6 | 999.4 | 1000.1 | 999.7 | 1001.8 | 1003.6 | 1001.5 | 1000.5 | 999.3 |
| Date (yy/dd) | 69/21 | 86/5 | 93/6 | 71/11 | 92/7 | 88/11 | 95/2 | 77/7 | 67/8 | 69/9 | 76/24 | 62/18 |
| Number of days fog | 0.2 | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 | 0.03 | 0.0 | 0.1 | 0.03 | 0.2 | 0.1 |

***Source: The Egyptian Meteorological Authority – Climate Directory (2001)***

Remarks: -The data cover an area of 50 km $^2$

Trace = amount of rainfall < 0.1 mm.

Rainfall

The area exhibits seasonal rainfall where nearly all rainfall occurs during winter. Similar to North African coast areas, most rain falls with W or NW winds. After heavy thunderstorms, local flooding near the coast may occur, but serious situations are rare.

In the dry season, from June to September inclusive, there is often no rain in any part of the region. The average annual rainfall in Damietta is approximately 115 mm. The number of days in the climatic year in which rainfall exceeds the average is shown in Table 5.8-4.

**Table 5.8-4: Number of Days with Above Average Rainfall**

| Rainfall | No. of Days |
|---|---|
| 0.1 mm | 40 Days |
| 1 mm | 20-25 Days |
| 5 mm | 5-10 Days |

B.5.8.3 Geological and Geotechnical Conditions:

The Nile Delta has two main Nile River branches encompassing the area, the western Rosetta Branch and the eastern Damietta Branch. The soils are typical of a major delta area; consist of a sequence of soils varying from sands to clays.

On the coast line of the Nile delta, the general sequence comprises recent coastal dune sands, overlying very soft recent alluvial clays which are in turn is underlain by inter-bedded Deltaic sands and clays. Often the interfaces between these units vary and buried in filled channels can be common. The water table is generally just above sea level.

Port Damietta is situated in the Nile Delta on the coast. From ground investigations carried out in the environs of the Port the thickness of the different units are:

- Upper sand is medium dense to dense around 10 m thickness
- Underlying clay is very soft to soft and its thickness varies between 10 to 20 m
- Underlying materials are inter-bedded dense to very dense sands and stiff to very stiff clays
- Groundwater is around 0.75 m above sea level.

B.5.8.4 Soil Description

The soil stratigraphy and properties as given in Annex 3 of the SOR "Soil Investigation at East Dock of Damietta Port (Extension Project of Existing Basin)" have been used for developing the civil foundation design. The soil parameters given in this soils report are summarized below.

The site consists of 12 to 14 meters of medium dense to dense fine sands overlying 15 m of soft clays, which overlie very dense sands and stiff clays. The upper sands have reasonable

bearing capacity. However, where foundation pressures from large heavily loaded or closely spaced smaller foundations combine to transmit bearing pressures to the clays, this will lead to significant settlements in the long term by consolidation of the clays.

The dense sand below the clays at elevation –30 m is suitable for end bearing piles. The thickness of the sand layer overlying stiff clays is important in determining the length of the piles.

B.5.8.5 Site Fill

If the land in the site is raised to +2.5 m to 3.0 m as in other areas of the port this will lead to considerable consolidation of the clays, which would give long term settlements in the range 100-200 mm.

Using balanced cut and fill to reduce change in site levels to a minimum. This has the advantage of avoiding importing fill. Piling would be required where the surface loadings would lead to unacceptable differential settlements in areas with large diameter piping and heavy equipment, such as compressors casings, which are sensitive to any nozzle movements.

B.5.8.6 Pile Design

Preliminary pile design is based on precast driven piles with a working capacity of 600kN after allowing for negative skin friction. A lateral capacity of 30kn and a tension capacity where required of 180 kN. These would be driven to founding level of approximate elevation of –32 m in the first dense sand level below the clay. This sand layer is sufficiently thick to provide adequate end bearing without overloading the underlying stiff clay. If the final site investigation shows the elevation and thickness of the sand layers to be different, the length and type will be adjusted to ensure the necessary capacity.

B.5.8.7 Foundations

The maximum bearing pressure for spread foundations is 300 kPa, where settlement is not a criterion. Spread foundations will be used where overall settlements from long-term consolidation of the soft clays is within allowable limits for the supported equipment.

The effect of this is that the methanol and ammonia/urea process trains and the Common Facilities areas will be piled. Other areas will not require piling.

A limiting differential settlement from consolidation of the clay, of 15 mm over a length of 20 m has been used for non-piled structures.

B 5.8.8 Topography

Ground elevations measured in the very similar Segas site next door varies from +2.368 m to +2.537 m (i.e., difference of 0.169 m in elevation) with an average of +2.38 m over the site. The ground surface at the site is thus almost plane.

B.5.8.9 Ground Water

The adjacent Segas site ran several boreholes and found that the average groundwater level was 1.75 to 1.90 meters below the surface.

B.5.8.10 Seismic Zone Classification

The Seismic Risk Zone is considered to be class 2A based upon the Uniform Building Code 1997 (UBC 1997).

B.5.8.11 Earthquake Design Criteria

The design parameters given below shall be adopted for seismic analysis and design. Design procedures and detailing rules shall be based on Zone 1 of UBC-97.

With reference to Section 1630 of UBC-97, the following global parameters shall apply:

Importance Factor, I = 1.25

whereby, equation 30-4 of UBC-97 becomes:

$$V = 1.25\ C.W/R$$

where W is in kNs and C is defined below.

Operational Basis Earthquake (OBE)

With reference to Section 1630 of UBC-97, the following site-specific parameters shall apply:

Horizontal Component of OBE:

Seismic Coefficient, $C_a = 0.07$

Seismic Coefficient, $C_v = 0.10$

*For Fundamental Period*, T (secs), the site specific acceleration coefficient, C, is given by:

$C = 0.07(1 + 13.12T)$ for $0.000 \leq T < 0.114$ secs
$C = 0.175$ for $0.114 \leq T < 0.571$ secs
$C = 0.10/T$ for $0.571 \leq T < 4.000$ secs

$C = 0.40/T^2$ for $4.000 \leq T$

Vertical Component of OBE:

Seismic Coefficient, $C_a = 0.045$

Seismic Coefficient, $C_v = 0.04$

For Fundamental Period, T (secs), the site specific acceleration coefficient, C, is given by:

$C = 0.045(1+24.44T)$ for $0.000 \leq T < 0.050$ secs
$C = 0.10$ for $0.050 \leq T < 0.400$ secs
$C = 0.04/T$ for $0.400 \leq T < 4.000$ secs
$C = 0.16/T^2$ for $4.000 \leq T$

Safe Shutdown Earthquake (SSE)

With reference to Section 1630 of UBC-97, the following site-specific parameters shall apply:

Horizontal Component of SSE:

Seismic Coefficient, $C_a = 0.20$

Seismic Coefficient, $C_v = 0.30$

For Fundamental Period, T (secs), the site specific acceleration coefficient, C, is given by:

$C = 0.20(1 + 12.5T)$ for $0.000 \leq T < 0.120$ secs
$C = 0.50$ for $0.120 \leq T < 0.600$ secs
$C = 0.30/T$ for $0.600 \leq T < 4.000$ secs
$C = 1.20/T^2$ for $4.000 \leq T$

Vertical Component of SSE:

Seismic Coefficient, $C_a = 0.15$

Seismic Coefficient, $C_v = 0.12$

For Fundamental Period, T (secs), the site specific acceleration coefficient, C, is given by:

$C = 0.15(1 + 20T)$ for $0.000 \leq T < 0.050$ secs
$C = 0.30$ for $0.050 \leq T < 0.400$ secs

$C = 0.12/T$ for $0.400 \leq T < 4.000$ secs

$C = 0.48/T^2$ for $4.000 \leq T$

B.5.8.12 Ground Water Elevation

The ground water varies with the tidal surge and is an average of 0.7 m above sea level.

B.5.8.13 Environmental Requirements

B.5.8.13.1 Relevant Laws and Regulations

Law No. 4 is the main Environmental Law in Egypt concerning the environment and was passed in 1994. The Executive Statutes of this law were set out in 1995. This law established an Egyptian Environmental Affairs Agency (EEAA). The EEAA has the power to set criteria and conditions, monitor compliance and to take procedures against violators of these criteria and conditions. Various decrees have also been passed dealing with drainage of liquid wastes, and protection of the River Nile and other waterways from pollution.

The law dictates that the licensing authority must assess the environmental impacts of proposed facilities, Article 10, Decree 338 (A10/D338). The license application must include data to be entered in Form A12/D338, which shall be maintained as a register of the facility's impact on the environment during operation (A17/D338).

Form A12/D338 is to contain the following information:

- Emissions emanating or draining from the facility;
- The efficiency of treatment processes and specification of any residual material from the treatment process;
- Details of environmental safety procedures applied in the facility;
- The results of periodic tests and measurements necessary to demonstrate compliance with emission, discharge and health and safety requirements; and,
- The name of the officer in charge of maintaining the register.

The EEAA can visit the facility and take samples to ensure conformity. The EEAA must be notified of any deviation from the criteria by registered letter. The letter must also outline the procedures taken to correct the problem. If a violation occurs and the establishment fails to comply within 60 days the facility could be closed, the violating activity suspended and/or court action could be taken (A18/D338).

Any expansions or renewals to the existing facility or any work, which might result in an adverse impact on the environment or workers, are subject to the preceding articles (A19/D338).

B.5.8.13.2 Conditions in the Workplace

The facility must operate such that leakage or emission of air pollutants inside the workplace will not affect worker's health and safety (A45/D338). The facility must operate such that humidity and temperature will be maintained within the set limits for workers (A46/D338) and suitable Personal Protective Equipment (PPE) are to be provided as required for workers in the facility.

B.5.8.13.3 Use of Hazardous Materials and Wastes

The production of dangerous materials and wastes is prohibited without a license. The license is issued for a fixed time interval. The required information to be submitted when applying for a license is summarized in A26/D338. Management of Hazardous wastes is subject to rules and procedures, which are set out in A28/D338.

B.5.8.13.4 Air/Odor Emissions

The facility must demonstrate that it will meet air/odor emission standards, taking into account not only the facility's emissions, but also those of existing industries in the same area (A34 - 36/D338).

The location of the facility must take into account suitability with respect to distance from urban areas and wind direction (A34/D338).

The release of noxious and harmful smoke, gases and fumes resulting from burning fuel at a facility is regulated by A42/D338. This article covers precautions and permissible limits as well as specifications of chimneys in burning any kind of fuel.

B.5.8.13.5 Noise Emissions

The facility must meet noise regulations for within the workplace, outside the facility and for the area as a whole (A44/D338).

B.5.8.13.6 Disposal of Liquid Wastes

A license is required to discharge industrial liquid wastes into the public sewer system (A7/Law 93 update and Decree 44/2000). There are existing discharge criteria (A11/D649) to which the liquid wastes must adhere (A8/Law 93). Routine analyses of the liquid wastes should be carried out periodically to ensure compliance with Law 4/94. The Authority in charge of sewerage has the right to obligate the owner to undertake treatment or purification (A4/D649).

Surface drainage of liquid wastes is not allowed except with a license. The criteria for drainage will be set by the Minister of Housing and Utilities (A14/Law 94).

Oily discharges are required to pass through an oil/water separator prior to being discharged (A3/D649).

B.5.8.13.7 Additional Relevant Egyptian Laws/Regulations

Additional relevant laws and regulations include:

- Egyptian Decree: Prime Minister's Decree No. 338 of the year 1995 (Executive Regulations of the Law Number 4, 1994).
- Minister of Housing and Infrastructure: Decree No. 44 for 2000 (Modifying the Executive Regulations of Law No. 93 for 1962) – maximum limits for reusing treated sewage for irrigation.
- EEAA: Guidelines for development of Ports, Harbors and Marinas. Environmental Impact Assessment (1999).
- EEAA. Guidelines for Egyptian Environmental Impact Assessment. Environmental Management Sector (1996).
- Egyptian Standard ES1109 (1971). Aggregates from Natural Sources.

B.5.8.13.8 Environmental Register Requirements

According to the Law of the Environment, all facilities must keep an environmental register.

B.5.8.13.9 Relevant Conventions, Standards and International Regulations

The design of the plant shall be in accordance to good engineering practice and shall be based on the latest issue of the following standards and/or codes.

B.5.8.13.10 International Conventions

- MARPOL (1978).
- UN Convention on the Law of the Sea 1982.
- Barcelona Convention.
- Basel Convention on Transboundary Movements of Waste.

B.5.8.13.11 Standards/Regulations

- General Guidelines for Full Environmental Impact Assessment, EGPC EH&S General Division, January 1997.
- Standard Methods for examination of Water and Wastewater - Amer. Public Health Assoc.
- Handbook for Sampling and Sample Preservation of Water and Wastewater - US EPA.
- Handbook for Analytical Quality Control in Water and Wastewater Laboratories - US EPA.
- International Maritime Organization Dangerous Goods Code.

# TASK C SITE INVESTIGATION AND PRELIMINARY ENVIRONMENTAL ASSESSMENT

## Introduction and Site Descriptions

ECHEM offered four sites for evaluation situated on the Egyptian Mediterranean Coast, identified as:

- Idku – to the west of the Rosetta Nile branch.
- Gamasah – 35 kms west of Damietta
- Damietta Port – 3 kms to the west of the Damietta Nile branch.
- Damietta Echem - 3 kms to the west of the Damietta Nile branch.

The sites are on, or close to the main highway that parallels the coastal areas. Distances between the sites are noted on the following table.

**Approximate Distances between Proposed Sites**

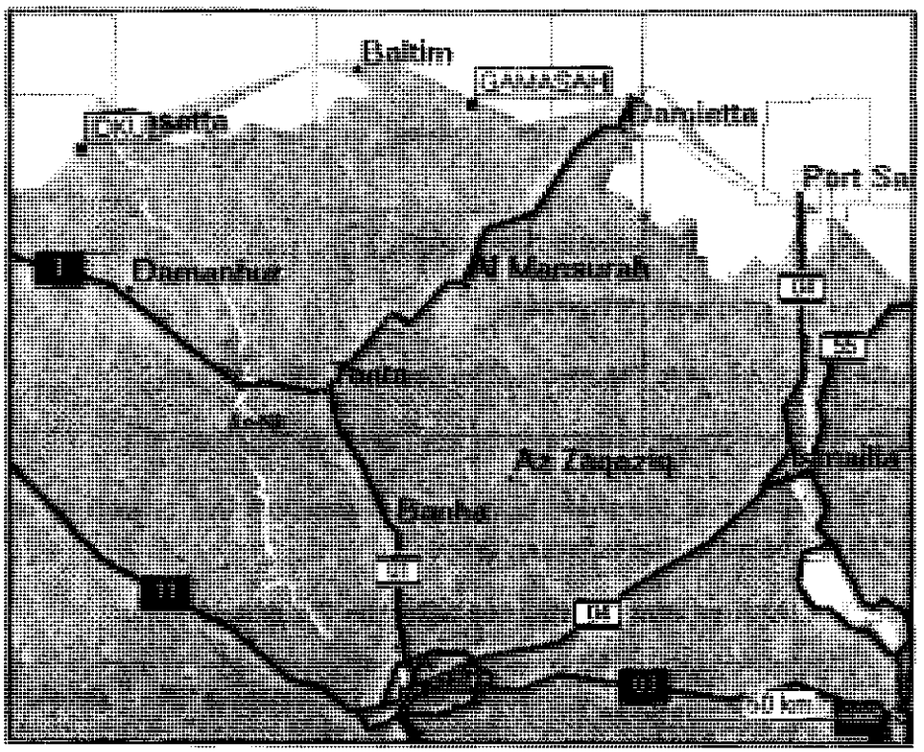
| Site | GPS Coordinates | Idku Site | Gamasah Site | Damietta Sites |
|---|---|---|---|---|
| **Idku Site** | N 31° 22'<br>E 30° 03' | 0 | 120 km | 155 km |
| **Gamasah Site** | N 31° 29'<br>E 31° 24' | 120 km | 0 | 35 km |
| **Damietta Sites** | N 31° 27'<br>E 31° 45' | 155 km | 35 km | 0 |

Both of the Damietta sites are located within one kilometer of one another, the Damietta Port Site being within the Damietta Port Industrial Free Trade Zone and the other being approximately one kilometer to the east of the port.

Idku and the Damietta Port sites are both located within established Industrial Free Trade Zones while the Gamasah and Damietta Echem sites are located in more urban locations. The Site Investigation team was advised that any of the sites selected will become Industrial Trade Free Zones in accordance with Egyptian Government regulations.

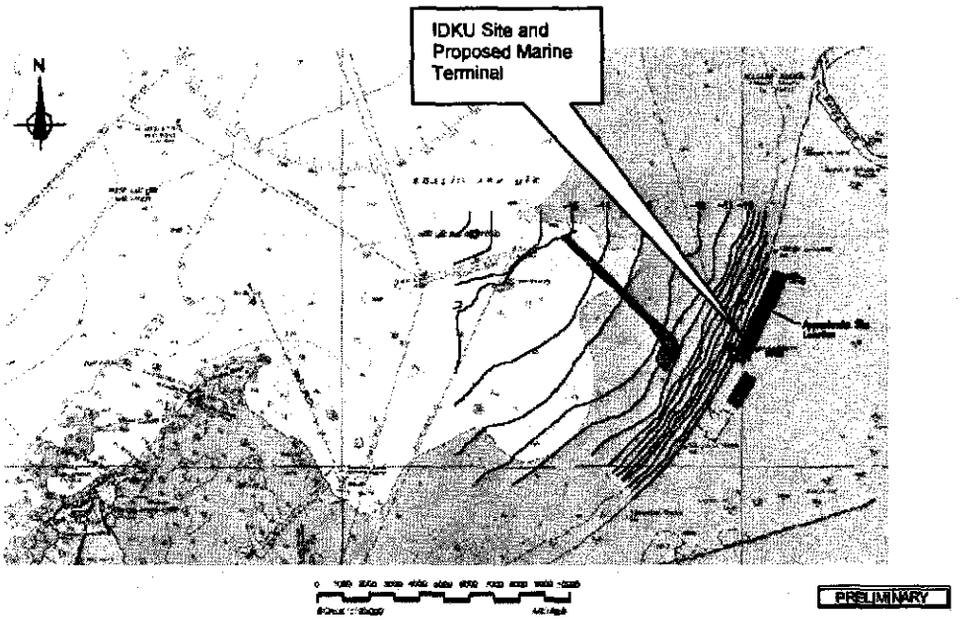
The marine chart included hereafter shows the overall Mediterranean Coast of Egypt and the locations of the sites. Separate detailed marine charts are included showing the location of the sites and the proposed marine export terminal construction. Site photographs are also included which provide a representative overview of the terrain at each site.

## EGYPTIAN MEDITERRANEAN COAST SHOWING SITE LOCATIONS



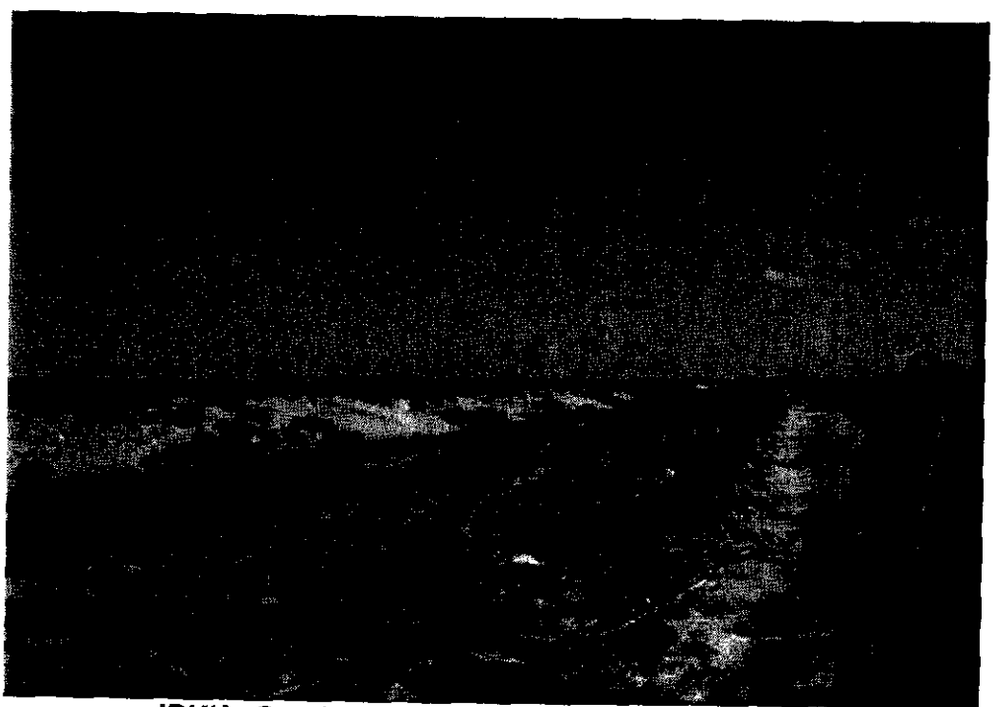

The following charts provide detail of the site locations and their proximity to deep water for construction of marine product loading facilities for bulk carrier ships.

## IDKU SITE LOCATION:

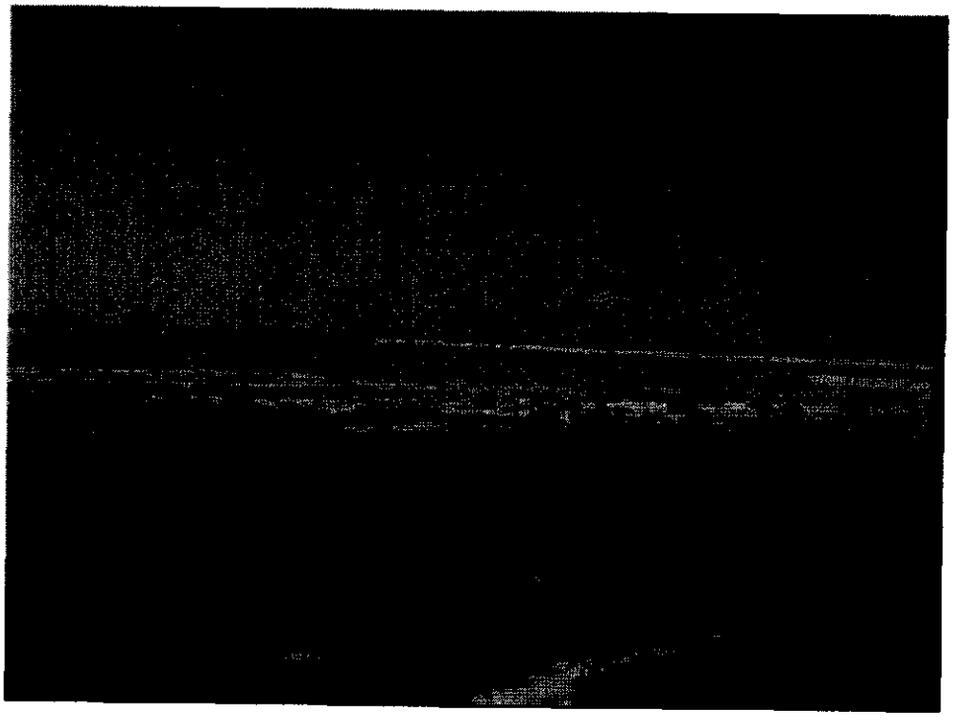


## IDKU SITE PHOTOGRAPHS

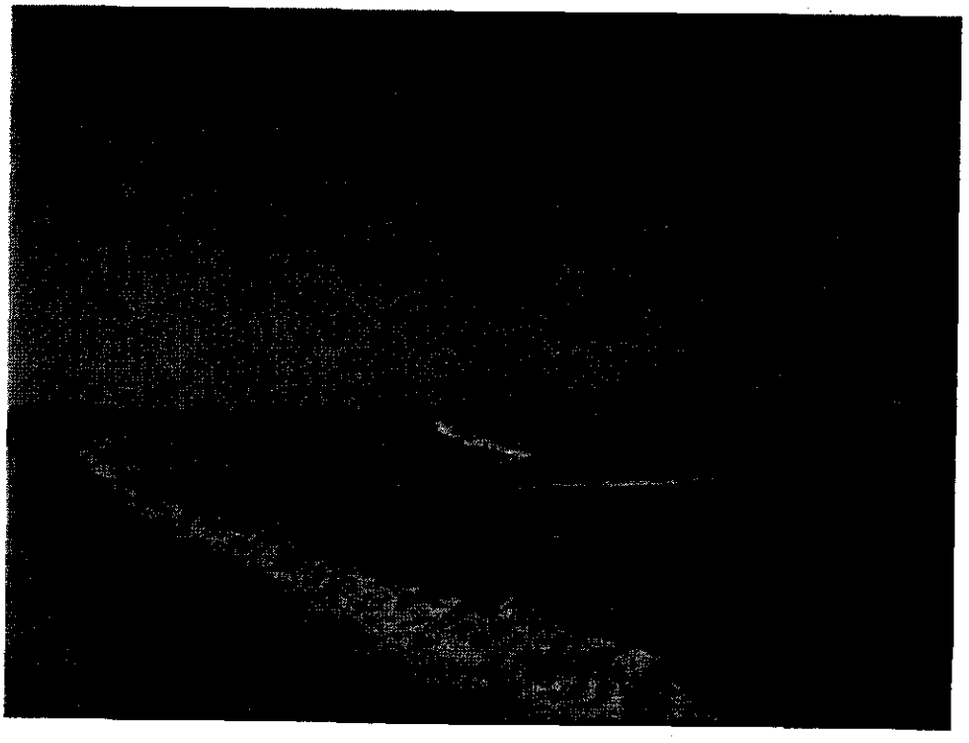
**IDKU - View from S-W corner looking North (Note Napoleonic Fort Ruins on left)**



**IDKU - Southern Boundary Road Looking East**

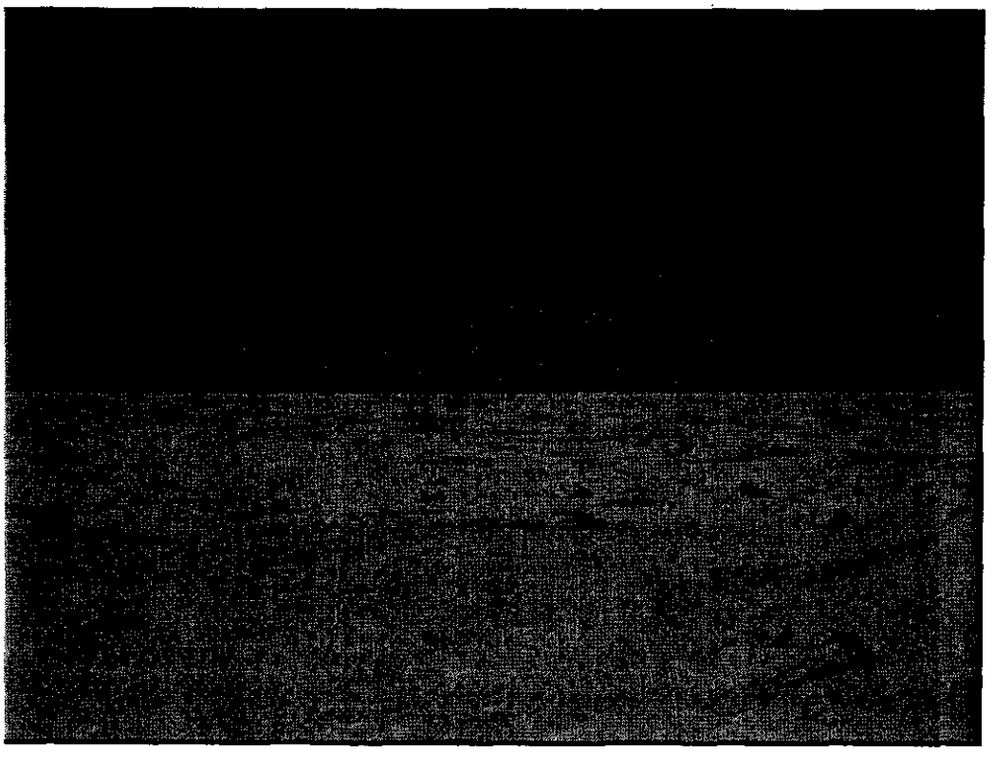


**IDKU - View towards West**



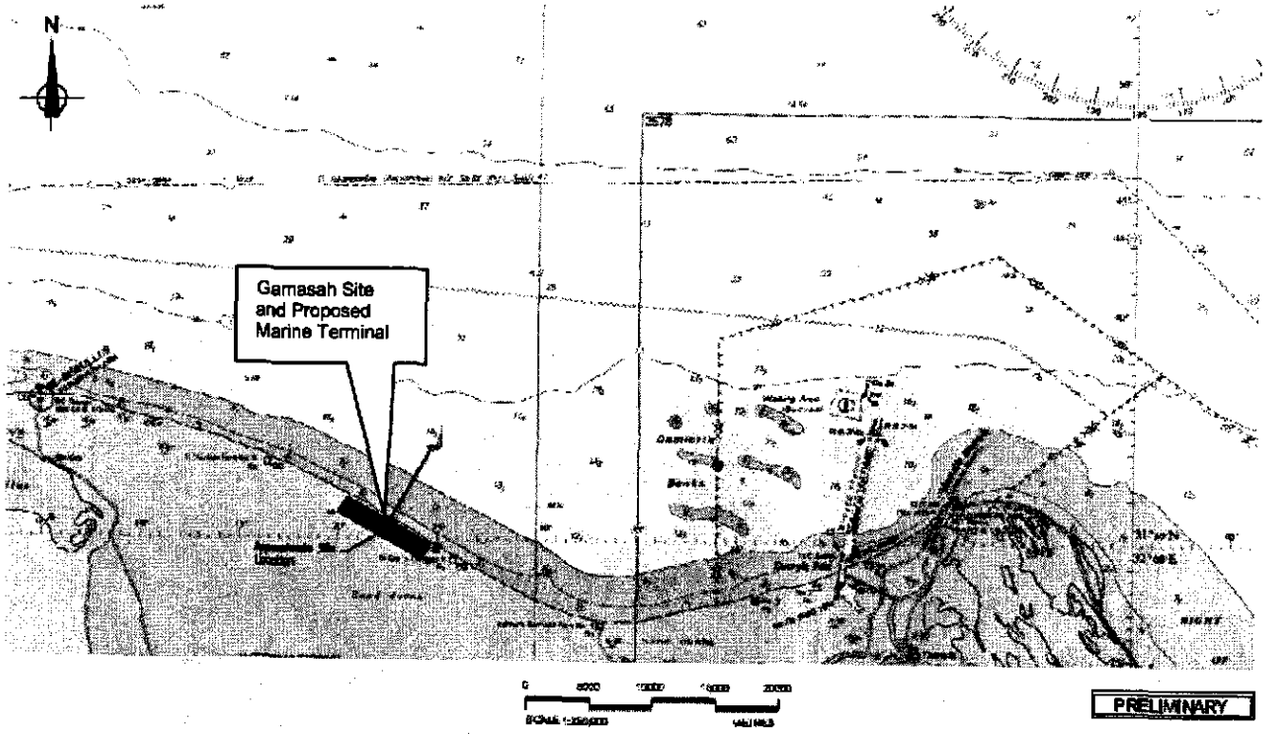
**IDKU -Agricultural Water being discharged onto the Site from the South**

**IDKU - View of Lake on West Site of Plot**

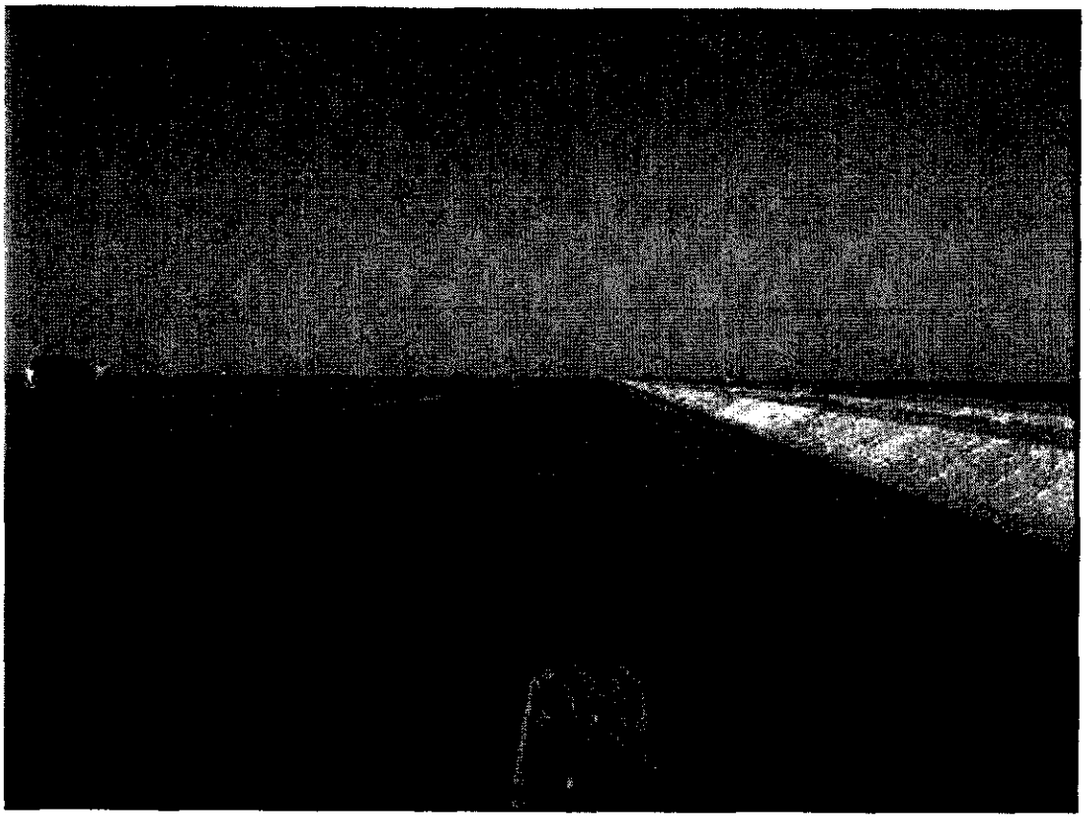


**IDKU - View to North-West from Southern Boundary Road**

## GAMASAH SITE LOCATION

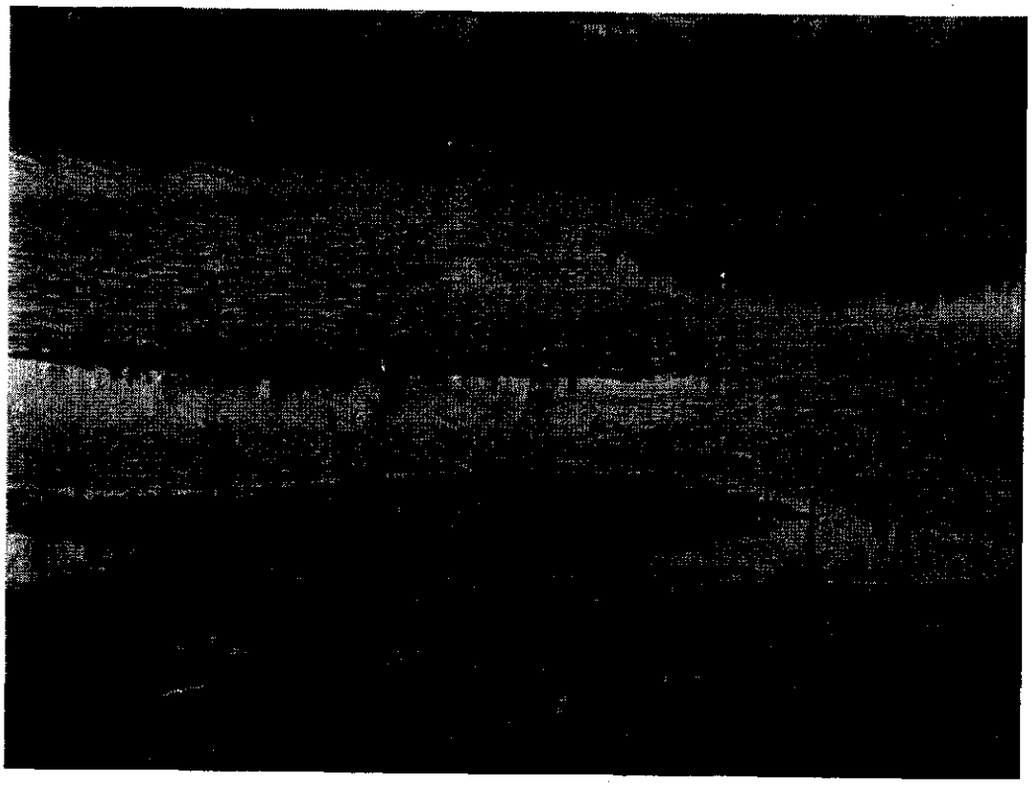


## GAMASAH SITE PHOTOGRAPHS

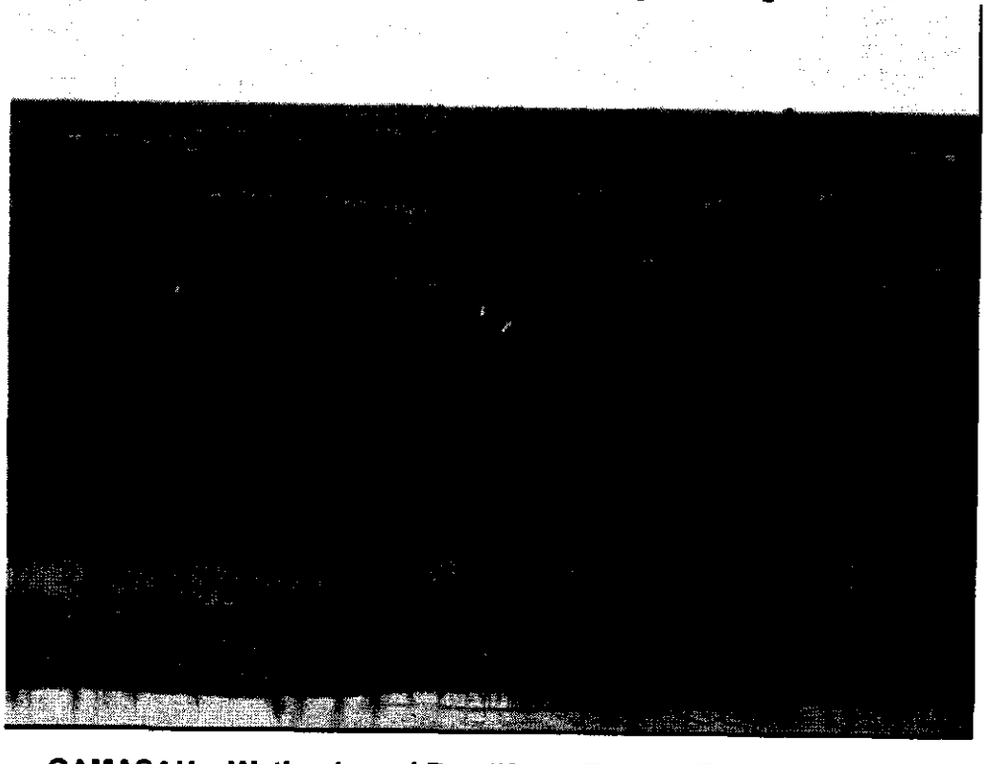


**GAMASAH - View along Irrigation Water Drain – Looking from Coastal Highway to North**

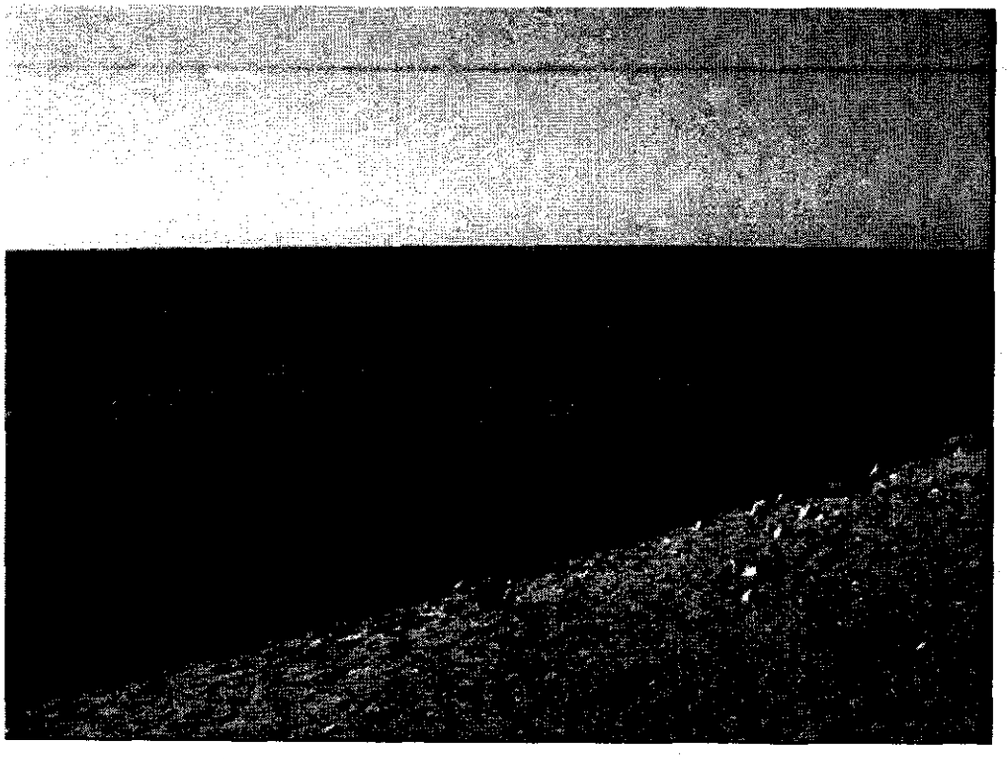
**GAMASAH - Main Gas Transportation Line Marker on W-E Coastal Highway – Looking North**



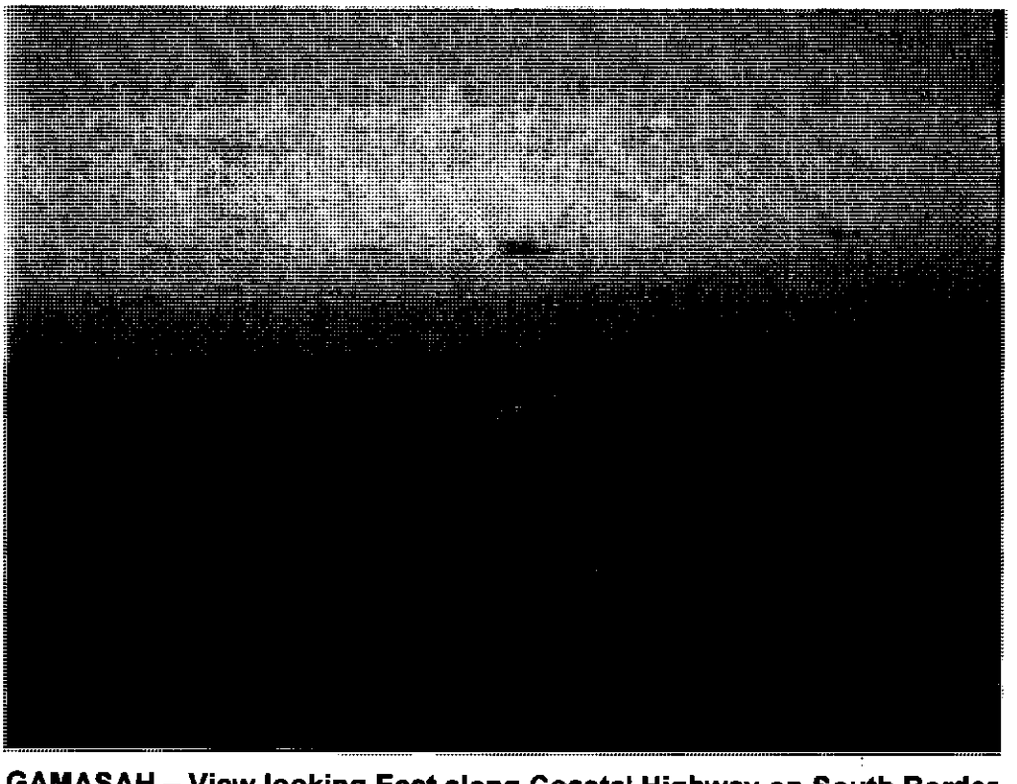
**GAMASAH - Wet Lands on East Boundary showing Eco-Life**



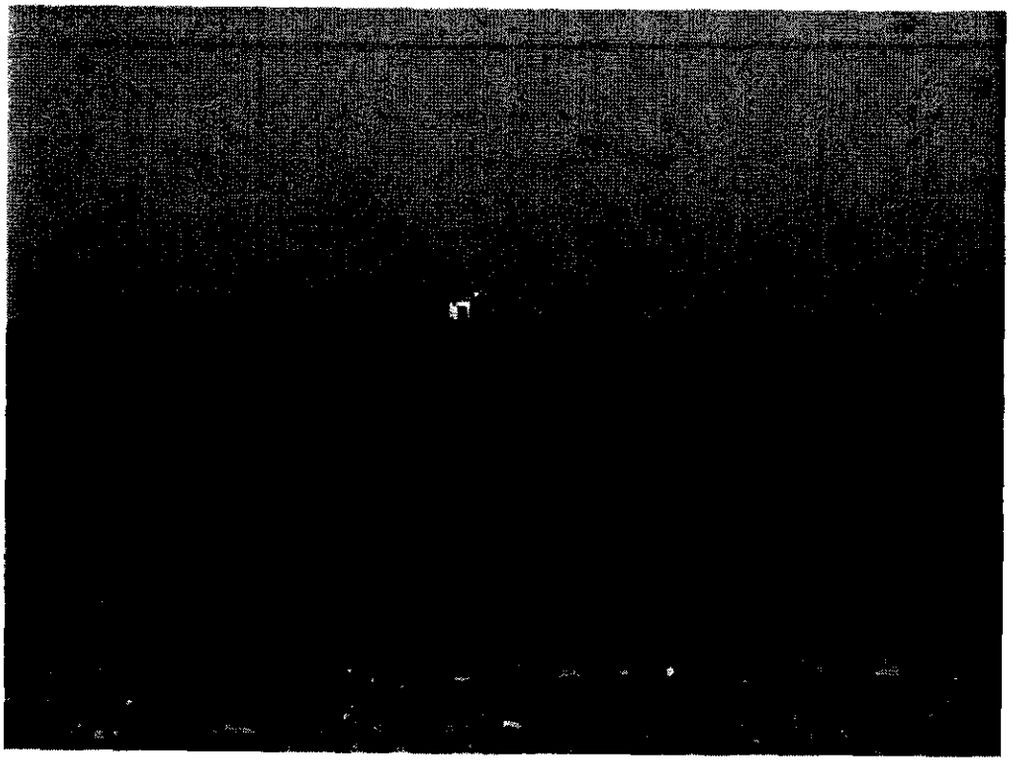
**GAMASAH – Wetlands and Eco-life on Eastern Boundary Road**



**GAMASAH – General View looking West**

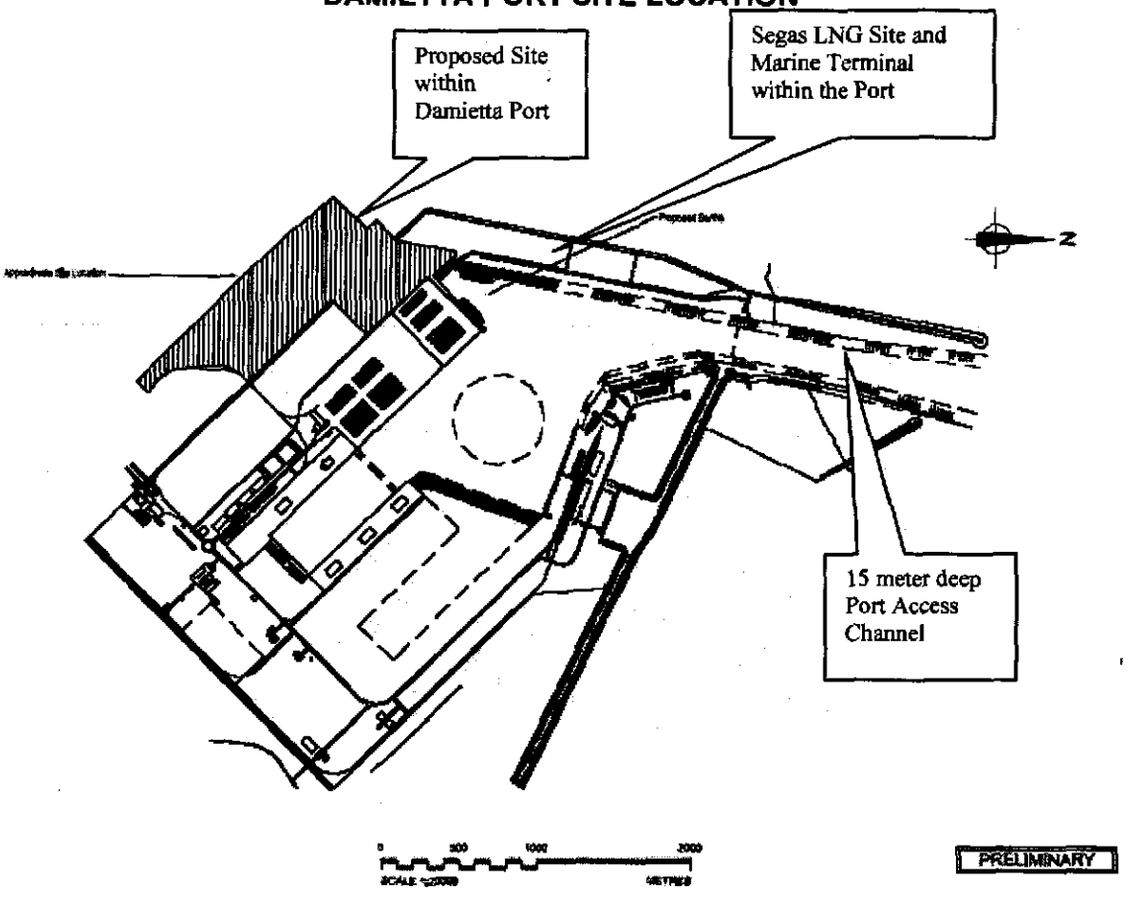


**GAMASAH – View looking East along Coastal Highway on South Border**



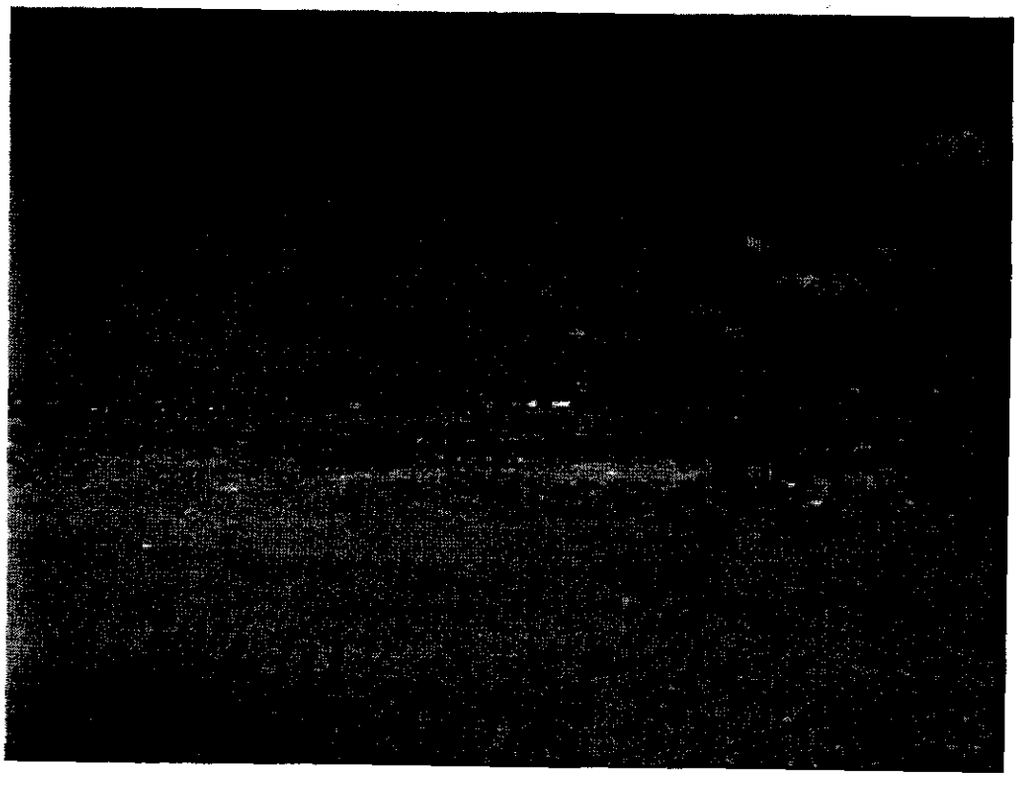
**GAMASAH – View to North showing Buildings near Beach**

## DAMIETTA PORT SITE LOCATION

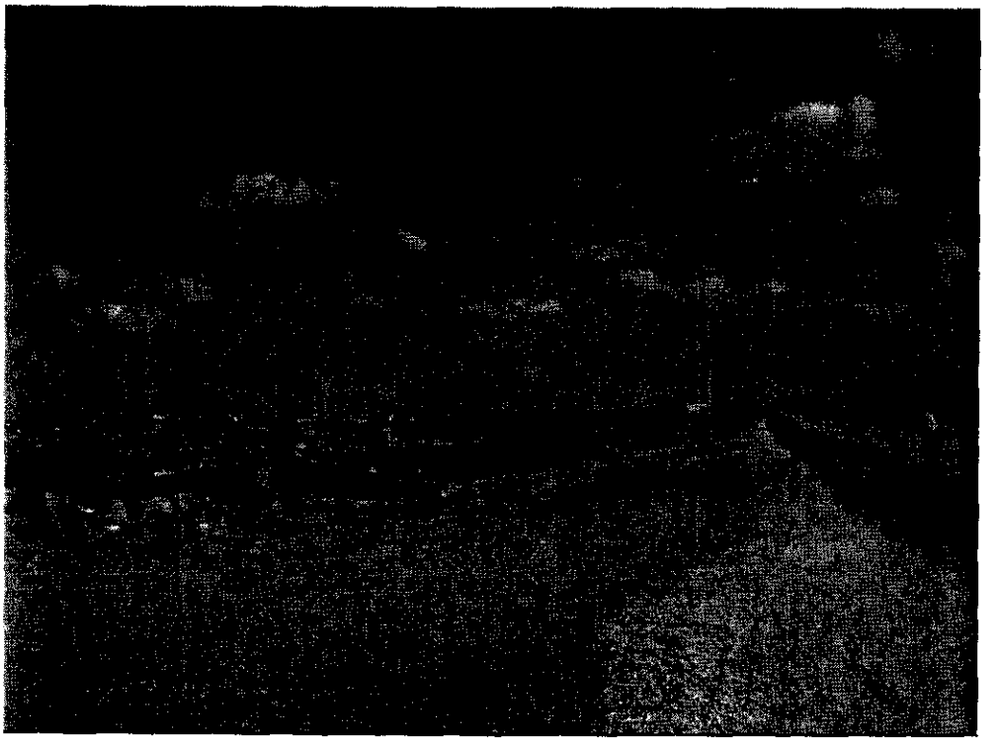


## DAMIETTA SITE

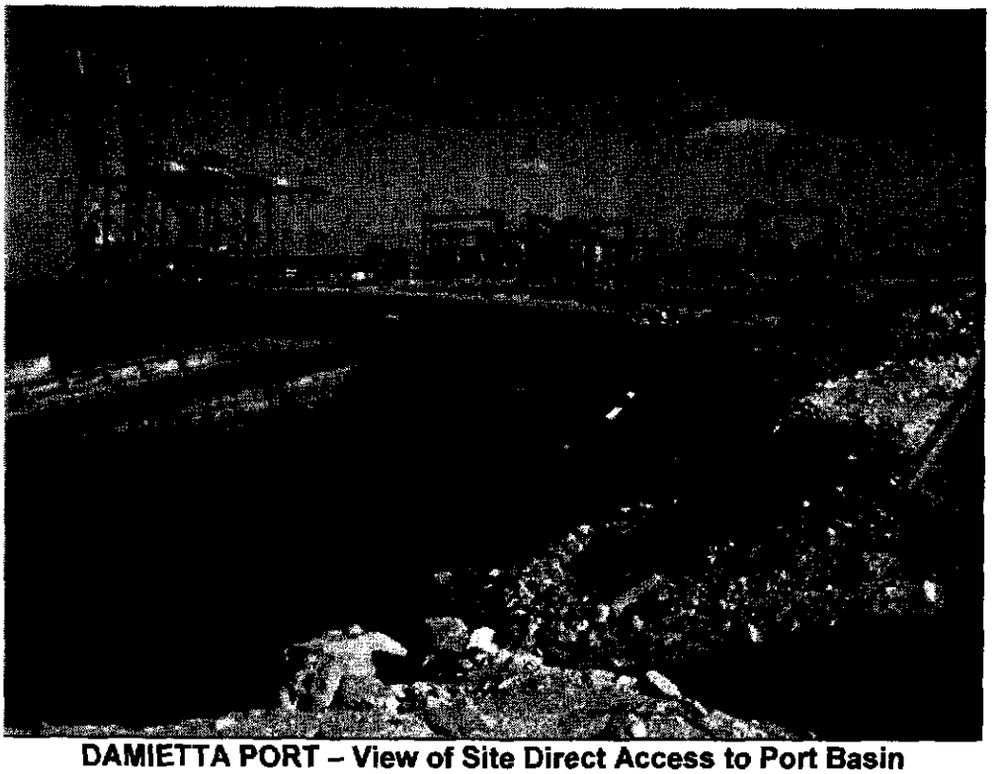
**DAMIETTA PORT – View from West looking towards Container Terminal**



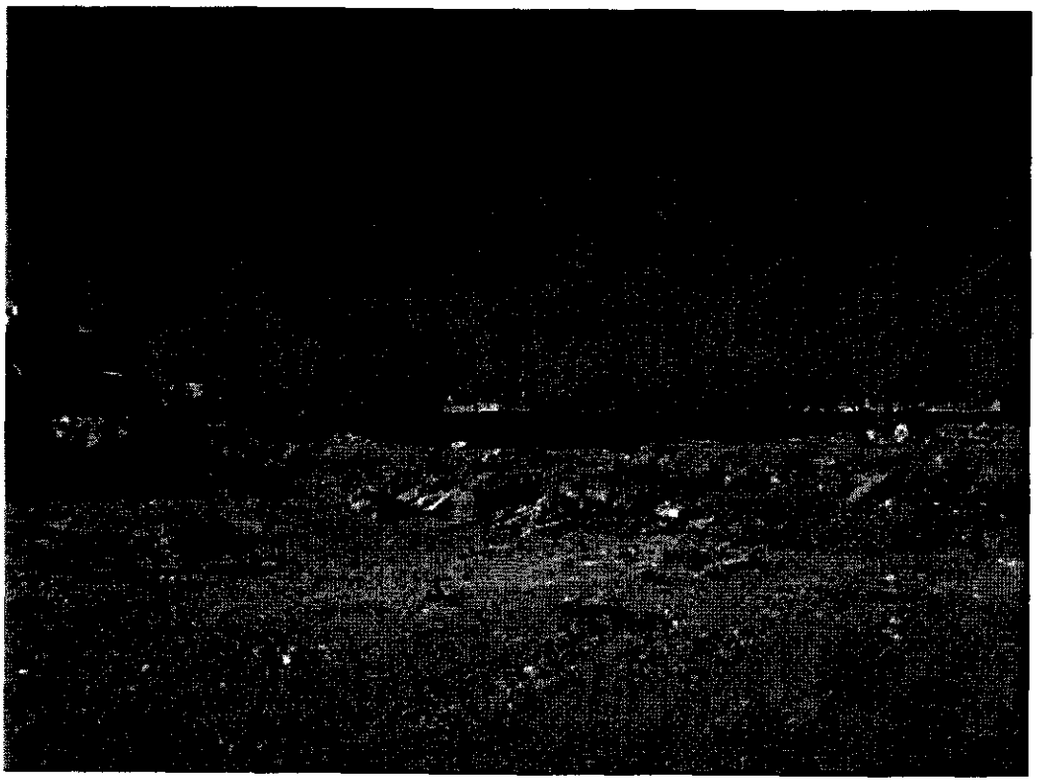
**DAMIETTA PORT – Another View from West**



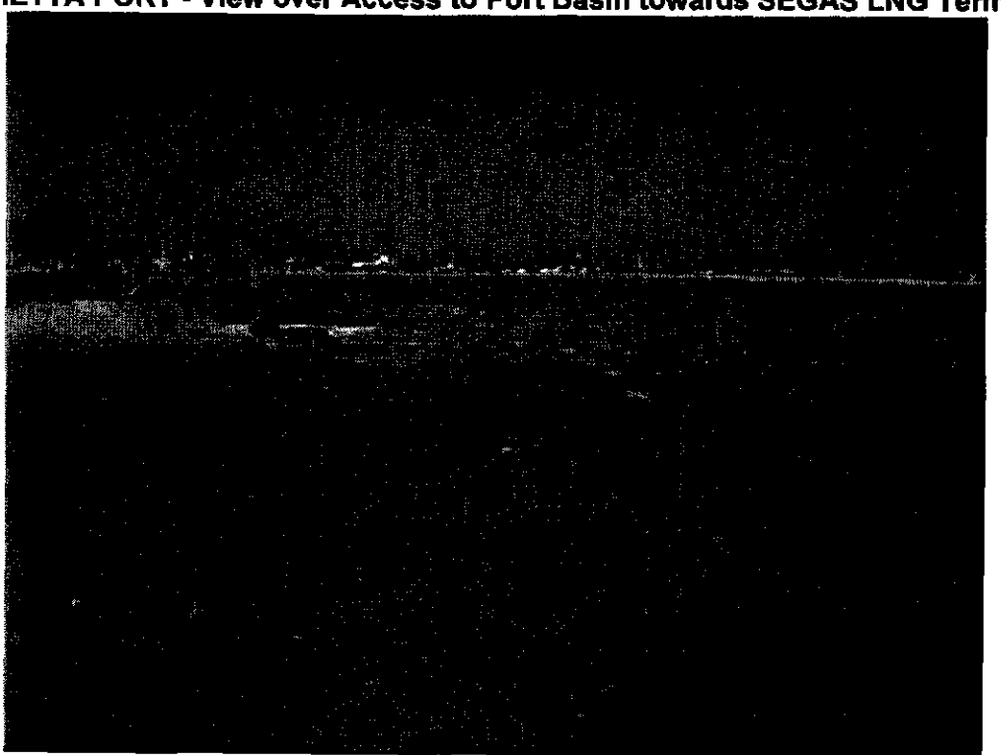
**DAMIETTA PORT – View Looking South**



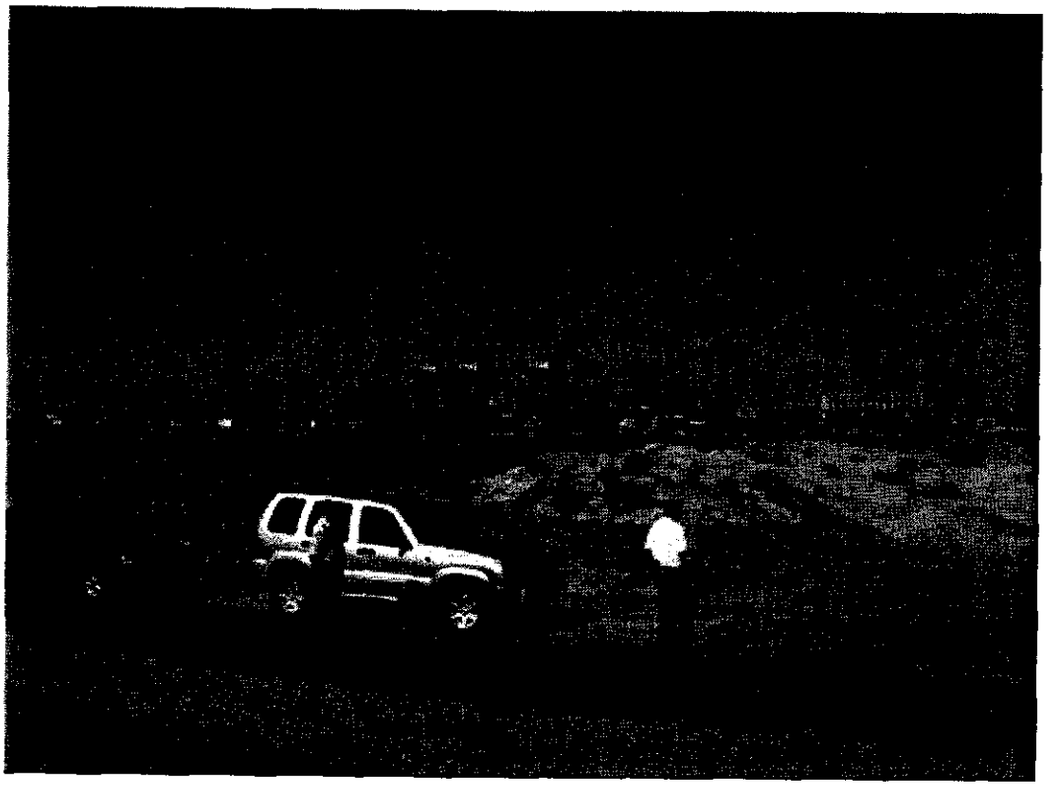
**DAMIETTA PORT – View of Site Direct Access to Port Basin**



**DAMIETTA PORT - View over Access to Port Basin towards SEGAS LNG Terminal**

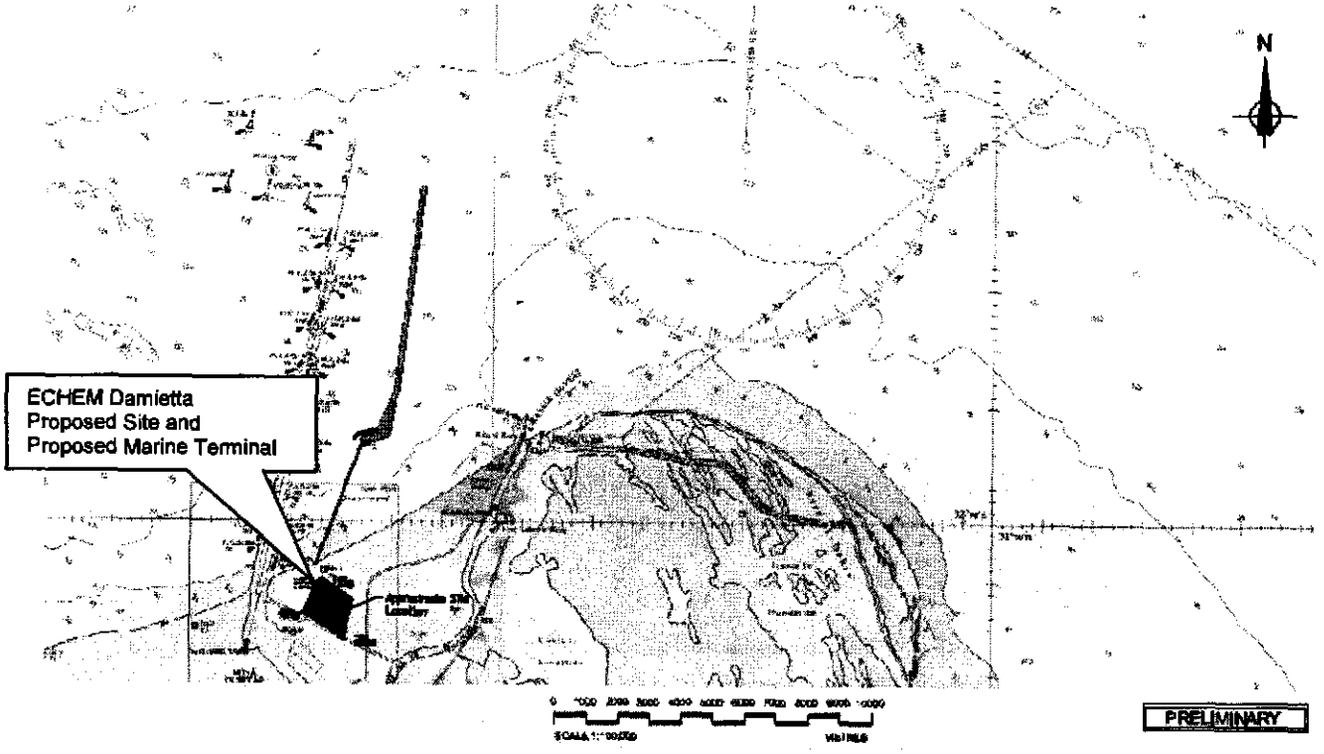


**DAMIETTA PORT – General View Over Site Area**

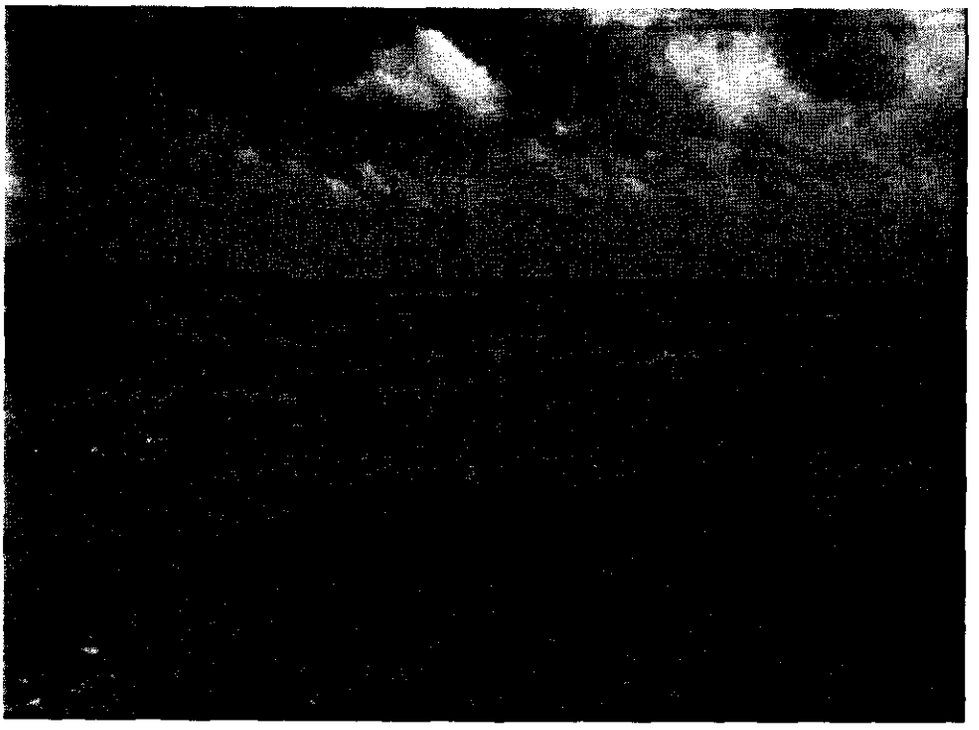


**DAMIETTA PORT – View Towards Container Terminal**

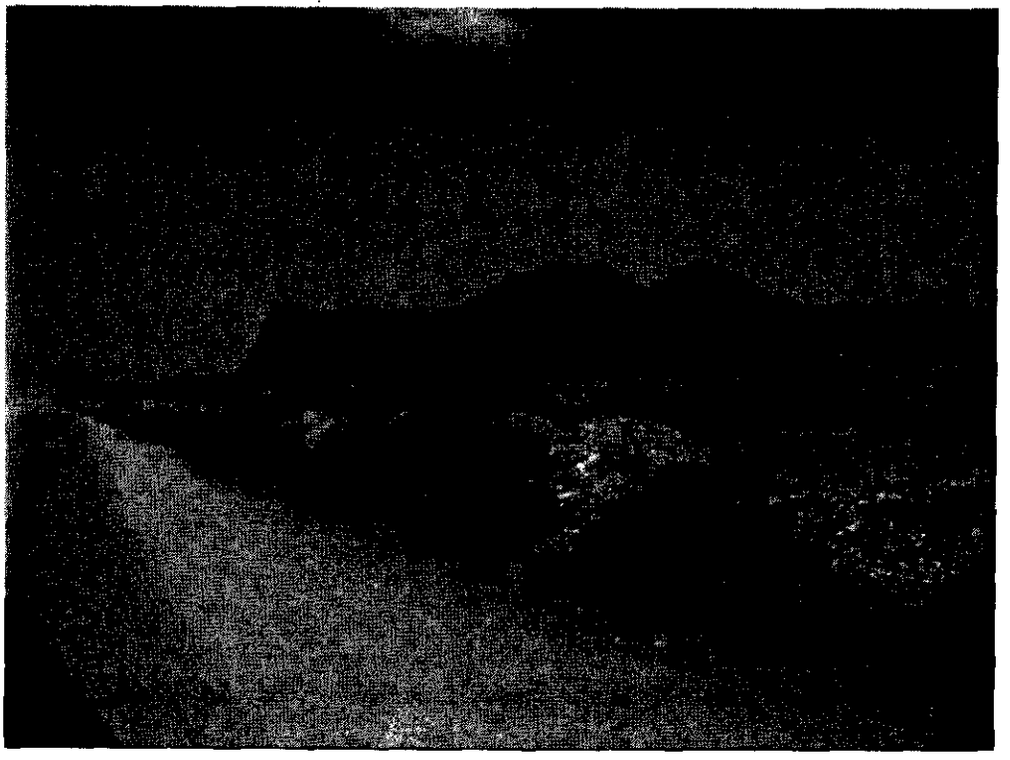
## DAMIETTA ECHEM SITE LOCATION



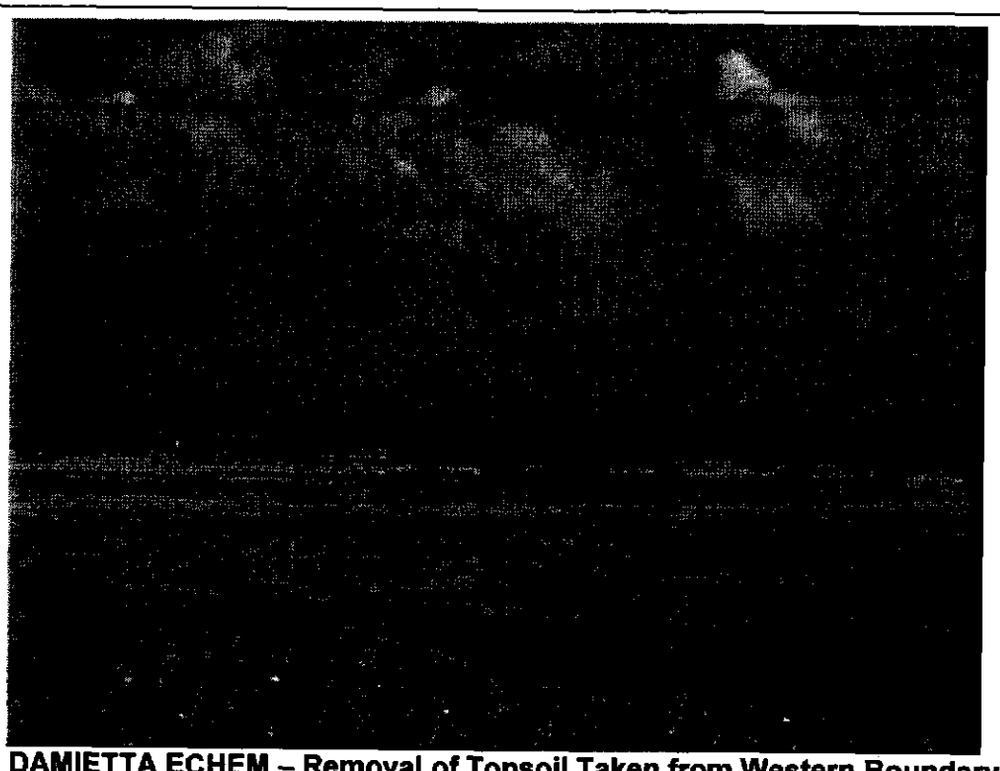
## DAMIETTA ECHEM SITE



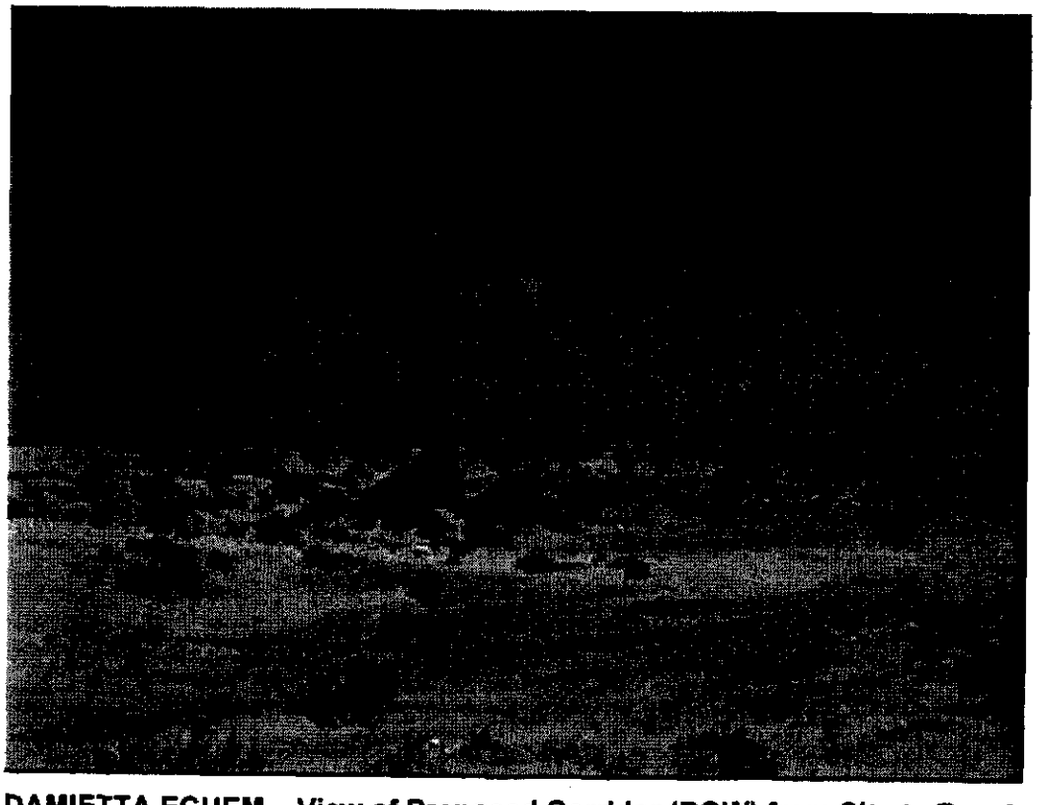
**DAMIETTA ECHEM - View from West showing Top Soil Removal**



**DAMIETTA ECHEM – View of Soil Debris along Western Boundary Road**

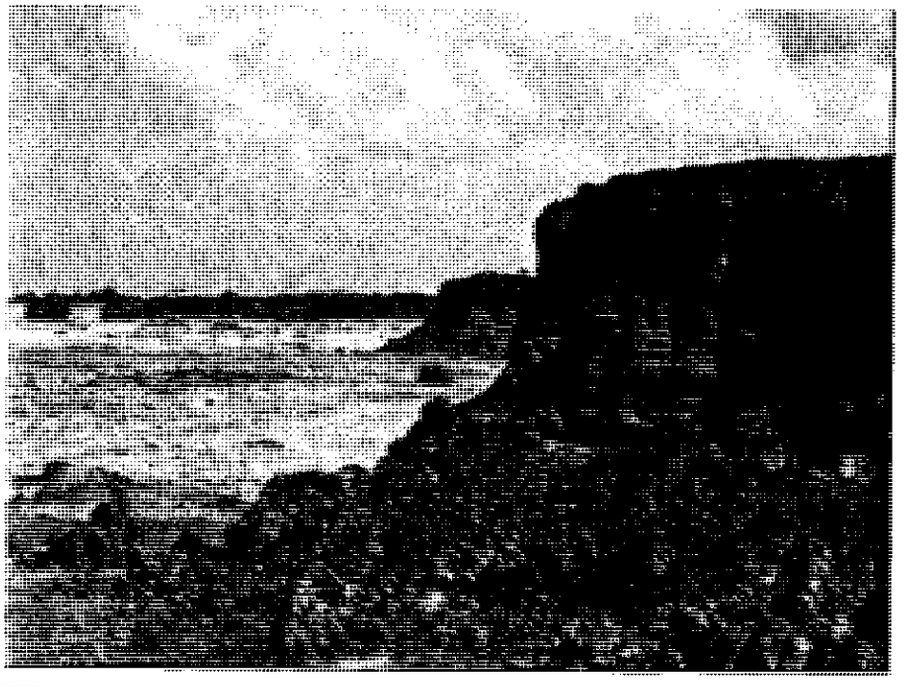


**DAMIETTA ECHEM – Removal of Topsoil Taken from Western Boundary**

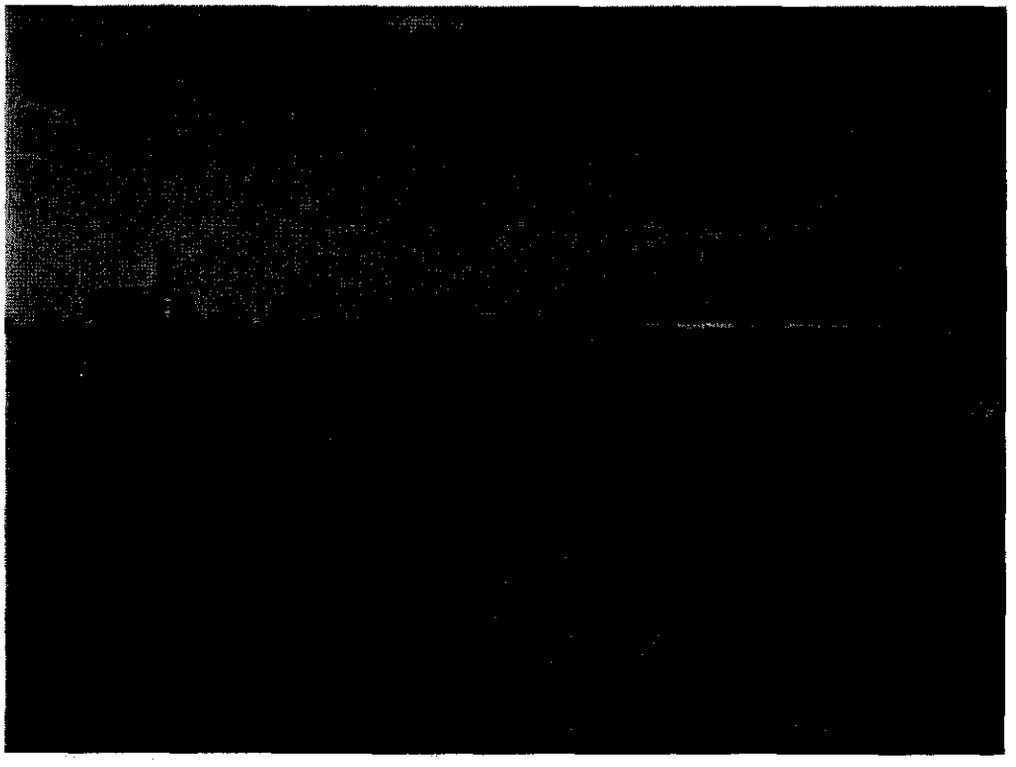


**DAMIETTA ECHEM – View of Proposed Corridor (ROW) from Site to Beach**

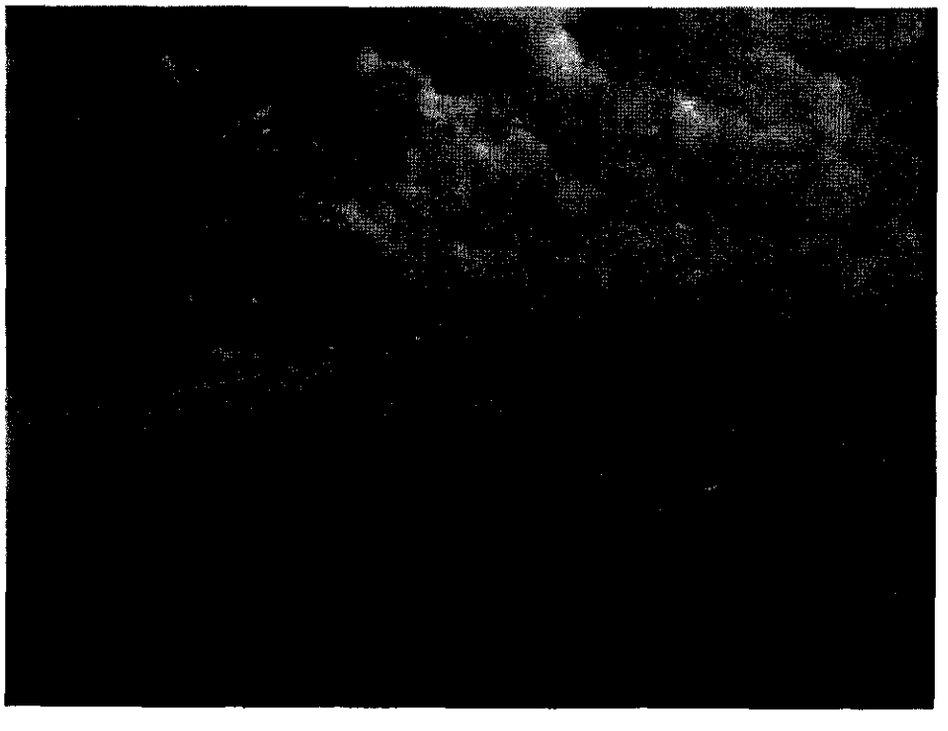
**DAMIETTA ECHEM – Bird Traps on Beach Area in Front of Site**



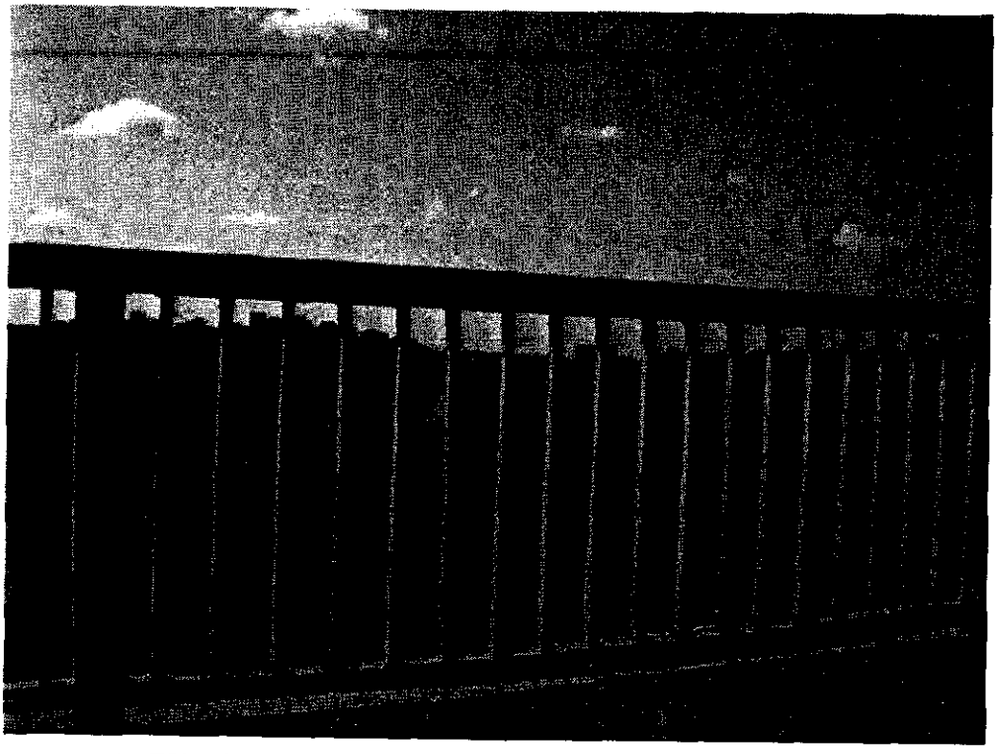
**DAMIETTA ECHEM – Mounds of Hard Clay Left from Excavation of Top Soil**



**DAMIETTA ECHEM – General View to West Showing Flour Mill**



**DAMIETTA ECHEM – View of Road and Canal on Southern Border of Site**



**DAMIETTA ECHEM – View West along Navigation Canal Bordering Site on Right**

## C.1 SITE EVALUATION CRITERIA

### Basis for Evaluation

The Site Evaluation Criteria focused on those features that differentiated the site environmental considerations and major site development cost issues. All sites were very similar in that the soil and topographic features did not significantly add differentiators to the development costs. All sites are located in similar soil conditions on the Nile Delta that will require significant foundation piling. The soil evaluation is covered elsewhere in this report.

During the initial site surveys, an environmental site ranking table was prepared, identifying major environmental considerations. This table is included in this section.

### Ranking Criteria

The overall Site Ranking Table included the following criteria, each being ranked in accordance with its assessed importance. The large cost of constructing a dedicated and project specific export marine terminal in the shallow Delta waters is the major ranking issue for each location.

| Differentiator Criteria | Ranking Points |
|---|---|
| Plot Size | 2 |
| Land Expansion Opportunities | 6 |
| Cost of Land Rental | 3 |
| Access to a Marine Export Terminal | 10 |
| Site Preparation Costs | 5 |
| Excessive Cost for Piping Conveyor Length | 5 |
| Cost of building a dedicated Marine Terminal | 30 |
| Annual Marine Terminal Maintenance Costs | 10 |
| Terminal Operating Costs | 3 |
| Location to sources of Cooling Water | 5 |
| Site Access and Constructability | 3 |
| Access to Natural Gas pipeline feed | 3 |
| Environmental Mitigation | 5 |
| Difficulties to obtain Permits | 10 |
| | --- |
| Total Points | 100 |

Granherne visited each of the sites to collect information to prepare the Site Investigation Report. An environmental engineer from Komex accompanied the team and prepared a Preliminary Site Environmental Ranking Report. Komex is an environmental consulting company subcontracted to Granherne.

Halcrow Group Limited was contracted by Agrium U.S. Inc. to prepare a marine Jetty Engineering Support Scoping Study. Granherne participated in the preparation of that report and sections are reproduced in this Report.

These reports and tables are included in the following sections of this document:

| | |
|---|---|
| Section C.2.1 | Site Investigation Report |
| Section C.2.2 | Preliminary Site Environmental Ranking Report. |
| Section C.2.3 | Granherne Jetty Assessment and Halcrow Jetty Engineering Support Scoping Study |

The Overall Site Selection Ranking Table was developed using the data from these reports.

## C.2 SITE ECONOMIC, LOGISTICAL & LIFE CYCLE ADVANTAGES

**Objective Site Evaluation**

All sites are very similar in that the geotechnical information is fairly consistent along the Nile Delta region and that each site would require piling for all major foundations. It was therefore decided to concentrate on those elements that incurred major environmental and/or cost implications. These differentiators are noted in Section C.1 above. The items having the greatest cost and life-cycle impact is the development cost of a marine export facility at each site, while the differences in site preparation at each site are also major factors.

All sites are within reasonably good road access from the major towns and ports of Port Said, Damietta Port and Alexandria Port. International airports are located at Cairo and Alexandria. Idku, Gamasah, and Damietta Echem sites will require the construction of their own dedicated marine export terminals,

To prepare an objective evaluation of each site, the initial activity was to visit each site. During that site investigation visit, Granherne prepared a Site Investigation Report (Attached as Section C.2.1). The visit was validated with the a participation of a representative from Komex, the Cairo Office of an international Environmental Engineering company subcontracted to Granherne. Komex prepared their Preliminary Site Environmental Evaluation Report that is attached in Section C.2.2.

The purpose of these reports was to accumulate information to prepare an overall site ranking study, using the Differentiator Criteria developed in Section C.1.

### C.2.1 Granherne Site Investigation Report – Egypt September 12 and 13, 2004

The Granherne Site Investigation Report is produced in the following section.

**Introduction**

This Report summarizes Granherne's findings during their Site Visits to the following proposed sites for the Echem Methanol and Ammonia Feasibility Study Project.

| | | |
|---|---|---|
| Damietta Echem Site | - | September 12, 2004 |
| Gamasah Site | - | September 12, 2004 |
| Idku Site | - | September 13, 2004 |
| Damietta Port Site | - | September 13. 2004 |

Present During Site Visits

| | | |
|---|---|---|
| ECHEM: | Mr. Gawdat Sadek | Echem Nominated Project Coordinator for the Granherne Feasibility Study |
| | Mr. Ali Hassan Ali | Operations General Manager |
| KOMEX: | Mr. Mohamed Hassan | Senior Environmental Engineer |
| GRANHERNE | Mr. Alun Waters | Project Director |

General: The team traveled 1,020 kms by car from/to Cairo to the Nile Delta, visiting the various sites proposed by Echem as well as visiting the SEGAS site at Damietta. The surveys were conducted by Granherne and Komex using GPS plotter instruments to record principal geodetic coordinates for each site and match them to marine maps loaded into the GPS plotter. Multiple single and panoramic digital photographs were taken of each site as well as background noise levels at Gamasah which will be used as a baseline noise reference for this non-industrial site.

Overall Summary and Conclusions from the Site Visits

**Onshore Construction**

The onshore construction for each of the proposed sites is very similar in that the geotechnical information indicates that the soil nature is very similar throughout the Mediterranean shores of

the Nile Delta. This will mean adding the cost of piling the foundations on all sites which makes the site selection criteria neutral.

The plot area required for Phase I installations is estimated to be approximately 450,000m$^2$.

The planned expansion of the production facilities is as follows:

- Ammonia: Agrium forecast that they will require additional space for 2 additional trains of ammonia. This equates to approximately 120,000 m$^3$ additional space.
- Methanex forecasts a need to add two more methanol units plus two additional storage tanks. This equates to approximately 140,000 m$^3$ additional space.

Allowing for space between the facilities, a preliminary plot plan would indicate a space requirement in the region of 1,275,000 m$^2$.

Each site appears to have adequate land area to accommodate the initial project requirements and the stated phased expansion requirements.

All sites are relatively flat, although the Echem Damietta Site will require backfilling and grading to replace the top soil that an unknown contractor continues to be removed in large quantities.

Environmental impact considerations are also fairly small, other than the Idku site that has had polluted agricultural wastewater being dumped upon the west/mid section for an unknown period of time which may have polluted the soil in that area.

Each site has acceptable access for construction equipment and there is no major impact on the surroundings. The proposed sites are close enough to Damietta or Alexandria to accommodate port offloading at either port.

Construction labor would not appear to be a problem. Accommodation also does not appear to be a problem for national workers and expatriate supervision/management.

There is very little to choose between the sites other than to evaluate the distance from the site from the beginning of the loading jetty (distance to beach).

The concerns about the "hassle" of constructing a facility within the Damietta Port area are real but will be similar on any of the sites once the site is declared an Industrial Free Zone. This should not be a deciding factor.

**Offshore Construction**

The offshore construction costs would seem to be the deciding factor for site selection. The fact that the Nile Delta is very shallow and slow shoaling means that the loading terminal has to be located a long way offshore. In the case of ELNG, this meant that they constructed a 2,400

meter trestle jetty to get into an area that was considered economical to dredge a 13 – 15 meter depth berthing arrangement and ship turning circle. They then had to dredge a navigation channel from the berth to deeper water, provide an 800 meter deep water breakwater and provide a harbor for pilot boats and tug boats, a very expensive option that must cost in the region of $80 – 100 million dollars. We are seeking firmer cost information for the construction of this terminal.

Unfortunately, this ELNG model repeats itself for Idku, Gamasah and the Damietta Echem sites, with marginal savings if the navigation channel can be shortened by cutting into the existing channel at Idku and Damietta. There may be some savings if discussions with ELNG and Damietta Port can result in cost sharing the dredging maintenance of the main navigation channels and the use of pilot/tug boat services, but these are small compared with the overall initial project investment cost.

The Damietta Port site seems to offer the best economics for the added cost of a marine terminal. SEGAS LNG has already selected that option, having dredged and constructed an LNG offloading terminal within the protected basin of Damietta Port at a cost of approximately $21 million. The real savings are in the limited need to dredge and construct only a 90 meter long jetty to the 15 meter depth basin with no requirement to construct a breakwater. Additionally, all port services, including pilots and tugs are available from the Port Authority. Charges for these services are to be advised by Echem from their meeting with the Authorities in early September.

There may be some consideration to the possibility of ammonia leaks and the effect on the local environment. The prevailing wind at all sites is NW to NE and the effects in the Damietta Port should be minimal, as there is no surrounding habitation. There are a large number of ammonia loading facilities within ports throughout the world that are accepted as manageable risks.

Damietta Port is already an Industrial Free Zone and "Permitting" within that zone will be easier than that for a new site.

**Preliminary Recommendation**

The marine terminal cost is the most prominent deciding economic factor in selecting the project site. The Damietta Port site would seem to offer the best economic, environmental, and logistical advantages, and Granherne suggests that Damietta Port Site be retained for the purpose of this Study.

The following discussion addresses the visits to each site.

**Damietta Echem Site - September 12th**

This site is located on the east of the Nile Delta, just east of the Damietta Port. The Damietta eastern branch of the Nile is to the east of the site, with a 5-meter deep Navigation Channel having been constructed connecting the Damietta branch to the Damietta Port. The area shown to the team is approximately 2.25 million square meters equivalent to 225 hectares.

Prevailing winds appear to be from the NE to NW.

**General Aspect**

The proposed site may be described as "agricultural," the soil being composed of rich, earthy, alluvial deposits. It is relatively flat, although there are major excavation activities where contractors are removing approximately 4 meters of the topsoil. While this soil removal is general over the site, it has resulted in areas where mounds of clay like deposits remain, having had the fertile topsoil removed around them. These clay-like deposits are exposed as uneven hills, several meters high. (NOTE: It was later learned that these alluvial deposits were the dredged material from the construction of the Barge Navigation Canal and possibly the Port construction.)

The site is approximately 400 meters from the beach. There will be a requirement to purchase a right-of-way to provide access from the site to the beach area/jetty that would be constructed on the northwest corner of the plot.

Unlike the other sandy sites to the west of Damietta, the Damietta Echem land is fertile silty soil. This rich soil is currently being removed from the site by unknown contractors. The soil removal has reached a depth of 4 – 6 meters over a very large area of the proposed site and will require replacing with sand fill to bring the site level back up to the level of the surrounding lands. There may be some opposition to construct chemical industrial plant on such rich agricultural land.

**Boundaries**

**South:** The southern boundary is a road running parallel to a large but shallow (5 meter) freshwater Navigation Canal which is used for barge and small boat traffic. This canal also borders the Damietta Port to the south. The flowing water in the canal is fresh water diverted from the Damietta branch of the River Nile to the east. It is reported that this water is heavily polluted with agricultural herbicides, fertilizers and other waste products.

**West:** There is a large working flour mill located on the western boundary.

**East:** There is a military residential area on the east.

**North:** There is no direct access to the sea on the north side although Echem advises that they will purchase a "right of way" (ROW) corridor should the site be selected

The principal geographic coordinates recorded by GPS at the site are noted below. The point references are those on the Echem supplied drawing (Attachment 2 to this report).

| POINT | NORTH | EAST |
|---|---|---|
| 5 | 31° 28.456' | 31° 46.169' |
| 4 | 31° 28.050' | 31° 46.999' |
| 1 | 31° 28.981' | 31° 46.465' |
| 2 | 31°29.031' | 31° 46.551' |

The beach coordinate, closest to point 2, are N31° 29.210' and E31° 46.453'

The coordinates of the HV power line and pylons on the south perimeter site road which is noted in the site description below were recorded as N31° 28.285' and E31° 46.436'.

The client map (Attachment 2) is augmented with a marine GPS map of the Damietta site area showing the site coordinates, marine depths, and the Damietta Port access channel (Attachment 3).

**Access**

Access to the site is from the Damietta – Ras el Bar 506 road, turning off at the bridge crossing the Navigation Canal onto a wide surfaced road, running parallel to the Navigation Channel. The road surface is good. Any very large/heavy pieces of construction equipment/materials can be barged to the site from the Damietta Port and lifted onto the site from the Navigation Channel road.

The nearest airport is Alexandria, with Cairo airport also being readily accessible by road.

This development will be considered as a new Industrial Free Zone and will be subject to the same access controls as Damietta Port.

**Utilities**

**Water:** There is "fresh" water in the Navigation Channel, but it is likely to be saline and contaminated and unlikely that the composition will be stable.

**Electricity:** There is an HV electrical feed running on large pylons across the Navigation Channel from the port area and terminating on a pylon on the proposed site.

It clearly has been run to provide electrical power to the site, although there is no indication why such an investment was necessary. There is a sign board advertising "Universal Food Co. – UFICO" along side the site pylon. Echem is to investigate.

**Natural Gas:** It is unlikely that the Egas main transmission line to SEGAS runs into this area. Echem is to obtain the information on the capacity of the existing line to SEGAS and the routing of the gas transmission line to evaluate pipeline extension costs. A quick, rough estimate of gas requirements for the first phase of the project is 190-200 MMSCFD at 52 Kg/cm$^2$ pressure at B.L.

**Environmental Considerations**

The land is made up from alluvial deposits and may be considered of agricultural value. There is no visible presence of a large bird or animal population. In fact, the beach area in front of the proposed site has rows of high seine nets that are installed for the express purpose of catching migratory birds for consumption!

**Project Site Considerations**

**Foundations:** The Nile Delta region comprises soft alluvial deposits and each site will require piled foundations. This makes the foundation construction cost comparison for each site "cost neutral."

**Marine:** The biggest differentiator on project costs will be the need for marine terminal requirements. All foundations for the jetty structures will need to be piled. In the case of the Echem Damietta site, in the absence of being able to transport product in pipelines and conveyors across the Navigation Canal into Damietta Port, there will be a need to construct a separate loading facility. This will comprise a ramp at the beach head, a trestle jetty running out to 12 – 14 meter depth, a jetty head, a breakwater, a dredged turning basin (14 meters) between the jetty head and the breakwater and a navigation dredged channel connecting the turning basin to the dredged Damietta Port navigation channel.

Additionally, there will be a requirement for regular dredging maintenance of the channels, turning basin, etc. Shared costs for these services need to be evaluated.

It is assumed that the Damietta Port Authorities will provide Pilot Boats and Pilots, along with Tug Boat services which will mean that there should not be a need to construct a small tug/pilot boat harbor. Charges for these services need to be evaluated.

In the case of ELNG, the trestle jetty is 2,400 meters long with a jetty head, turning basin and 800 meter breakwater, additionally, there is a separate deep water dredged channel

providing access to the jetty and a tug/pilot boat harbor. Using rule of thumb estimates, this installation will cost $80 -100 million, plus regular dredging maintenance.

Even though this will be a "private port," it will be considered to be within a new Industrial Free Zone and there will be controlled access into and out from the site during construction and operation. We understand that like other countries, even though the installations are "private," the Egyptian Administration will charge fees for the construction and port usage. Echem is to obtain such cost information.

**Environmental:** The rich soil conditions on the site may make it difficult to permit for industrial use.

**Construction Considerations:** There is good access to the site. It is near the Industrial Zone and there is a plentiful supply of labor and housing for national workers as well as expatriate supervision.

**Gamasah Echem Site - September 12th**

This site is located approximately 30 kms to the west of Damietta Port, on the north side of the International Coastal Highway that parallels the seashore across the Delta. The area shown to the team is approximately 7.6 million square meters equivalent to 760 hectares.

Prevailing winds appear to be from the NE to NW.

**General Aspect**

The proposed site may be described as "dry sandy scrub land." It is relatively flat, although there are some excavations to the east side of the plot, along with some marsh lands and shallow water supporting bird life and other ecological environmental issues. The site is approximately 370 meters from the beach. There will be a requirement to purchase a right of way to provide access from the site to the beach area/jetty that would be constructed off the beach. There are several dry drainage canals that cross the site from the south to the sea. We collected the coordinates for these ditches.

The site is in a desolate area with no local habitation. These are some rough huts on a field to the east where local fishermen sleep but no other habitation. The land to the south, across the International Coastal Highway, is noted on the Echem map as being "agricultural," but in fact they are sandy scrub. This site would be a virgin industrial site and would need to be fully evaluated for environmental and socioeconomic impact.

## Boundaries

**South:** The southern boundary is the International Coastal Highway, a large heavily used double lane highway connecting Damietta to Alexandria.

**West:** There is only a picket noting the limit of the plot. The land continues as sandy scrub.

**East:** The eastern boundary is a surfaced road that parallels a channel discharging large amounts of water to the sea. This water is agricultural waste that is pumped by a major pump station located on the south side of the International Coastal Highway. There would be need to analyze and monitor the quality and quantity of water flowing in this channel. The plot area adjacent to the N-S road and drainage channel is wet and marshy, providing home to several species of birds. This marshy area extends for several hundred meters to the west.

**North:** While the N-S road does provide direct access to the sea, the Echem plot terminates about 370 meters from the beach. That area has military posts on the land and we did not encroach. There will be a requirement to purchase a "right-of-way" (ROW) corridor should the site be selected.

The two principal geographic coordinates on the International Coastal Highway were recorded by GPS and are noted below. These point references are shown on the Echem map (Attachment 4) in this report. Point "A" is a picket denoting the S-E corner of the plot and is about 50 meters north of the International Coastal Highway.

| POINT | NORTH | EAST |
|---|---|---|
| A | 31° 29.227' | 31° 24.182' |
| B | 31° 31.244' | 31° 20.025' |
| C | 31° 29.692' | 31° 24.526' |
| D | 31° 29.850' | 31° 24.650' |
| Drain 1 | 31° 29.945' | 31° 22.656' |
| Drain 2 | 31° 30.642 | 31° 21.246 |

The client map of Gamasah site (Attachment 4) is augmented with a marine GPS map of the Gamasah site area showing the site coordinates, marine depth contours off the Gamasah beach. (Attachment 5)

### Access

Access to the site is from the International Coastal Highway, which is a busy wide surfaced two carriage road, running parallel to the coast. The road surface is good. Any very large/heavy pieces of construction equipment/materials can be barged to the site from the Damietta Port and lifted onto the site from the Navigation Channel road.

The nearest airport is Alexandria, with Cairo airport also being readily accessible by road.

This development will be considered as a new Industrial Free Zone and will be subject to the same access controls as Damietta Port.

### Utilities

**Water:** There are large quantities of flowing "fresh" water in the irrigation drain running parallel to the east boundary, but it is likely to be contaminated and unlikely that the composition will be stable.

**Electricity:** There are HV power lines on pylons running parallel to the International Coastal Highway, on the south side.

**Natural Gas:** The 32-inch diameter EGAS gas transmission line to Damietta runs on the north side of the International Coastal Highway and is clearly marked at intersections/crossings. Echem is to verify the current rated capacity.

### Environmental Considerations

The land is dry and sandy for the main part, covered in scrub. The eastern part of the plot is wet and marshy over a strip of a few hundred meters, providing home to numerous species of birds. Again, along the shore line, there are long lines of seine nets set up to catch migrating birds.

There is no evidence of local housing for tourism, other than the rough huts erected by a few fishers.

### Project Site Considerations

**Foundations:** The Nile Delta region comprises soft alluvial deposits and each site will require piled foundations. This makes the foundation construction cost comparison for each site "cost neutral."

**Marine:** This site is on an undeveloped coastal strip and, being too far from Damietta, will require fully independent marine terminal capabilities. This will mean that in addition

to the facilities described for the Echem Damietta site, it will need the construction of a tug/pilot boat harbor (with a dredged access channel) and full dredging/maintenance of an access channel to the jetty head from deep water. Tug boats and pilot boats will need to be purchased.

It is believed that even though this will be a "private port," it will be considered to be within a new Industrial Free Zone and subject to the Zone controls. There will be controlled access into and out from the site during the construction and operation periods and the Egyptian Administration will charge fees for the construction and port usage. Echem is to obtain such cost information.

Additionally, there will be a requirement for regular dredging maintenance of the channels, turning basin etc. As there is little option for sharing these costs, there may be a need for a full time on-site dredging capability.

In the case of ELNG, the trestle jetty is 2,400 meters long with a jetty head, turning basin and 800 meter breakwater. Additionally, there is a separate deep water dredged channel providing access to the jetty and a tug/pilot boat harbor. Using rule of thumb estimates, this installation will cost $80 -100 million, plus regular dredging maintenance.

**Environmental:** The fact that this area is in undeveloped countryside, away from any industrial areas, the PEA will need to be more focused in the event of this site being selected. The ecosystem in the marshy area on the east boundary will need careful consideration.

Noise will also be a consideration in this non-industrial area. A base line noise level check was undertaken on a light breezy day and we recorded 48 dB with a NW wind blowing at 8-10 knots (5.5 m/sec).

**Construction Considerations:** There is good access to the site from the International Coastal Highway. Heavy/long equipment can be offloaded in Damietta Port and trucked to the site without the need for the development of a site construction jetty.

Labor would be available and would have to be housed in Damietta, as well as the expatriate supervision, although the 30 kms trip each way may make the construction of a camp a safer option.

**Idku Echem Site - September 13th**

This site is located approximately 45 kms to the east of the city of Alexandria, off the north side of the International Coastal Highway that parallels the seashore across the Delta. The map issued by Echem was incorrect, being for another site area, while the revised map was also

incorrect. This revised map shows the ELNG site to the east of the Echem site, while in fact it is to the west.

This report is therefore based upon the plot that Echem pointed out to the team.

Prevailing winds appear to be from the NE to NW.

**General Aspect**

The site area is described as 2.7 million square meters or 2,700 hectares. The proposed site may be described as "sandy scrub," with standing water covering a large area to the east of the plot. The lake area is the result of agricultural waste water that is being pumped continuously onto the site from a drainage channel on the south side of the "Circular Road." The small pump station is permanently manned. The site is shown as being directly on the beach. However, when trying to obtain access, we saw military outposts and did not go further. It therefore has to be clarified by Echem where the northern boundary ends.

There is a ruined Napoleonic Fort on the N-W corner of the plot at coordinates N31° 22.440 and E30° 19.953 (which includes three large rusted cannon). This area will be regarded as "National Heritage" and will require access to the public.

The shallow lake commences within a few hundred meters of the western boundary and extends eastward to N31° 22.914 E30° 20.628. The pump house is across the road from that point at N31° 22.646 E30° 20.513. This lake is home to a well established ecosystem of birds and other wild life and will need further evaluation.

There is cultivated land to the south of the Circular Road, although this gives way to arid sandy areas to the east of Point "X" on the map. Trees and crops can be seen growing about 1-2 kms further south beyond this arid area.

**Boundaries**

**South:** The southern boundary is the Circular Road running past the LNG and Gas/Liquids Sites to Rosetta which roughly parallels the International Coastal Highway.

**West:** ELNG site, being constructed by Bechtel, is to the west of the plot with RashPetco Gas/Liquids removal plant immediately on the western boundary. There is a small expansion area still being developed by RashPetco alongside a drain channel running N-S which sets the plot western boundary.

**East:** The eastern boundary was loosely defined as being near the new highway connecting the Circular Road to the International Highway. However, the new map supplied by Echem shows that the boundary is considerably more to the East Highway.

**North:** It is not clear whether the Idku Site does in fact stretch to the beach, as the new drawing suggests. Echem needs to clarify the plot limits.

The principal geographic coordinates, based upon our assumed site location, were recorded by GPS and are noted below. These point references are shown on the Echem map (Attachment 6) in this report.

| POINT | NORTH | EAST |
|---|---|---|
| A | 31° 22.440' | 30° 19.953' (Fort) |
| B | | |
| C | 31° 22.343' | 30° 20.136' |
| D | | |
| X | 31° 24.072' | 30° 21.090' |
| Pump Station | 31° 22.489' | 30° 20.350' |

The client map of Idku site (Attachment 6) is augmented with a marine GPS map of the Idku site area showing the site coordinates and marine depth contours off the Idku beach. (Attachment 7). Unfortunately, the currently available marine charts do not show the EGAS jetty terminal and dredged access channel as are found in the charts for Damietta Port.

## Access

Access to the site is from the Circular Road, joined from the International Coastal Highway. The road surface is good. Equipment can be offloaded at Alexandria Port and trucked to the site. The shallow water at the beach would make the building of a Construction Jetty and dredged channel prohibitively expensive.

The nearest airport is Alexandria, with Cairo airport also being readily accessible by road.

This development will be considered as a new Industrial Free Zone and will be subject to the same access controls as Damietta Port.

## Utilities

**Water:** There is a flowing "fresh" water irrigation drain running parallel to the south road, but it is likely to be contaminated and unlikely that the composition will be stable.

**Electricity:** We did not see any power pylons although it is likely that the authorities will install a power distribution system to encourage investors to the new Industrial Free Zone.

**Natural Gas:** There is obviously a natural gas pipeline feeding the ELNG project. Echem is requested to obtain routing drawings and current/planned capacity.

**Environmental Considerations**

The land is to the east of the plot is dry and sandy for the main part, covered in scrub. However, the western part of the plot is covered by a lake, covering several thousand square meters. This lake is an established ecosystem and provides home to many different species of birds and plant life.

There is no evidence of local housing for tourism.

***Project Site Considerations***

**Foundations:** The Nile Delta region comprises soft alluvial deposits and each site will require piled foundations. This makes the foundation construction cost comparison for each site "cost neutral."

**Marine:** To take advantage of sharing the ELNG ship access channel by connecting a new branch access channel to the new terminal facility, the methanol/ammonia project should be sited as far west as possible. This will mean draining the lake and finding other ways to dispose of the agricultural wastewater currently being pumped onto the site. The marine construction requirements will be similar to those described for the Echem Damietta site, providing that the parties can agree to share the maintenance costs for dredging the channel, and that ELNG will provide the pilot and barge boat services. Echem is to advise.

It is believed that even though this will be a "private port," it will be considered to be within a new Industrial Free Zone and subject to the Zone controls. There will be controlled access into and out from the site during the construction and operation periods and the Egyptian Administration will charge fees for the construction and port usage. Echem is to obtain such cost information.

Additionally, there will be a requirement for regular dredging maintenance of the channels, turning basin, etc.

In the case of ELNG, the trestle jetty is 2,400 meters long with a jetty head, turning basin and 800 meter breakwater. Using rule of thumb estimates, this installation will cost $80 - 100 million, plus regular dredging maintenance.

**Environmental:** This area will be within a new Industrial Free Zone and as such the noise and other regulations are less stringent than in the case for Gamasah. The ecosystem in the lake area on the eastern portion of the site will require careful consideration, particularly as this would be the preferred area for the site to get as close as possible to the existing entrance channel.

A base line assessment should be undertaken prior to the EPC to decide whether the lake area soil will need to be removed due to contamination from the waste polluted agricultural water.

There is no noticeable housing in the area.

The problem of re-routing the polluted agricultural wastewater will need to be addressed.

**Construction Considerations:** There is good access to the site from the International Coastal Highway. Heavy/long equipment can be offloaded in Alexandria Port and trucked to the site without the need for the development of a site construction jetty.

Petro-Jet has invested in a large fabrication facility a few kilometers to the west.

Labor would be available and would have to be housed in Idku town. The expatriate supervision would probably be housed in Alexandria, although the 30 kms trip each way may make the construction of a camp a safer option.

**Damietta Port Site - September 13th**

Damietta Port is located on the east of the Nile Delta. The Damietta eastern branch of the Nile is to the east of the port, with a 5-meter deep Navigation Channel having been constructed connecting the Damietta branch of the Nile to the Damietta Port. The area shown to the team appears to be somewhat different to that shown to the Methanex team earlier in that the actual area available is under expansion to the west, making a total available area of approximately one million square meters.

Prevailing winds appear to be from the NE to NW.

**General Aspect**

The proposed site is within the expanded Damietta Industrial Free Zone, controlled by the Port Authority, Customs, Military and others. The area comprises several parcels of land, each connected into a loose "L" shaped plot with a frontage directly onto the port navigation basin. The area is definitely "industrial," being within the port concrete walls and provides a high level of security. While the new area offered to the west is flat and graded, the original offered area to the east is covered with large mounds of construction debris which will need to be removed.

The site has a corridor directly to the port basin. The shoreline at that point will require dredging to arrive at a 13-15 meter draft depth as was done by SEGAS, but the port basin coastline drops off rapidly to that depth.

Unlike the Echem proposed land on the east of the port, the offered land is sandy and does not offer any agricultural potential.

**Boundaries**

**South:** The site is enclosed within large concrete walls with guard towers. There is a main road outside the concrete wall.

**West:** Again, there is a high concrete wall with guard towers. A major road runs outside, parallel to the wall.

**East:** The expanded Container Storage area (fenced off and independent from the proposed site) covers most of the eastern boundary. However, there is an area of some 200 meters wide that is open and provides direct access to the port basin.

**North:** The north boundary is a concrete wall that divides the site from the SEGAS site area.

Unfortunately, we did not have a map of the proposed area at the time of undertaking the survey. The coordinates recorded may not therefore be the most useful coordinates. However, the map subsequently supplied may be scaled to obtain the plot area and dimensions.

The principal geographic coordinates recorded by GPS at the site are noted below. As we did not have a map at the time of taking the referenced points, they are described below:

| POINT | NORTH | EAST |
|---|---|---|
| Basin Frontage at SEGAS Boundary | 31° 27.814' | 31° 45.039' |
| Corner at Existing Container Yard | 31° 27.675' | 31° 45.074' |
| Middle Road at SEGAS Boundary | 31° 27.526' | 31° 44.927' |
| Corner at SEGAS Entrance | 31° 27.314' | 31° 44.748' |
| Corner at Service Area | 31° 26.619' | 31° 45.482' |

The Port Authority Map (Attachment 8) attached. The marine GPS map of the Damietta site area, showing the site coordinates, marine depths, and the Damietta Port access channel is shown in Attachment 9.

**Access**

Access to the port is from the International Coastal Highway, a wide road with a good surface. All pieces of equipment may be unloaded directly in the Port. The nearest airport is Alexandria, with Cairo airport also being readily accessible by road.

This development is within an Industrial Free Trade Zone and will be subject to access controls.

**Utilities**

**Water:** There is "fresh" water in the Navigation Channel but it is likely to be contaminated and unlikely that the composition will be stable.

**Electricity:** There is electricity supplied by the National Grid to the Port.

**Natural Gas:** There is a main gas transmission line feeding natural gas to the SEGAS LNG plant. Echem are to obtain the information on the capacity of the existing line to SEGAS and the routing of the gas transmission line to evaluate pipeline extension costs. A quick, rough estimate of gas requirements for the first phase of the project is 190-200 MMSCFD at 52 $Kg/cm^2$ pressure at the battery limits.

**Environmental Considerations**

The site is within an existing Industrial Free Zone and environmental studies have already been carried out to meet the Baseline and other assessments for the industrial development of the zone. Consequently, we would not anticipate major problems.

**Project Site Considerations**

**Foundations:** The soil information from the adjacent SEGAS site shows that the foundations will require piling, as will the other sites.

**Marine:** The huge advantage of this site is its proximity to Damietta Port basin. The site has a frontage of some 200 meters onto the basin. This means that a loading terminal may be constructed, similar to SEGAS LNG, with a short trestle structure to the jetty head. The short jetty means short loading pipelines. There is no requirement for a breakwater or tug/pilot boat harbor.

Port charges are to be evaluated.

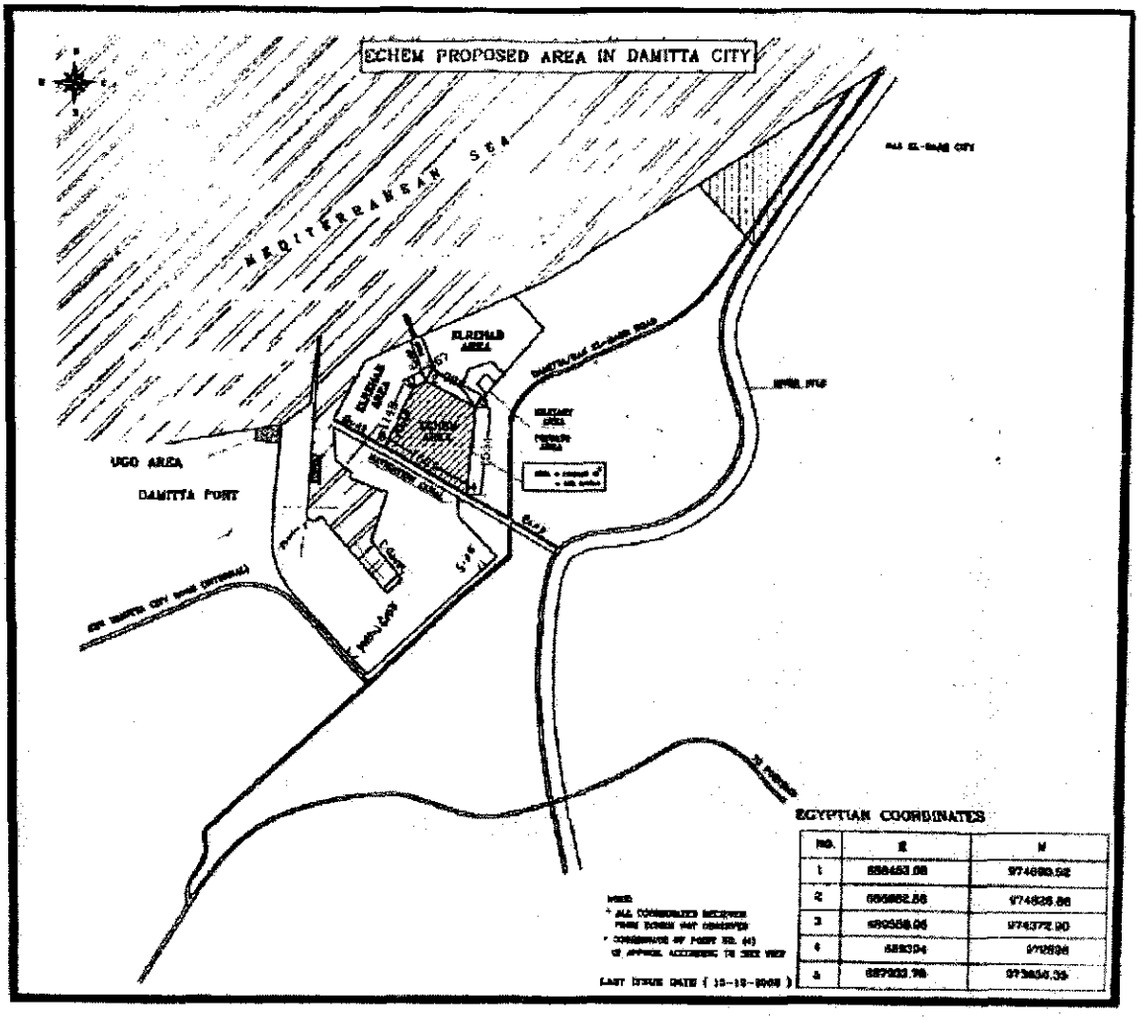
**Construction Considerations:** There is good access to the site. It is within the Industrial Zone, and there is a plentiful supply of labor and housing for national workers as well as expatriate supervision.

## Attachment No.1 - Summary of Major Differentiator Findings during the Site Investigations

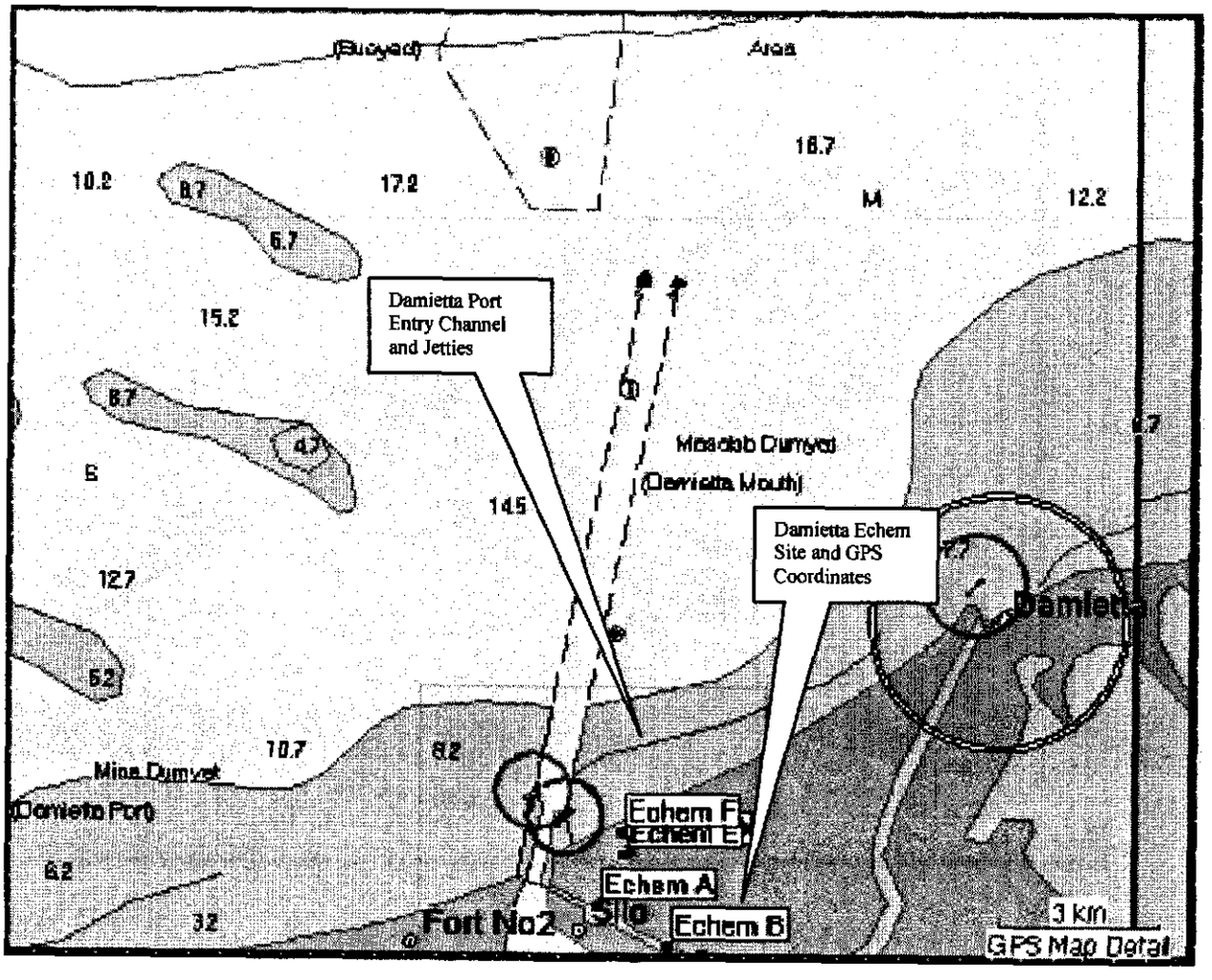
| Item | Detail | Idku | Gamasah | Damietta ECHEM | Damietta Port |
|---|---|---|---|---|---|
| Site Preparation | Site Area<br>Backfill<br>Grading<br>Site Clearance<br>Access ROW<br>Ownership<br>Available Expansion Area<br>Military Zone | .....$m^2$<br>Backfill Lake on East Side<br>Minimum<br>Not Reqd<br>Needs negotiation by Echem<br>Ample<br>Yes before beach area | .....$m^2$<br>No<br>Little | .....$m^2$<br>4-6 meters reqd<br>After backfill | .....$m^2$<br>Not Required<br>Required<br>On Site Boundary |
| Civil Work | Piling<br>Drainage<br>Availability Sand/Aggregate<br>Surface/Ground Water | Required<br>Required to Sea<br>TBA<br>TBA. Drain Ag. Water Lake | Required<br>To Canal on East border<br>TBA<br>Looks about (-) 1 meter | Required<br>Required to Sea<br>TBA<br>TBA but more than (-) 4 meters | Required<br>Required into Port Basin<br>TBA<br>TBA |
| Marine Works | Distance Site to Jetty<br>Length of Trestles<br>Jetty Piling<br>Dredge Access Channel<br>Breakwater Construction<br>Dredge Turning Circle<br>Maintenance Dredging<br>Availability of Tug Boats<br>Need for Tug Harbor | Kms....<br>Kms.....<br>Yes<br>Yes .....Kms<br>Yes<br>Yes<br>Yes - Part shared cost?<br>Negotiate with EGAS<br>Not if EGAS tugs used | Kms.....<br>Kms.....<br>Yes<br>Yes....Kms<br>Yes<br>Yes<br>Yes all costs<br>None - Need to Purchase<br>Yes - Need to Construct | Kms.....<br>Kms....<br>Yes<br>Yes.....Kms<br>Yes<br>Yes<br>Yes – Share Cost with Port?<br>Negotiate with Damietta Port<br>Not if from Port | Port Water on Plot Boundary<br>Kms....<br>Yes<br>No – Use Existing Channel<br>No – Jetty in Port<br>No – Exists in Port<br>Included in Land Rental Fee<br>Port will Provide<br>Port has Tug Harbor |
| Environmental | Polluted Soil<br>Near Habitation<br>Local Fishing<br>Birds and Fauna<br>Local Tourism<br>Marine Dredging<br>Spoil Dispersal<br>Effluents/Emission Issues<br>Agricultural/Sand Land<br>Noise Impact<br>Historical Importance | Yes. Evaluate impact<br>Industrial Zone<br>No<br>Yes in Lake on West Lake<br>No<br>Yes – New Access/Turning<br>TBA<br>Minimum<br>Non-Agricultural<br>None – Industrial Zone<br>Yes – Napoleonic Fort | No<br>No<br>Yes<br>Yes on East Marshes<br>No<br>Yes – Access/Turning Cannel<br>TBA<br>Minimum<br>Non-Agricultural<br>Yes – New Industry<br>Yes – Napoleonic Fort | No but Topsoil to Replace<br>No<br>No<br>Yes – New Area<br>No<br>Yes – Access/Turning Channel<br>TBA<br>No<br>Agricultural<br>None – Local to Port<br>None | Remove Construction Waste<br>Industrial Zone<br>None<br>Follow Existing EIA<br>Not Applicable<br>Dredge new Jetty in Basin<br>At Sea as Current Dispersal<br>Control Discharges into Port<br>No – Industrial Zone<br>N/A – Industrial Zone<br>None. Existing Ind. Zone |

| Item | Detail | Idku | Gamasah | Damietta ECHEM | Damietta Port |
|---|---|---|---|---|---|
| Feedgas/Utilities | National Grid Electricity | Will need to be run to site | South of Coastal Highway | Small 6 Kv Feeder exists | Available in Port |
| | Availability Fresh Water | None | None | Navigation Channel ?? | Available in Port |
| | Availability Sea Water | Yes at Beach | On Beach | Through ROW to Beach | Port Basin and Beach |
| | Feed Gas Supply Line | TBA | Along South Site Border | TBA | SEGAS line. |
| Feedgas/Utilities (Continued) | Phone Lines | TBA | None | TBA | In Port Area |
| Financial | Land Rental | TBA | TBA | TBA | $2.80/m2 per year inclusive of Port Maintenance, Dredging Etc. |
| | Port Charges | TBA | TBA | TBA | TBA |
| | Dredge Maintenance Cost | TBA | TBA | TBA | |
| | Tugboat Assistance Cost | TBA | TBA | TBA | |
| Construction Issues | Equipment Delivery to Site | Through Damietta/Alexandria | Damietta Port | Damietta Port | Damietta Port |
| | Available Airport | Alexandria International | Cairo/Alexandria | Cairo/Alexandria | Cairo/Alexandria |
| | Lay down Area | Ample Space | Ample | Ample | Ample |
| | Local Fabrication Shops | Petrojet Shop Nearby | Damietta | Damietta | Damietta |
| | Labor Availability | Available | Damietta | Damietta | Damietta |
| | Labor Accommodation | Idku | Damietta | Damietta | Damietta |
| | Expat Accommodation | TBA | Damietta | Damietta | Damietta |

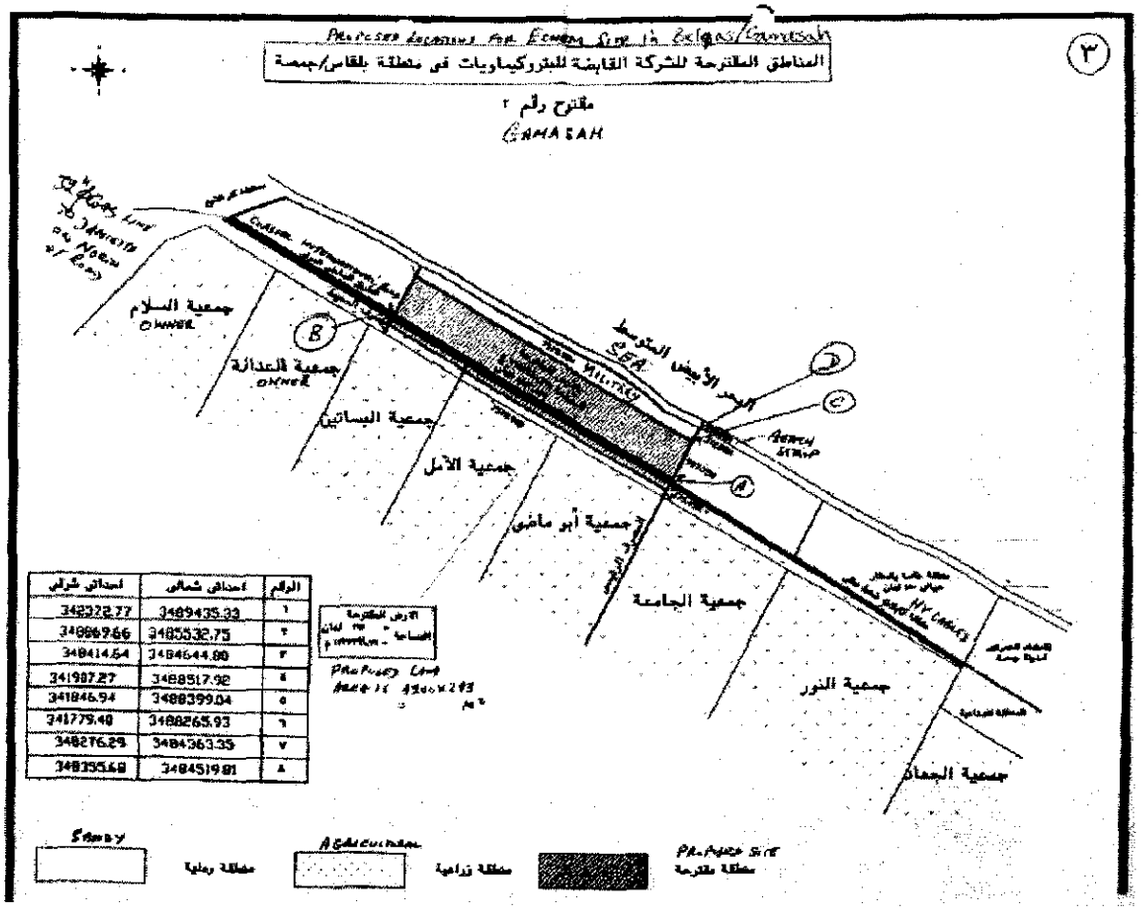
## ATTACHMENT No. 2 - ECHEM DAMIETTA SITE (CLIENT MAP)



## ATTACHMENT No. 3 – DAMIETTA MARINE DATA

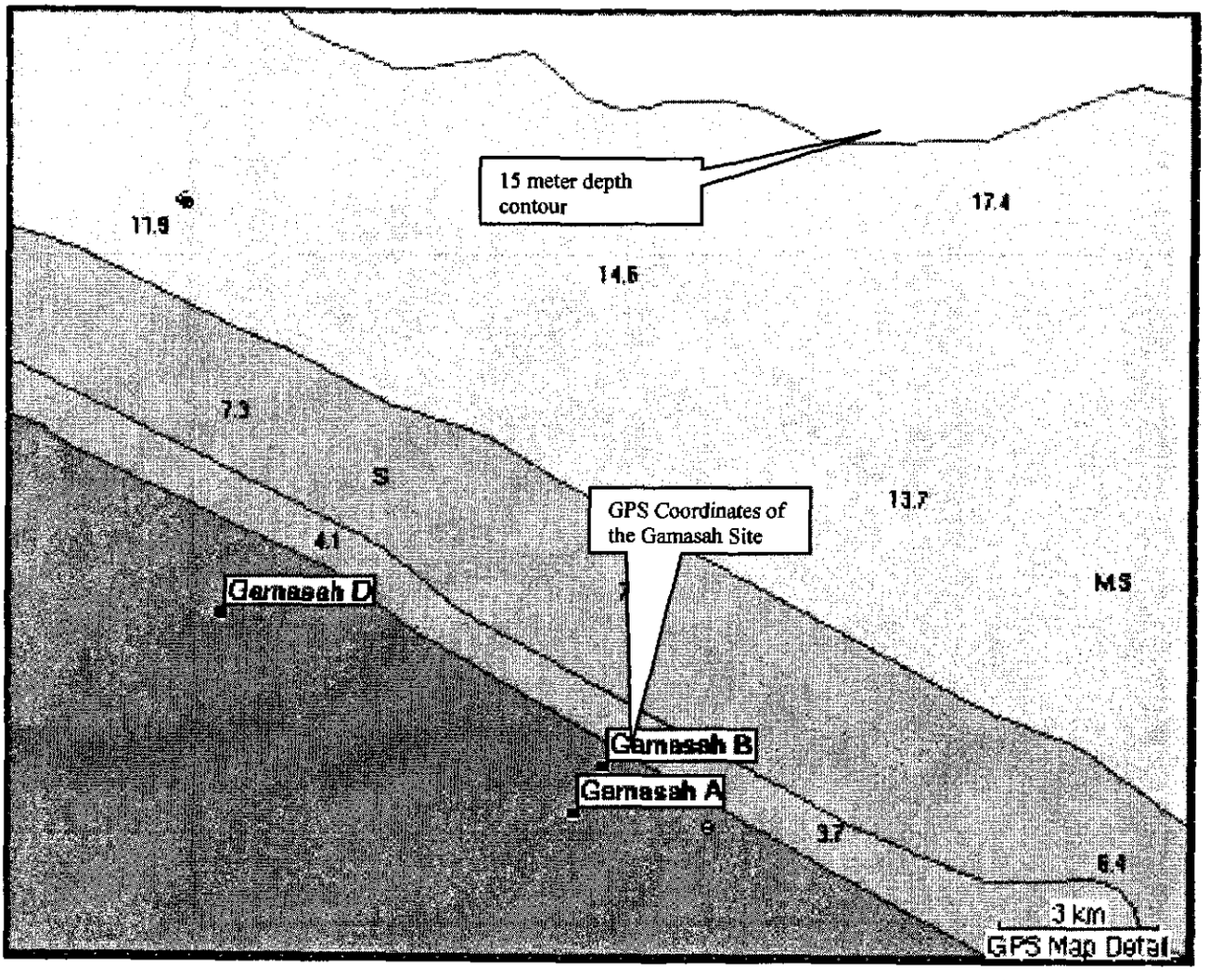


## ATTACHMENT No. 4 – ECHEM GAMASAH SITE (CLIENT MAP)

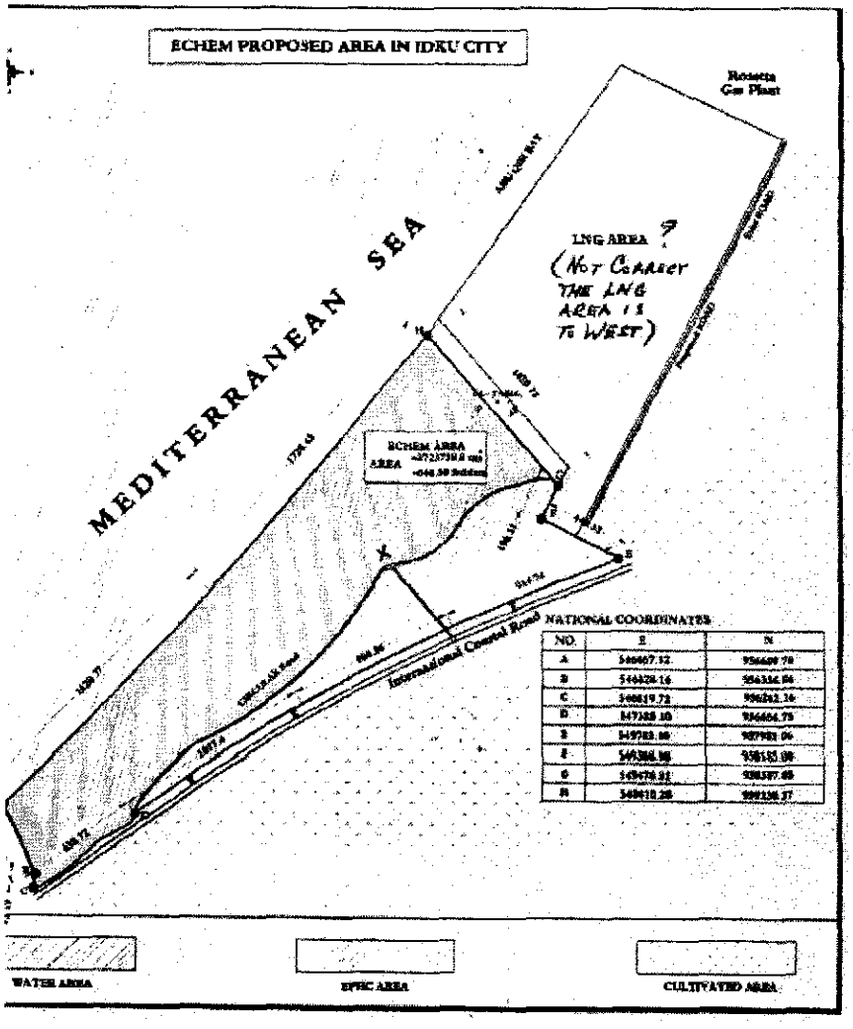



| الرقم | احداثى شمالى | احداثى شرقى |
|---|---|---|
| ١ | 3489435.33 | 348232.27 |
| ٢ | 3485532.75 | 348869.66 |
| ٣ | 3484644.80 | 348414.64 |
| ٤ | 3488517.92 | 341987.27 |
| ٥ | 3488399.04 | 341846.94 |
| ٦ | 3488265.93 | 341779.48 |
| ٧ | 3484363.35 | 348276.29 |
| ٨ | 3484519.91 | 348355.68 |

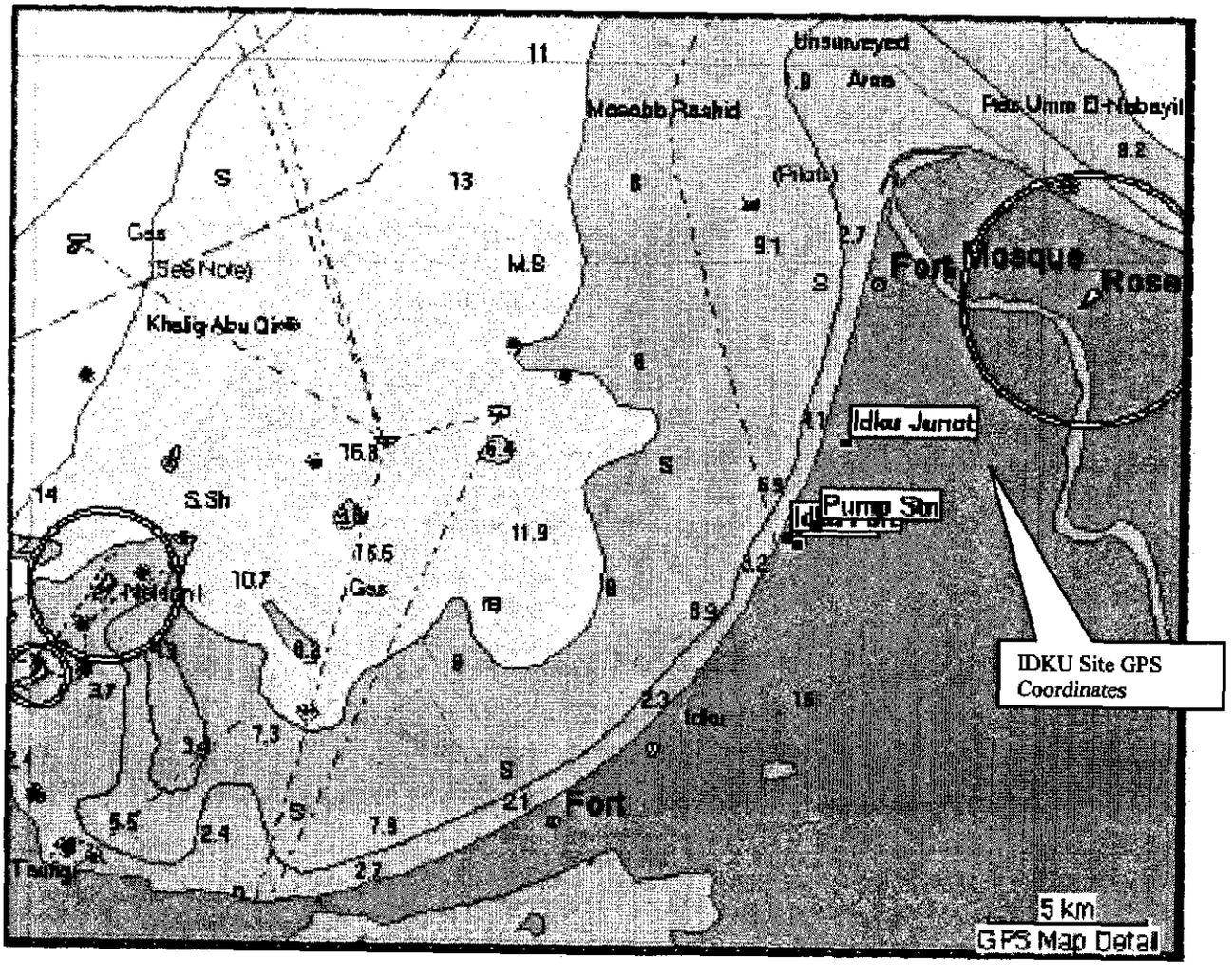
## ATTACHMENT No. 5 – ECHEM GAMASAH MARINE DATA



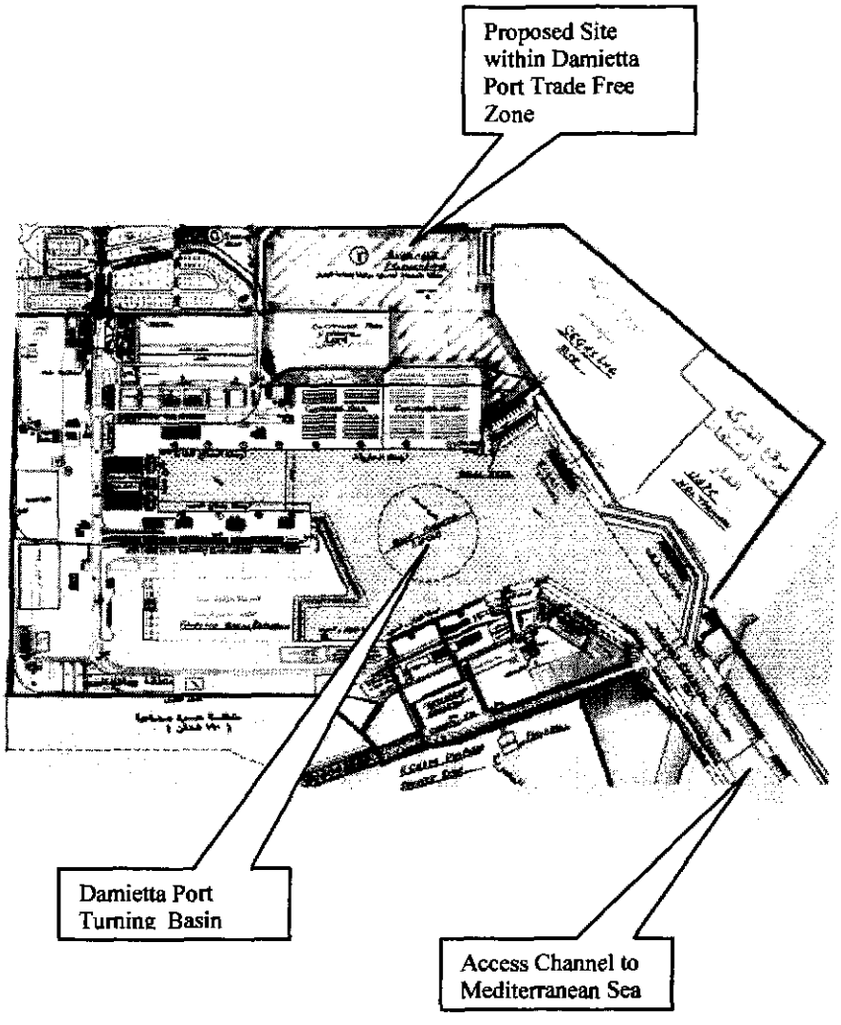
## ATTACHMENT No. 6 – ECHEM IDKU SITE



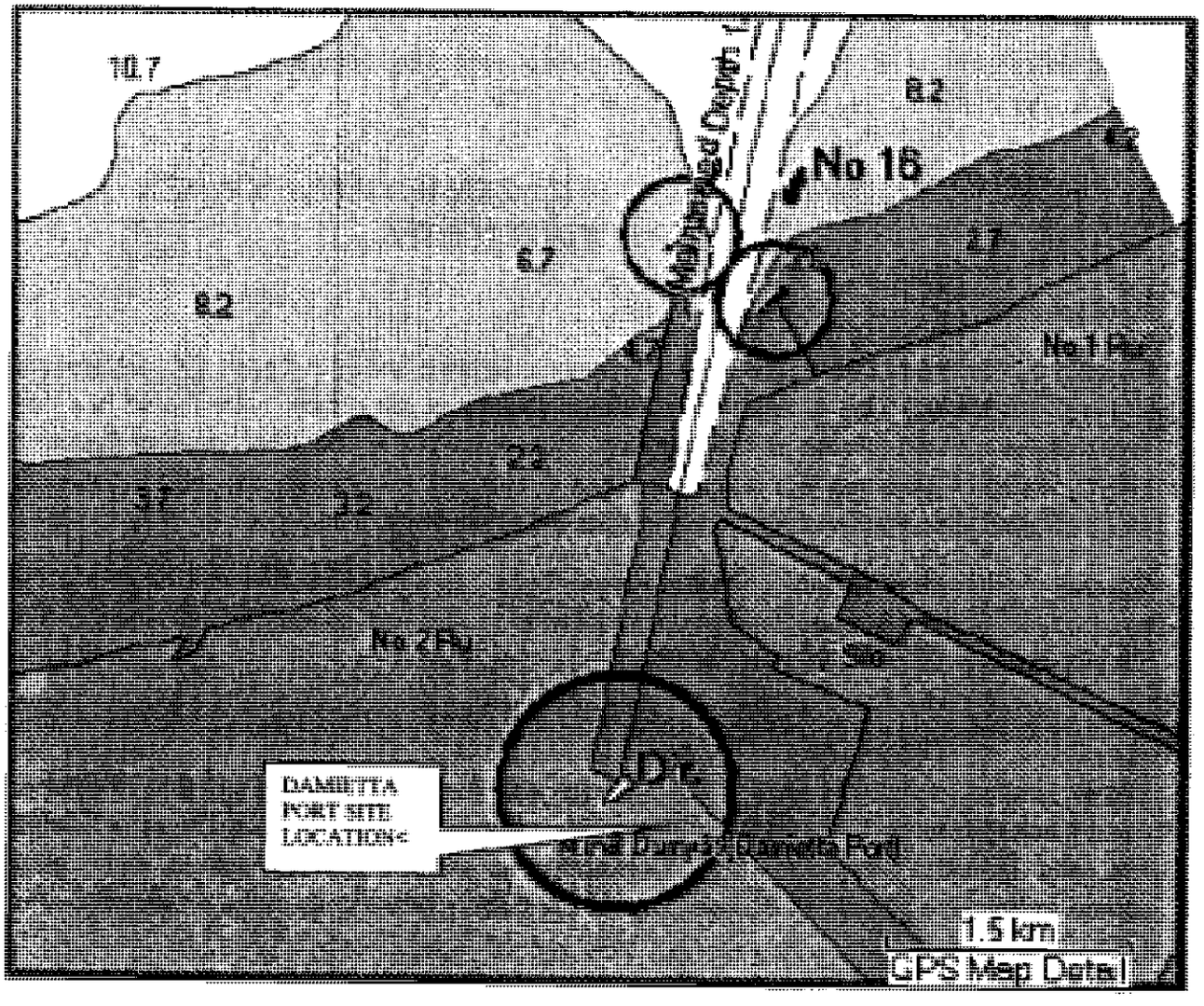
## ATTACHMENT No. 7 – IDKU MARINE DATA



## ATTACHMENT No. 8 – DAMIETTA PORT SITE



## ATTACHMENT No. 9 - DAMIETTA PORT MARINE CHART



## C.2.2 Preliminary Environmental Site Visit Report

The report and site ranking table attached to this section is the result of the site visits made by Komex to the four selected sites on September 7th, 12th, and 13th, 2004. The report was prepared by Komex, an international environmental consulting company with offices in Cairo. Komex was subcontracted to undertake this work by Granherne.

# *KOMEX SITE RANKING AND PRELIMINARY ENVIRONMENTAL EVALUATION REPORT*

### Background

ECHEM is planning to build a Methanol/Ammonia integrated facility in Egypt. ECHEM secured funding from the US TDA to finance the feasibility study of the project. Granherne has been awarded the contract to conduct the feasibility study according to the TDA Terms of Reference (TOR). ECHEM proposed four alternative sites to evaluate and identify the most suitable site for the project. The Methanol/Ammonia facilities would be on the same site.

Granherne Environmental subcontracted Komex Egypt, as a local/Egyptian environmental firm to participate in the site selection/environmental ranking and later conduct a preliminary EIA for the selected site, as per TDA TOR Task C.

### Field Program

Komex conducted two site visits. The first site visit was conducted by ECHEM, Methanex, Agrium and Komex on 07 September 2004. The group visited the Idku site, Damietta ECHEM site, and Damietta Port site. The Gamasah site was not visited due to other group commitments. The overall trip distance (round trip: Cairo – Alexandria – Idku – Damietta – Port Said - Cairo) was 764 km.

The second site visit was conducted by Granherne, ECHEM, and Komex on 12 and 13 September 2004. Four sites were visited. The overall trip distance (round trip: Cairo – Damietta – Gamasah - Alexandria (overnight) – Idku – Damietta - Cairo) was 1,080 km. The approximate distances between sites are presented in Table 1.

**Table 1: Approximate Distances between the Four Proposed Sites**

| Site | Idku Site | Gamasah Site | Damietta Sites |
|---|---|---|---|
| **Idku Site** | 0 | 120 km | 155 km |
| **Gamasah Site** | 120 km | 0 | 35 km |
| **Damietta Sites** | 155 km | 35 km | 0 |

**1st Site: Idku (visited September 7 and 13, 2004)**

**Site Summary**

The proposed site is located on the Mediterranean Sea (northern boundary with approximate length of 3.5 km) 45 km east of Alexandria. The southern boundary of the site is a paved road (full length of the southern boundary), drainage canal, and cultivated land (crops). At the western boundary of the site there are two cannons (Napoleonic Fort of archaeological importance) and further west is the Rashpetco site (an oil and gas company). The offshore wells of Rashpetco can be seen to the north. The agricultural wastewater drains are on the southern side of the paved road. The total area of the site is approximately 600 Feddans (250 Hectares). A lake was observed on the site. Large quantities of agricultural wastewater are pumped into the site lake from a drain on the other side of the main road. Two persons were noticed fishing in the lake. Many birds were observed around the lake and some were feeding on the lake. The dry area of the site is sandy and flat with minor vegetation. The eastern boundary of the site is unused land with a similar nature to the ECHEM site.

The site is east of existing oil and gas facilities (ELNG and Rashpetco). Komex is very familiar with this area, as Komex has been working on the neighboring facility for more than a year.

**Environmental Concerns**

- Socio-cultural (cultivated land, fisheries).
- Potentially contaminated lake onsite (need for baseline assessment).
- Existing on site ecosystem of significance (lake, fish, birds, some vegetation).
- Two cannons of archaeological importance (western boundary).
- Offshore dredging/construction activities needed for the jetty, sea cooling water intake/outfall.

**Benefits**

- No construction camp is required (lower impact during construction phase) due to being close to Idku and Alexandria..
- Natural Gas pipeline passes by the site (no major additional works needed to connect NG to site).
- Possibility of sharing facilities of the LNG jetty (access channel, etc.)
- Good road access.

## Table 2 Idku Site: Locations

| Time/ date | LM | GPS Readings[1] N | GPS Readings[1] E | Measurement | photos | Remarks |
|---|---|---|---|---|---|---|
| 10:35 7/9/04 | 1 | 31° 22' 00.9" | 30° 20' 03.4" | Noise & Meteorol. | Panorama 1-4 for the site facing north taken from west to east<br>Photo 5 noise meter during measurement<br>6 & 7 shows stagnant water on site | Wrong site (west of ECHEM site) |
| 11:14 7/9/04 | 2 | 31° 22' 23.2" | 30° 20' 17.0" | | Panorama 8-13 facing north, from west to east | SW corner of ECHEM site |
| 11:15 7/9/04 | 3 | 31° 22' 23.1" | 30° 20' 16.9" | Noise | Photo 14, 2 people fishing onsite.<br>Panorama 15-17 facing east, shot taken from north to south<br>Photo 18 on the other side of the road facing west.<br>Photo 19 on the other side of the road facing east. | On the road south of ECHEM site |
| 11:35 7/9/04 | 4 | 31° 22' 36.3" | 30° 20' 32.5" | | Photos 20-22 showing pump house and pipe discharging to the site (agricultural wastewater)<br>Panorama 23-28 from west to east facing north. | Name of Area "Tabyet Al-Alayem" |

## Table 3 Idku Site: Meteorological Data

| Time/date | LM | Meteorological Information: Wind Direction | Max 3 sec Gust m/s | Average Wind m/s | Temp °C | Wind Chill °C | Humidity % | Heat Index % | Dew Point % | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| 10:35 7/9/04 | 1 | N/NE | 3.8 | 2.9 | 27.8 | 27.3 | 74 | 30.0 | 22.6 | Wrong Location, (west of the ECHEM site) |
| 11:15 7/9/04 | 3 | N/NE | 3.6 | 2.5 | 27.8 | 28.2 | 68 | 31.4 | 22.1 | Southwest corner of ECHEM site on the public road |

## Table 4 Idku Site: Background Noise Data

| Site | LM | Time/Date | Leq (dB) | Remarks |
|---|---|---|---|---|
| Wrong Site (West of ECHEM site) | 1 | 10:41 – 7/9/04 | 65.6 (5 min Average) | The background noise is high due to heavy traffic (truck movements) and ongoing activities at Rashpetco site (hammering) west of the measurement location. |
| ECHEM Site | 3 | 11:10 – 7/9/04 | 42.9 (5 min Average) | The measurement was taken on the southern border of ECHEM site on the public road. The instrument was paused when trucks were passing. |

[1] Geod Datm '49, CDI +/- 0.25

**Table 5 Idku Site: List of Photos**

| Photo # | Description |
|---|---|
| 102, 103 | Shot taken from the International Coastal Road showing ELNG Jetty. |
| 104-107 | Panoramic shot from the SW corner of the site (N-NE-E) showing Rashpetco site, the drain, the Fort, and ECHEM site. |
| 108 – 111 | Panoramic shot facing W-S taken from the Fort location showing the ELNG facilities and the Western boundary facilities. |
| 112-113 | Napoleonic Fort |
| 114-124 | Panoramic shot taken from the Fort location S – S (360°) |
| 125, 126, 137 | Pipe (on site)/pump (south of the site) discharging agricultural wastewater to the lake on ECHEM site. Foam can be seen in the photos. |
| 127, 128 | Birds species onsite feeding on the lake. |
| 129 | Photo taken from the SE corner of the site facing south |
| 130-136 | Panoramic shot from the SE corner of the site N – W – S |

## 2nd Site: Gamasah (visited on September 12, 2004)

### Site Summary

The site is located 155 km east of Alexandria and 35 km west of Damietta, on the Coastal International Road. The total area of the site is approx 2500 Feddans (1050 Hectares). The site is rectangular in shape and is bounded by the Mediterranean on the North (after a 200 m set back area by law, there is a military post) and the Coastal International Road on the south (full length of the southern boundary). On the eastern boundary, there is an unpaved road and a drain that discharges to the sea. The site is flat, sandy, and homogeneous in nature. The eastern area of the site is wet and marshy. Few bird species were noticed in the area. On the available drawings/layouts, the southern side of the coastal road is agricultural land (has similar homogenous nature as ECHEM land) owned by different associations, but not cultivated. The site is remote. There are 2 dry drains passing from south to north of the site.

A 32" Natural Gas pipeline is passing by the southern boundary of the site (parallel to the site). No other existing infrastructure was noticed at the site.

On the northern edge of the site, nets were observed, which are installed by locals to catch migratory birds (seasonal).

### Environmental Concerns

- Socio-cultural (fishing activities of locals, seasonal bird catching, etc.)
- A camp may be needed onsite.
- Gamasah is known as a summer holiday place for Egyptians.
- No other industrial activities in the area. Area is not classified as an industrial area (needs confirmation from ECHEM).

- Offshore dredging/construction activities needed for the jetty, sea cooling water intake/outfall.

- Possible wetland, with associated ecological impact concerns.

**Benefits**

- Natural Gas pipeline passes by the site (no major additional works needed to connect NG to site).

- Good access to main coastal road.

**Table 6 Gamasah Site: Locations**

| Time | LM | GPS Reading | | Measurement | Remarks |
|---|---|---|---|---|---|
| | | N | E | | |
| 17:45 12/9/04 | 10 | 31° 29' 11.8" | 31° 24' 13.3" | | SE corner of the site |
| 17:50 12/9/04 | 11 | 31° 29' 09.8" | 31° 24' 12.9" | | - Agricultural Drain (photo 84)<br>- NG pipeline sign (photo 85), site shown at the background. |
| 18:00 | 12 | 31° 29' 39.5" | 31° 24' 33.9" | Noise, Meteorological | NE corner of the site |
| | 13 | 31° 29' 49.3" | 31° 24' 41.4" | | - The agricultural drain discharging to the sea (photo 92, N direction).<br>- Birds catching nets installed by locals, photo 93 facing west. |
| | 14 | 31° 29' 54.6" | 31° 22' 41.8" | | Dry drain 1 crossing the site from south to north, photo 94 facing N. Shot taken from the ICR. |
| | 15 | 31° 30' 36.5" | 31° 21' 17.2" | | Dry Drain 2 crossing the site from south to north, photo 95 facing N. Shot taken from the ICR. |
| | 16 | 31° 31' 12.6" | 31° 20' 03.8" | | SW corner of the site on ICR. |

**Table 7 Gamasah Site: Meteorological Data**

| Time | LM | Meteorological Information | | | | | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Wind Direction | Max 3 sec Gust m/s | Average Wind m/s | Temp °C | Wind Chill °C | Humidity % | Heat Index % | Dew Point % | |
| 18:10 12/9/04 | 12 | NW | 5.7 | 3.6 | 27.2 | 27 | 54 | 28.7 | 16.7 | Windy, readings were recorded on the Eastern boundary of the site adjacent to the drain. |

**Table 8 Gamasah Site: Background Noise Data**

| Site | LM | Time/Date | Leq (dB) | Remarks |
|---|---|---|---|---|
| ECHEM Site | 12 | 18:05 – 12/9/04 | 48.7 | Windy, reading (5 min Average) was recorded on the Eastern boundary of the site adjacent to the drain. |

**Table 9 Gamasah Site: List of Photos**

| Photo # | Description |
|---|---|
| 84, 92 | Agricultural drain discharging to the sea. Shots taken facing north. |
| 85 | GASCO natural gas pipeline passing parallel to the site southern boundary |
| 86-88 | Marshes on the eastern area of the site. |
| 89-90 | NE corner of the site facing n-NW |
| 91 | Noise measurement at the NE corner |
| 93 | North to the site, nets installed by locals to catch migratory birds. On the right a military post can be seen. Shot was taken facing west. |
| 94 | Onsite Dry Drain 1, shot taken from the Coastal Road facing north. |
| 95 | Onsite Dry Drain 2, shot taken from the Coastal Road facing north |
| 96 | Onsite building, shot taken from the Coastal Road facing north |
| 97-101 | Panoramic shot taken from the Coastal Road facing W – N – E, from the SW corner of the site |

### 3rd Site: Damietta ECHEM Site (visited on September7 and 12 2004)

#### Site Summary

The site is located to the east of Damietta Port on a navigational channel that is connected to the port. The site is trapezoidal in shape. To the northern boundary of the site is a flour mill property. The eastern and southern boundaries are agricultural lands. The western boundary is a navigational canal connecting the Damietta Branch (the River Nile) with the sea. The northern corner of the site is about 400 m away from the sea shoreline.

The soil of the site is very rich/fertile. There are ongoing excavation activities on the site taking fertile soil to use for desert land reclamation. The excavations vary up to 8 meters in height. This would require a tremendous amount of soil for back filling the site. The site is severely impacted by the excavation activities.

#### Environmental Concerns

- Site is impacted by the ongoing excavation activities.
- Site is not easily accessible.
- Socio-cultural (agricultural/fertile land).
- Substantial offshore dredging/construction activities needed for the jetty, sea cooling water intake/outfall, as the site is not on the shoreline.
- Nets were installed by locals to catch migratory birds.

#### Benefits

- A camp is not needed onsite.

- There are industrial and agricultural activities in the area. Area classification is not clear (needs confirmation from ECHEM).

### Table 10 Damietta ECHEM Site: Locations

| Time | LM | GPS Reading | | Measurement | Photos |
|---|---|---|---|---|---|
| | | N | E | | |
| 18:30 7/9/04 | 6 | 31° 28' 05.8" | 31° 46' 50.2" | Noise, Meteorological | Panorama 39-48 from north to west clockwise direction, showing El Rehab facility, the site, road, navigation canal and the other side of the canal (DPA). Photos 49, 50 shows noise instrument used for noise measurement. |
| | | | | | Photo 51 shows the gate of the facility located north to the proposed site. Shot were taken on our way to investigate the jetty location |
| 18:45 7/9/04 | 7 | 31° 29 10.3" | 31° 46' 29.9" | | Photos 52-56 facing north at jetty proposed location |
| 18:50 7/9/04 | 8 | 31° 29' 10.8" | 31° 46' 28.9" | | Photos 57-61 facing east, south for jetty propose location (about 30 meter north east of LM 7) |
| 14:45 12/9/04 | 9 | 31° 29' 10.8" | 31° 46' 28.9" | | Birds catching nets on the shore line, approx 400 meters north of the site. Photos 67 (facing NE), 68 (facing west) |

### Table 11 Damietta ECHEM Site: Meteorological Data

| Time/ date | LM | Meteorological Information | | | | | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Wind Direction | Max 3 sec Gust m/s | Average Wind m/s | Temp °C | Wind Chill °C | Humidity % | Heat Index % | Dew Point % | |
| 18:30 7/9/04 | 6 | N/NE | 4.8 | 2.5 | 28.2 | 27.2 | 67 | 30.9 | 21.2 | Before sun set (sunset at 19:10) |

### Table 12 Damietta ECHEM Site: Background Noise Data

| Site | Time/Date | Leq (dB) | Remarks |
|---|---|---|---|
| Damietta Site | 16:35 – 7/9/04 | 43.6 (5 min Average) | One truck passed by during the measurement duration and the instrument was paused while the truck was passing by. |

### Table 13 Damietta ECHEM Site: List of Photos

| Photo # | Description |
|---|---|
| 62 | Construction waste onsite |
| 63-66 | Ongoing excavation activities onsite |
| 69 | Excavated soil |
| 70-72 | Excavation onsite |
| 73-75 | Salt deposits onsite |
| 76 | Power Line coming from the Damietta port side and ending onsite |
| 77, 78 | Signs onsite with names of land owners (probably previous land owners) |
| 79 | Onsite truck way, used by trucks loaded by excavated clay/soil. |
| 80, 81 | Pipe noticed onsite |
| 82 | Facing SE on the road showing navigation channel on the right, the bridge crossing the navigation channel and a neighborhood agricultural land. |

| | |
|---|---|
| 83 | Shot taken facing NW while crossing the bridge. Site is shown on the right between the flour mill and the neighborhood agricultural land. |

### 4th (optional) Site: Damietta Port Site (visited 07, 13 September 2004)

#### Site Summary

The Port authority suggested this site for the project. No detailed investigation was conducted as this site is out of the scope of work of Komex. However, Komex is very familiar with this site, as Komex has been working on the neighboring facility for the last 4 years.

The site is impacted by the ongoing activities in the port. The dredging spoil from the LNG jetty was dumped onto this site. The site is in an industrial zone, within DPA premises.

#### Environmental Concerns

- Sea cooling water outfall is not close to site as it has to discharge to the open sea and not into the basin (Law 4/94). Possibility of sharing the LNG plant outfall worth consideration.

#### Benefits

- This site has a better option for Jetty construction than other sites. Lower dredging and only 30-50 m jetty length instead of 2-2.5 km jetty for other sites.
- Good access and infrastructure.
- No camps needed on site.
- Sea cooling water intake structure direct from the basin.
- This site has lower environmental impacts than other sites.
- Designated industrial zone (applicable for noise).
- Utilize existing port facilities (spill contingency plans, etc., if existing)

#### Table 14 Damietta Port Site Location

| Time/ date | LM | GPS Reading | | Photos | Remarks |
|---|---|---|---|---|---|
| | | N | E | | |
| 18:05 7/9/04 | 5 | 31° 27' 44.6" | 31° 45' 07.2" | Photo 29 from the western boundary facing east. | DPA proposed Site located south of SEGAS (1 million m2). |
| | | | | Photos 30-38 from the eastern boundary facing west. showing SEGAS and LNG jetty | |

## Table 15 Damietta Port Site List of Photos

| Photo # | Description |
|---|---|
| 138-141 | Panoramic shot (E-S) showing SEGAS fence and the proposed site. Old Port wall can be seen on the right. |
| 142 | Southern boundary of the proposed site, the leveled site (on the right) is a neighborhood site. |
| 143-148 | Panoramic shot (E-N-W) taken at the old port wall showing the proposed site that extends to the new port wall shown at a distance in the photos. |
| 149 | Construction waste and SEGAS/LNG jetty at the background |
| 150 | Shoreline at the proposed location south of SEGAS. Construction waste can be seen on the right. |
| 151-152 | Panoramic shot facing east taken at the new port wall. |

## Table 16 Sites Environmental Ranking[2]

| | Idku Echem Site | Gamasah Echem Site | Damietta Echem Site | Damietta Port Site |
|---|---|---|---|---|
| **Environmental Concerns** | 1. Socio-cultural (cultivated land, fisheries).<br>2. Potentially contaminated lake onsite.<br>3. Existing on site ecosystem of significance (lake, fish, birds).<br>4. Two cannons of archaeological importance.<br>5. Offshore dredging/construction activities needed for the jetty, sea cooling water intake/outfall. | 1. Socio-cultural (fishing activities of locals, seasonal bird catching, etc).<br>2. A camp may be needed onsite.<br>3. Gamasah is known as a summer place for Egyptians.<br>4. Area is potentially not classified as an industrial area.<br>5. Offshore dredging/construction activities needed for the jetty, sea cooling water intake/outfall. | 1. Site is impacted by the ongoing excavation activities.<br>2. Site is not easily accessible.<br>3. Socio-cultural (agricultural/fertile land).<br>4.Substantial dredging/construction activities needed for the jetty, sea cooling water intake/outfall, as the site is not on the shoreline.<br>5. Nets were installed by locals to catch migratory birds (potentially illegal). | 1. Outfall route to the open sea may require additional onshore construction.<br><br>***Note full site visit not conducted*** |
| | | | | |
| **Environmental Benefits** | 1. No construction camp is required (lower impact during construction phase).<br>2. Natural Gas pipeline passes by the site (no major additional works needed to connect NG to site).<br>3. Possibility of sharing facilities of the LNG jetty (access channel, etc.).<br>4. Good road access.<br>5. There are industrial activities in the area. Area classification is not clear (needs confirmation from ECHEM). | 1. Natural Gas pipeline passes by the site (no major additional works needed to connect NG to site).<br>2. Good access to main coastal road | 1. A camp is not needed onsite.<br>2. There are industrial and agricultural activities in the area. Area classification is not clear (needs confirmation from ECHEM). | 1. Lower dredging at only 30-50 m jetty length instead of 2-2.5 km jetty for other sites.<br>2. Sea cooling water intake structure direct from the basin<br>3. No camps needed on site. This site has lower environmental impacts than other sites.<br>4. Designated industrial zone (applicable for noise).<br>5. Utilise existing port facilities (spill contingency plans etc if existing).<br>6. No maintenance dredging/disposal are required in main channel, as it will be conducted by DPA.<br>7. Good Road access.<br>8 Industrial zone designation. |
| | | | | |
| **Environmental Components/Impacts** | | | | |
| Soil | The lake area is potentially contaminated with agricultural wastewater. | High Possibility for the Eastern area of the site parallel to the drain. Sandy with Vegetation. The Eastern | The soil is excavated. The soil is severely impacted but no evidence of contamination. Fertile clay | The soil of the NE part (old port) is impacted by neighbourhood activities (dumping of dredged |

[2] The predicted impacts are relative and not absolute.

| | Idku Echem Site | Gamasah Echem Site | Damietta Echem Site | Damietta Port Site |
|---|---|---|---|---|
| | Sandy soil. | area is marshes. | | sediment and construction waste). Mixed sand and silt |
| Near Habitation | Agricultural Land & Village (South) | Remote Village (East) | Agricultural land & Village (East/South) | Fenced Industrial area, Remote Village - west |
| Local Fishing | Yes | Yes | At the proposed jetty location | No |
| Birds & Fauna | Yes (onsite Lake) | Yes (Birds migratory route) | Already impacted. Birds migratory route | No |
| Flora | Low | Medium in Future (Neighbourhood lands are designated agricultural) | Height impact on the neighbourhood agricultural land/crops | No or very low impact. Site is already impacted. |
| Local Tourism | No | Yes (few KM east of the site) | No | No |
| Marine Dredging | High | High | High | Low for the Jetty and Medium for the outfall |
| Spoil Dispersal | High | High | High | Medium |
| Effluents Impacts | High | High | High | Medium |
| Emissions Impacts | High (Impact directly on agricultural crop, nearest residential area) | Medium | High | Medium (potential for cumulative impacts) |
| Solid Waste | Easy to Manage | Not Easy to Manage | Can be Managed | Easy to Manage |
| Agricultural Land | No | No | Yes | No |
| Background Noise | Acceptable | Acceptable | Acceptable | — |
| Noise | Industrial Area (Higher allowable Limits) | Non-Industrial Area (Lower allowable Limits) | Non-Industrial Area (Lower allowable Limits) | Industrial Area (Higher allowable Limits) |
| Social concerns | Moderate | Moderate | High | Low |
| Archaeological | High | Low | Low | Low |
| | | | | |
| **Overall Sensitivity[3]** | Medium | High | High | Low |
| **Environmental Significance Ranking[4]** | **2** | 1 | 1 | **3** |

[3] Classified Low, Medium, and High
[4] 1: High Significance. 2: Moderate Significance. 3: Low Significance 4. Not Significant. 5: No enough data to Rank

**Recommendation**

In summary, following the site visits, we suggest that the sites with the lowest level of environmental concern, are the Damietta Port and the Idku site.

***(Note that full site assessment was not conducted at the Damietta Port site, as it was not included in the original TOR and the above ranking is based on our experience of the area.)***

## C.2.3 Site Selection Economic and Logistical Considerations

The cost of constructing a dedicated marine export terminal is a major differentiator when comparing the suitability of each site. The location of the site to such facilities and the location of the site to existing sources of labor and infrastructure has been considered in the evaluation.

Anther significant economic differentiator is the cost of site preparation for the construction of the process and utility/offsite structures. These factors are examined in the following sections.

### C.2.3.1 Marine Terminal Considerations

The ammonia and methanol products will require a marine terminal facility to export the products. In the case of Idku, Gamasah and Damietta Echem sites, this will require the construction of new marine structures involving a long trestle of several kilometers along which the methanol and ammonia piping would be run to a jetty head. As the jetty loading head in these locations would be in the open sea, the layout would also need a very expensive breakwater and a dredged access channel to the jetty. A listing of these requirements, based upon the marine depth contours at each of these sites is shown in the following table.

**PRELIMINARY TERMINAL CONSTRUCTION COMPARISONS**

| Item | ELNG (Idku Site) (Reference Case) | Echem Idku Site Trestle Jetty | Gamasah Site Trestle Jetty | Damietta Echem Integrated Breakwater Option | Damietta Port Dual Berths within Port Basin |
|---|---|---|---|---|---|
| Ship draft | LNG ships 140,000 m3 capacity (293m x 48m x 11m draft) | Greatest draft is on Methanol Bulk Carrier (186m x 32.2m x 12.22 m draft) | Greatest draft is on Methanol Bulk Carrier (186m x 32.2m x 12.22 m draft) | Greatest draft is on Methanol Bulk Carrier (186m x 32.2m x 12.22 m draft)) | Greatest draft is on Methanol Bulk Carrier (186m x 32.2m x 12.22 m draft)) |
| Swell | <2.5m: 4% annual; 10% winter monthly <4m: 1% annual, 2.5% winter monthly | Same | Assume same | None | Assume same |
| Wind | <25 knots: 1% S/SW <30 knots: 0.2% S/SW | Same | Assume same | Assume same | Assume same |

| Item | ELNG (Idku Site) (Reference Case) | Echem Idku Site Trestle Jetty | Gamasah Site Trestle Jetty | Damietta Echem Integrated Breakwater Option | Damietta Port Dual Berths within Port Basin |
|---|---|---|---|---|---|
| Tides | Semi-diurnal with small range of < 0.9m | Same | Same | Same | Same |
| Seabed | Surveyed depth contours. Note there is a difference in the surveyed contours and the Admiralty Charts. | Use Idku surveyed depth contours. | Use Admiralty Charts Seabed slopes gently from 10m contour for approx 35 kms with gradients of 1:650 to the 100m contour | Use Admiralty Charts Seabed slopes gently from 10m contour for approx 35 kms with gradients of 1:650 to the 100m contour | Not Applicable |
| Depth Contour Data | ELNG Survey Data – Distance from shoreline:<br>5m - 690m<br>10m - 1,930m<br>20m - 14,500m | Use ELNG Data | 5m - 850m<br>10m - 3,700m<br>20m - 10,300 | 5m - 1,600m<br>10m - 2,600m<br>20m - 15,400m | Not applicable. Port basin is dredged to -14.5. Port entry Navigation Channel is dredged to -15m and is 11,300 long |
| No of Berths Required | 2 including 1 on breakwater | 2 for largest Bulk Methanol and Ammonia | 2 | 2 | 2 |
| Natural Depth Contour at Jetty Head | 11 m | 14 m | 14m | 5m | 14.5m |
| Dredge depth at jetty head | Basin dredged to -13 m<br>Turning Circle 615m dia. dredged to -13.5 | Basin to -16m Turning Circle 280m radius dredge to -16.5 | Basin to -16m Turning Circle 280m radius dredge to -16.5 | Basin to -16m Turning Circle 280m radius dredge to -16.5 | Dredge 2 berth slip to -14.5 |
| Trestle length to Jetty Head | 2,400 m to -11m contour | 6400m to -14 m contour | 7,700m to -14 m contour | 520m to 3.5m contour | Not Applicable |
| Deck | 3m wide road, 4m wide pipe rack and footpath | Road and Pipe rack (14m) +Conveyor (5m). Total 19m wide | Road and Pipe rack (14m) +Conveyor (5m). Total 19m wide | Road and Pipe rack (14m) +Conveyor (5m). Total 19m wide | Separate Wharf (Solid Handling) and Liquid Loading Jetty. |
| Piling | Trestle designed to carry load of 10kN/m2<br><br>Approx 250 piles 42" to 54" driven into seabed to average depth of 30m. | Same<br><br>More piles for longer trestle | Same | Same | Wharf and Jetty. |
| Jetty Head | 2 Liquid loading arms | Liquid on one berth and solid handling on other. | Liquid on one berth and solid handling on other. | Liquid on one berth and solid handling on other. | Separate Wharf and Jetty |
| Tugboat Mooring | 4 tugboat moorings on jetty | May be able to share tug and pilot boat services with ELNG. | 4 tugboat and one pilot boat moorings on jetty | May be able to share tug and pilot boat services with Damietta Port | Damietta Port will provide all tug and pilot services. |
| Dolphins | 6 mooring and 4 breasting dolphins | 2 sets of dolphins required for 2 berths. | 2 sets of dolphins required for 2 berths | 2 sets of dolphins required for 2 berths | Dolphins for Liquid Loading berth only. |

| Item | ELNG (Idku Site) (Reference Case) | Echem Idku Site Trestle Jetty | Gamasah Site Trestle Jetty | Damietta Echem Integrated Breakwater Option | Damietta Port Dual Berths within Port Basin |
|---|---|---|---|---|---|
| Breakwater 800m long, 6.5 m above sea level | In 11.5 m depth | 800m In 14.5 m depth | 800m In 14.5 m depth | 800m In 14.5 m depth | No breakwater required |
| Dredge Turning Circle 620m diameter | To 13.5 m depth in 11m depth contour | 280m radius to 16.5 m depth in 14 m depth contour | 280m radius to 16.5 m depth in 14 m depth contour | 280m radius to 16.5 m depth in 3.5m depth contour | -15m Turning Circle exists in Port Basin. |
| Dredge Access Channel 230m wide | 4,000 m to -14 m deep | 10,300 m from Jetty Head to -17 m depth contour | 1,800m from Jetty Head to -17 contour | Connect to existing 15 meter dredged channel. May need extending. | Not Applicable. Port provides access 15m dredged channel. May need extending. |
| Annual dredging maintenance | 1 – 2 million m3/year or 25-50% of original dredged amount. | Assume 25% | Assume 25% | Assume 25% | Maintenance dredging included in Port rental fees. |

**Project Marine Export Terminal Requirements and Order of Magnitude Cost Estimates**

The defined export requirement is to have bulk liquid ammonia and methanol being loaded on ships at a common marine terminal. Consequently, other options for loading methanol and ammonia from facilities such as Single Buoy Moorings were not considered.

The draft requirements for the proposed bulk ammonia and methanol ships as shown below:

**Terminal Requirements - Ship Sizes**

**.Methanol Bulk Carriers:**

| | MTDWAT | Length (m) | Beam (m) | Draft (m) (Summer Salt Water) |
|---|---|---|---|---|
| | 48,000 | 186 | 32.2 | 12.22 |
| | 30,000 | 175 | 27.7 | 10.02 |

- **Ammonia Bulk Carriers:**

| | | | | |
|---|---|---|---|---|
| Hugo N | 43,350 | 215.7 | 32.3 | 11.48 |

- **Ship Loading Rates:**

Methanol 2,750 mtph (2 x 12" dia. lines) – Note manifold height approx 19 ft. above sea level.

Ammonia 750 mtph

- **Shipping Frequency**

  Ammonia 1 ship per month

  Methanol 3 - 4 ships per month

The Egyptian Nile Delta coast of the Mediterranean is heavily silted and shelves very gradually. The 14 meter depth contour is generally several kilometers from the shore, as shown in the following table:

The distance from shore to an acceptable depth contour of 14 – 15 meters drives the cost of the new terminal. The cost to develop new marine terminals at the Idku, Gamasah, and Damietta Echem sites is consequently very high as can be seen in the following table.

**Marine Terminal Costs – 2 Berths for Phases I through III**

| | Site 1 | Site 2 | Site 3 | Site 4 |
|---|---|---|---|---|
| | Idku | Gamasah | Damietta Echem | Damietta Port |
| Total Cost ($M US) ** | 128.94 | 254.22 | 200.37 | 46.83 |

** These costs include the costs for adding loading arms. These costs will be segregated in the final cost estimate.

This table considers the costs for constructing project specific marine terminals with one shared berth loading both liquid ammonia and methanol during Phases I and II of the project, and a second berth being constructed to meet the extra shipping demand for Phase III. As can be seen from the table, the cost of building dedicated berth arrangements in Damietta Port is considerably less than at the other sites.

The marine works cost estimate for the construction of the berths at each site is shown below.

**EGYPT N2 MARINE COST ESTIMATES - PHASE 1**

***Halcrow Scoping Study - November 2004***

| Cost Summary - Phase 1 | | Idku | Gamasah | Damietta Echem | Damietta Port |
|---|---|---|---|---|---|
| Item | Item Description | Amount | Amount | Amount | Amount |
| 1.0 | Marine Works - Berth | | | | |
| 1.1 | Loading Platform & Dolphins | 19,534,500 | 19,534,500 | 19,534,500 | |
| 1.2 | Jetty Approach Trestle | 38,937,500 | 126,936,250 | 76,317,500 | |
| 1.3 | Berth Ancillaries | 6,971,440 | 6,971,440 | 6,971,440 | |
| 2.0 | Marine Works - Breakwaters/ Revetments | 31,250,000 | 23,692,500 | 22,572,000 | |
| 3.0 | Service Tugs | 0 | 15,000,000 | 15,000,000 | |
| 4.0 | Dredging Works | 7,674,624 | 15,984,450 | 25,557,631 | |
| 5.0 | Excavation Works | 0 | 0 | 0 | |
| 6.0 | Flood Protection Mound | 1,000,000 | 1,000,000 | 1,000,000 | |
| 7.0 | Contractor's Preliminaries and General Items | 23,570,188 | 45,097,104 | 33,414,964 | |
| TOTAL FOR MARINE WORKS *** | | 128,936,252 | 254,216,244 | 200,366,034 | |

***The above estimate includes costs for mechanical items such as liquid loading arms. These mechanical items will be removed from this table in the final cost analysis and included elsewhere.

It can be seen that Damietta Port site construction costs are considerable less than constructing terminals on other sites. Additionally, the Damietta Port site borders the sheltered port basin, reducing the distance (and cost) to move the products to the ships.

### C.2.3.2 Site Preparation Cost Considerations

The site preparation costs were estimated to be significant and did vary for each site. In general, each finished elevations at each site is required to be increased to reduce the risk of flooding. The table following this section summarizes the estimated site preparation costs.

## Site Preparation Preliminary Cost Estimates

| LOCATION | ITEM DESCRIPTION | Pcs (EA) | Plan Area ($m^2$) | Depth (m) | Qty | Unit Rate USD | Factor | Cost USD | UOM | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| **Damietta Port** | | | | | | | | | | |
| | Concrete waste removal | 1 | 174,900 | 1.00 | 174,900.00 | 3.25 | 1.20 | 682,110.00 | M3 | Area = 550 m x 318 m |
| | Unsuitable soil removal | 1 | 300,000 | 1.00 | 300,000.00 | 2.50 | 1.00 | 750,000.00 | M3 | Left over dredge spoil |
| | Spread & compact existing stock pile | 1 | 825,100 | 0.50 | 412,550.00 | 4.70 | 1.00 | 1,938,985.00 | M3 | Raise site 1 m |
| | Imported fill for cap | 1 | 1,000,000 | 0.45 | 450000.00 | 8.00 | 1.20 | 4,320,000.00 | M3 | |
| | | | | | | | Total | $7,691,095.00 | | |
| **ECHEM Damietta** | | | | | | | | | | |
| | Remove drege spoils | 1 | 50,000 | 2.00 | 100,000.00 | 2.50 | 1.00 | 250,000.00 | M3 | Spoil area = 200 x 250 m |
| | Strip top 300 mm of soils | 1 | 1,000,000 | 0.30 | 300,000.00 | 2.50 | 1.00 | 750,000.00 | M3 | |
| | Imported fill for cap | 1 | 1,000,000 | 0.95 | 950,000.00 | 8.00 | 1.20 | 9,120,000.00 | M3 | Raise site 0.95 m |
| | | | | | | | Total | $10,120,000.00 | | |
| **Idku Site** | | | | | | | | | | |
| | Strip top 300 mm of soils | 1 | 1,000,000 | 0.30 | 300,000.00 | 2.50 | 1.00 | 750,000.00 | M3 | |
| | Imported fill for cap | 1 | 1,000,000 | 2.00 | 2,000,000.00 | 8.00 | 1.20 | 19,200,000.00 | M3 | Raise site 2.0 m |
| | | | | | | | Total | $19,950,000.00 | | |
| **Gamasah Site** | | | | | | | | | | |
| | Strip top 300 mm of soils | 1 | 1,000,000 | 0.30 | 300,000.00 | 2.50 | 1.00 | 750,000.00 | M3 | |
| | Imported fill for cap | 1 | 1,000,000 | 1.75 | 1,750,000.00 | 8.00 | 1.20 | 16,800,000.00 | M3 | Raise site 1.75 m |
| | | | | | | | Total | $17,550,000.00 | | |

| Differential Cost | |
|---|---|
| Damietta Port | Base line |
| ECHEM Damietta | $2,428,905.00 |
| Idku Site | $12,258,905.00 |
| Gamasah | $9,858,905.00 |

## C.2.4 Site Life Cycle Cost Considerations

The cost of annual land rental is shown in the following table.

| | IDKU | GAMASAH | Damietta Port | Echem Damietta |
|---|---|---|---|---|
| **Annual Cost of Land Rental $/m2** | $2.00 | $2.00 | $2.80 | $2.80 |

The maintenance and operating costs of a port facility add a considerable burden to the project. In the case of Damietta Port Site, the Damietta Port Authority plot space annual rental charge includes the general cost of maintaining the port facilities. In the case of Idku site, it has been assumed that ELNG, who have a marine terminal being constructed adjacent to the proposed Echem Idku site, will share the use of their 4,000 meter long navigation access channel and Echem will participate in the annual costs to dredge and maintain depth in that channel and use of ELNG tug boats..

For the other two sites, there will be a need to bear all of the costs for dredging and maintaining access channels of several kilometers long as well as maintaining the other dedicated port facilities and to provide the tug boats, pilots, etc.

**Port Operating Costs**

The following table lists the costs of renting the land to construct the process units and the costs associated with the maintenance and upkeep of the marine facilities.

## PORT OPERATING COST COMPARISON

| Item | Total Wt | IDKU | Wt | Gamasah | Wt | Damietta Echem | Wt | Damietta Port | Wt | Comments |
|---|---|---|---|---|---|---|---|---|---|---|
| **Marine Terminal Annual Maintenance Costs** | 10 | $4,250,000 for dredging operation (500,000$m^3$/annum)<br><br>$625,000 for annual Maintenance of Breakwater<br><br>$1,000,000 Annual maintenance to other marine installations | 6 | $10,750,000 for dredging operations (1,500,000 $m^3$/annum)<br><br>$474,000 for annual Maintenance of Breakwater<br><br>$2,500,000 Annual maintenance to other marine installations | 2 | $7,500,000 for dredging operations (1,500,000 $m^3$/annum)<br><br>$451,000 for annual Maintenance of Breakwater<br><br>$1,780,000 Maintenance to other marine installation | 4 | All included Port Authority Plot rental cost other than maintenance of the new 2 berth mooring at 1.5% CAPEX $702,000 per annum. | 10 | Dredging and port maintenance costs are included in the Damietta Port charges. |
| **Marine Terminal Annual Port Operating Costs** | 3 | $500,000<br><br>Possibility of shared cost of tugboat and pilot services with ELNG (to be verified) | 3 | $1,000,000 | 1 | $1,000,000 | 1 | $853,000/annum for Phase I allowing $750,000 possible demurrage charges/annum, growing to $2,600,000 for three phases (assumes possible 10% of vessels will incur one day delay) | 2 | Demurrage charges and associated delays at DPA terminal need to be considered. Unclear what additional port charges may be levied on Project Specific terminals by Egyptian Authorities. |

| Item | Total Wt | IDKU | Wt | Gamasah | Wt | Damietta Echem | Wt | Damietta Port | Wt | Comments |
|---|---|---|---|---|---|---|---|---|---|---|
| **Land Rental (Assume 1,000,000 m3 plot))** | 3 | $2.00 per m2<br>$2,000,000 per annum | 3 | $2.00 per m2<br>$2,000,000 | 3 | $2.8 per m2<br>$2,800,000 | 2 | $2.80 per m2<br>$2,800,000 | 2 | Rates need be be confirmed by Echem. Segas Project in Damietta Port is charged $3.36/m2. |
| **Differentiator Annual Operating Costs (Phase 1)** | **16** | **$8,375,000** | **12** | **$16,724,000** | **6** | **$13,531,000** | **7** | **$4,355,000** | **14** | **Damietta Port Site, despite allowing for demurrage to shipping, is still the cheaper alternative.** |

## C.2.5 Site Evaluation According to the Criteria Developed in Section C.1

Considering the findings from the Site Investigation Report and the Environmental Site Ranking Report in this section, along with the differentiator criteria developed in this section, the following Site Selection Differentiator Cost Comparison Table has been prepared.

It may be seen that the overwhelming factor that favors the Damietta Port Site is the comparative cost to develop a marine export terminal. The fact that the DPA site is already within an established Industrial Free Zone is also an advantage, although room to expand further than the existing plot currently appears to be limited.

Based upon the reports and analysis in this section, we recommend Damietta Port Site as the optimum site for the development of all three phases of the project.

## SITE SELECTION DIFFERENTIATOR COST COMPARISON AND RANKING TABLE

## ECHEM METHANOL/AMMONIA STUDY

| Item | Wt | IDKU | Wt | Gamasah | Wt | Damietta Echem | Wt | Damietta Port | Wt | Comments |
|---|---|---|---|---|---|---|---|---|---|---|
| **Required Plot Size (for 3 Phase Expansion)** | 2 | 1,000,000 m2 | 2 | 1,000,000 m2 | 2 | 1,000,000 m2 | 2 | 1,000,000 m2 | 2 | All 3 phases fit into the optimized plot plan (1 MM m2) for the allocated space at Damietta Port |
| **Land Expansion Opportunities** | 6 | Idku site has large development opportunities to the east of the proposed site. The site area is selected as maximum required. | 6 | Gamasah site has large development opportunities to the east of the proposed site. The site area is selected as maximum required. | 6 | Limited space for expansion with occupied properties to the east and west. | 4 | Limited expansion possibilities on the proposed site. Possibility to use surplus 500,000 $m^2$ land on the UDGC hydrocarbon liquid plant at the north west side of the Port Basin. Additionally, the UDGC Hydrocarbon Liquid Loading Terminal may become vacant within 3 years. | 2 | Plot area studies indicate that approximately 1,000,000 m2 is adequate for the Stand Alone Methanol and Ammonia requirements, including expansion to three units. |
| **Access to the Marine Terminal** | 10 | The proposed trestle and jetty cuts across RasPetCo gas separation plant which may cause problems. There are gas sea lines in the area that would cross the proposed trestle jetty structure. Assumes that the plot runs to the beach line. | 5 | There is a strip of 372 m of sand and dunes between the plot and the beach. A right of way and approval to build the trestle access will be required. | 3 | There is a strip of 300 m of between the plot and the beach. A right of way and approval to build the trestle access will be required. | 3 | Access directly onto the Port Shipping Basin. | 10 | ECHEM will need to confirm that an agreement can be reached to provide a ROW through third party property. No provision of rental costs for this corridor has been made. |

| Item | Wt | IDKU | Wt | Gamasah | Wt | Damietta Echem | Wt | Damietta Port | Wt | Comments |
|---|---|---|---|---|---|---|---|---|---|---|
| **Site Clearance and Backfill to +2.5m above MSL**<br><br>**Site Clearance and Backfill to +2.5m above MSL (Cont)** | 5 | Site to be raised 2m. No soils or debris removal required. Assume some dune sand is available.<br><br>$7,700,000 | 2 | Site to be raised 1.75 m and no spoils or debris removal is required. Assume some dune sand is available.<br><br>$10,120,000 | 3 | The site contains some dredge spoil which will have to be removed since it is not suitable for structural fill. The site will be raised 0.5m.<br><br>$19,950,000 | 5 | One section of the available property is littered with reinforced concrete rubble. The rest of the available plot space is also littered with soil piles and some of it may not be suitable for structural fill. Estimate provides that site will have to be raised about 0.75 m taking into account that some of the soil piles will not be usable<br><br>$15,550,000 | 4 | There may be an opportunity to reduce costs at Damietta Port Site if the concrete rubble was removed by the Port Authority and it proves that the soils dumped on the area are suitable for site fill. Based on 1 million square meters. |
| **Piping Cost on Beach Approach and Trestle** | 5 | Assumes that Idku property fronts the beach. Add 2,750m trestle to a breakwater in 14m depth on the east of ELNG Turning Basin.<br><br>$1,002,000 | 4 | Gamasah property is 300 m from the beach. Add trestle of 13,000 to breakwater in 14m depth.<br><br>$$13,300,000 | 2 | Echem property is 300m from beach. Add 8,000 m to a breakwater in 14m depth.<br><br>$8,300,000 | 3 | Short trestle of say 100m<br><br>$100,000 | 5 | These trestle figures do not include cost of extended piping and cable costs. |
| **Marine Terminal Works** | 30 | Assumes shared use of the 4,000 m x 14 m draft dredged navigation access channel and turning basin constructed by ELNG Project. | 15 | $254,200,000 | 5 | $200,400,000 | 10 | $46,800,000 | 30 | Damietta Port offers a sheltered harbor and a shorter marine construction duration. Dredged fill may offset the Site Preparation costs. |

| Item | Wt | IDKU | Wt | Gamasah | Wt | Damietta Echem | Wt | Damietta Port | Wt | Comments |
|---|---|---|---|---|---|---|---|---|---|---|
| | | $129,000,000 | | | | | | | | |
| **Location to Cooling Water** | 5 | Idku site has no major quantities of fresh water. There is a municipal water supply provided to the ELNG project, about 2 kms west of the proposed site, but inadequate for process water. Sea water/Air cooling is the only option. Access to the sea is believed to be direct from the site. | 4 | Gamasah also does not have any identified municipal fresh water supply. There is an agricultural drain to the eastern boundary that has marginally suitable water for a cooling tower/air cooling design. However, the analysis is unique and the flow measurement too. Access to sea water would require a right of way through a 372 m strip of dunes and sand, as would permission to build the jetty access and roads. | 2 | Damietta Echem Site has no fresh water source which can provide the quantity required for process requirements. Water analysis from the Navigation Canal shows that the water is unsuitable. Access to the sea traverses a 300m wide strip of land owned by third parties and a right of way will have to be negotiated. | 3 | Although the Port Authorities refused to accept a proposal to extract the large quantity of sea water for a "once through" sea water cooling solution, the lesser quantity (20" pipe) required for a sea water cooling tower solution should be acceptable. The reject pipe would run in the Utilities Corridor to the sea and then in a sea-line to the 5 meter depth contour. | 4 | Considering the absence of adequate supplies of fresh cooling water, Granherne considers that fresh cooling water is not a viable option. A separate study summarizes the site specific cost comparisons which lead Granherne to recommend the use of a sea water cooling tower with closed system fresh water and maximizing the use of air cooled exchangers. |
| **Cooling Water Piping (Sea Water Cooling Tower)** | | 1,000m of 20" diameter inlet pipeline running along the trestle from pumps/filters structure at 5 m (500m) depth contour. 1,500 m of 20" | | 2,250 m of 20" diameter inlet pipeline running along the trestle from pumps/filters structure at 5 m (1,200m) depth contour. 3,500 m of 20" dia. reject line laid as | | 1500 m of 20" diameter inlet pipeline running along the trestle from pumps/filters structure at 5 m (500m) depth contour. 2,500 m of 20" dia. reject line laid as | | 500 m of 20" diameter inlet pipeline running from pumps/filters structure in Port. 1,500 m of 20" dia. reject line laid as sea-line along the 50m wide Utility Corridor to the west of the installed sites. | | Damietta Port is likely to accept a water intake from a 20" diameter line directly from the Port Basin. |

| Item | Wt | IDKU | Wt | Gamasah | Wt | Damietta Echem | Wt | Damietta Port | Wt | Comments |
|---|---|---|---|---|---|---|---|---|---|---|
| | | dia. reject line laid as sea-line. | | sea-line. | | sea-line. | | | | |
| **Site Constructability** | 3 | There are established pipe and structural steel fabrication shops as well as civil works prefabrication facilities existing, having been established for the ELNG Project. Access to the land is reasonable although the access road will require improving. Heavy equipment may be delivered through Alexandria Port or through Damietta, with a possibility of using the ELNG construction jetty. There is currently ample space for additional lay down areas, although that may be reduced should additional industrial developments occur on the plot boundaries in between the | 2 | Gamasah is an urban, non-industrial area. The access to the site is very good as the Coastal Highway, a 4 carriage highway, borders the southern boundary. Major equipment would need to be moved into Damietta or Alexandria Port and trucked to the site unless a further study warranted the construction of a construction wharf at the beach during the construction of the trestle jetty.<br><br>There is currently ample space for additional lay down areas, although that may be reduced should additional industrial developments occur on the plot boundaries in between the phased construction. | 1 | The Barge Navigation Channel on the south western boundary of the plot lends itself to easy unloading of major equipment from barges, used to unload heavy equipment from heavy load ships that may be docked in Damietta Port. The access road to the site is reasonable and adequate for general construction traffic.<br><br>There is currently ample space for additional lay down areas, although that may be reduced should additional industrial developments occur on the plot boundaries in between the phased construction. | 2 | The deepwater port, with it's direct sea access to the proposed site, makes it ideal to offload and move heavy and general equipment and material. The port is within the Industrial Free Zone which will mean that the clearance of imported material and equipment for direct delivery to the construction site will be minimized.<br><br>Lay down area for the equipment for Phase 3 will need to be found away from the plot. There is the nearby option of the 500,000m2 surplus area proposed by UGDC which is within reasonable distance of the proposed construction site. | 3 | All sites will require piling. All are reasonably flat and access problems are not considered to be significant. Labor may be housed in nearby towns within reasonable traveling distance of the construction sites. |

| Item | Wt | IDKU | Wt | Gamasah | Wt | Damietta Echem | Wt | Damietta Port | Wt | Comments |
|---|---|---|---|---|---|---|---|---|---|---|
| | | phased construction. | | | | | | | | |
| **Natural Gas Pipelines** | 3 | It is assumed that the NG transmission line to the ELNG plant may be extended to the Echem plot (say 2 kms). No information on location of the line or capacity. | 3 | The NG trunk line runs along the southern boundary, along the Coastal Highway. No information on capacity. | 3 | There is a NG transmission line to the Segas LNG facility (5 kms to run around the port). No other information | 2 | The NG Segas transmission line runs close to the proposed Port site. No information on routing or capacity. | 3 | Echem will need to confirm routing and capacity of the existing NG transmission pipelines. |
| **Environmental Considerations** | 5 | There is a Napoleonic Fort on the North-West corner of the plot which will lengthen the trestle structure having to start further from the east. There is a large lake on the east side of the plot with established eco-system. The water filling this lake is pumped from an agricultural drain and may have deposited contaminants on the west portion of the site. Although the beach areas are | 4 | Gamasah site is covered with scrub and has wet lands on the eastern edge. There is a thriving eco-system in the wetlands and probably in the scrub land. The area is designated a tourist area and there is evidence of local fishing activities. The land to the south of the Intercoastal Highway is designated as "agricultural". Socioeconomic issues will occur, from the tourist characteristics of the site and due to there being little permanent | 2 | Damietta Echem Site has a large amount of fertile soil dumped upon it, probably in part from the dredging of the Damietta Port and Barge Navigation Canal. It is sandwiched between an existing flour mill and a private estate. It is on the outskirts of Damietta Town. There are minimum ecological issues likely on this land, nor socioeconomic issues as it borders Damietta Town and the existing Industrial Zone. . | 4 | The Damietta Port site is in an existing Industrial Zone with large process units already permitted to operate in that zone. Consequently, it may be assumed that the approval of the Environmental Impact Assessment studies which were accepted for the UGDC and Segas LNG projects and which are within close proximity to the proposed site would indicate minimum objections by the Authorities to the permitting of the new site. | 5 | There has been exhaustive Environmental Base Line studies and Environmental Impact Assessment Studies carried out at Damietta Port which have met the Egyptian Authorities criteria. It must be therefore assumed that the approval from the same authorities will be easier than dealing with a new site. |

| Item | Wt | IDKU | Wt | Gamasah | Wt | Damietta Echem | Wt | Damietta Port | Wt | Comments |
|---|---|---|---|---|---|---|---|---|---|---|
| | | tourist beaches, it is understood that the area has been designated an Industrial Zone. Consequently, there is little socioeconomic impact as labor can be lodged in nearby towns. | | habitation currently in the area. | | | | | | |
| **Permits** | 10 | Although designated as Industrial Development, there is an active eco system on the lake. Additionally the area is a summer tourist area. Permitting of "medium" difficulty. | 8 | This area is non-industrial and permitting is likely to be difficult. | 3 | This is adjacent to the Port and next to a flour mill. Permitting expected to be "medium" difficulty | 8 | Damietta Port is an existing Industrial Zone. Permitting is expected to be simpler. | 10 | Considering the established Damietta Port Industrial Zone where major gas and hydrocarbon projects have been successfully constructed, it must be assumed that the likelihood of obtaining favorable response to the various permitting applications will be easier to obtain. |
| **Marine Terminal and Site Prep Costs** | **84** | **$137,700,000** | **55** | **$277,620,000** | **32** | **$228,650,000** | **45** | **$64,450,000** | **78** | **Idku assumes that the ELNG channel will be shared. Damietta Port construction costs are still much cheaper than others.** |
| **Marine Terminal Annual Maintenance Costs** | 10 | $4,250,000 for dredging operation (500,000m3/annum)<br><br>$625,000 for | 6 | $10,750,000 for dredging operations (1,500,000 m3/annum)<br><br>$474,000 for | 2 | $7,500,000 for dredging operations (1,500,000 m3/annum)<br><br>$451,000 for | 4 | All included Port Authority Plot rental cost other than maintenance of the new 2 berth mooring at 1.5% CAPEX $702,000 per annum. | 10 | Dredging and port maintenance costs are included in the Damietta Port charges. |

| Item | Wt | IDKU | Wt | Gamasah | Wt | Damietta Echem | Wt | Damietta Port | Wt | Comments |
|---|---|---|---|---|---|---|---|---|---|---|
| | | annual Maintenance of Breakwater<br><br>$1,000,000 Annual maintenance to other marine installations | | annual Maintenance of Breakwater<br><br>$2,500,000 Annual maintenance to other marine installations | | annual Maintenance of Breakwater<br><br>$1,780,000 Maintenance to other marine installations | | | | |
| **Marine Terminal Annual Port Operating Costs** | 3 | $500,000<br><br>Possibility of shared cost of tugboat and pilot services with ELNG (to be verified) | 3 | $1,000,000 | 1 | $1,000,000 | 1 | $853,000/annum for Phase 1 allowing $750,000 possible demurrage charges/annum, growing to $2,600,000 for three phases (assumes possible 10% of vessels will incur one day delay) | 2 | Demurrage charges and associated delays at DPA terminal need to be considered. Unclear what additional port charges may be levied on Project Specific terminals by Egyptian Authorities. |
| **Land Rental (Assume 1,000,000 m3 plot))** | 3 | $2.00 per m2<br><br>$2,000,000 per annum | 3 | $2.00 per m2<br><br>$2,000,000 | 3 | $2.8 per m2<br><br>$2,800,000 | 2 | $2.80 per m2<br><br>$2,800,000 | 2 | Rates need be be confirmed by Echem. Segas Project in Damietta Port is charged $3.36/m2. |
| **Differentiator Annual Operating Costs (Phase 1)** | **16** | **$8,375,000** | **12** | **$16,724,000** | **6** | **$13,531,000** | **7** | **$4,355,000** | **14** | **Damietta Port Site, despite allowing for demurrage to shipping, is still the cheaper alternative.** |

## C.3 RECOMMENDED SITE

Of the four sites investigated, the Criteria Analysis Table developed in Section C.2 indicates that the Damietta Port Site offers the better economic, logistical and life cycle advantages over the others. The driving factor is the lower cost to develop a dedicated export marine terminal for the products. There are some concerns in developing this site, these being:

- Possible shipping delays due to heavy port traffic.
- Limited room for further expansion
- Access restrictions due to the area being within a large Industrial Free Trade Zone.
- Ammonia production plants being located within the port area.
- No ready access to supplies of fresh water for cooling purposes.

However, considering the advantages and disadvantages compared to the other three sites, Granherne recommends that the project site be the Damietta Port Site.

## C.4 PRELIMINARY ENVIRONMENTAL IMPACT ASSESSMENT

The Preliminary Environmental Impact Assessment was undertaken by engineers and professionals from the Cairo Office of Komex, an internationally recognized environmental consulting company. Komex was subcontracted by Granherne. Komex and Granherne environmental engineers prepared the mitigation recommendations. The report is included in Appendix 1 of this Report.

The summary of their report findings and recommendations is as follows.

### C.4.1 Purpose of the Preliminary Environmental Impact Assessment

This document covers the PEA for construction and operation of new fertilizer and methanol production facilities in Damietta, Egypt.

Preparation of the PEA involved the following tasks:

- Detailed literature survey/review on the project area, including reviewing reports, maps, textbooks, atmospheric and climatic conditions, geological settings, and groundwater, etc.
- Several site visits.
- Public consultation with relevant stakeholders and interested parties.
- Assessment of the project - environment interactions using matrix tables and source-pathway-receptor risk assessment concepts.
- Production of a PEA report.

The overall purposes/objectives of the PEA are:

- To assist with project planning, including identification of key issues and opportunities;
- To assist in ensuring environmentally sound and sustainable development by providing all the environmental information necessary to determine the environmental acceptability and feasibility of the project;
- To present the regulatory requirements;
- To provide investors with an understanding of the resource values, their constraints and other resource users in the area;
- To provide a forum for other local industry and local residents to become knowledgeable about this project; and

- To provide a baseline of management information essential to the long-term viability of the project.

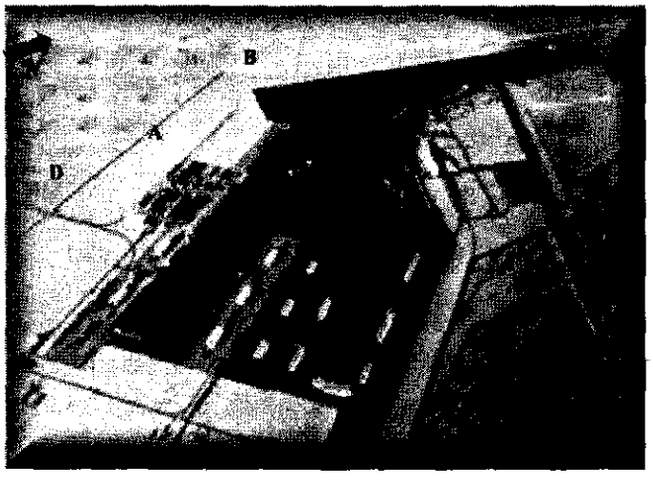
The terms of reference for the environmental assessment were developed during discussions between Granherne and Komex.

The proposed facility will produce approximately 800,000 metric tonnes/year of Ammonia for urea production, (of which approximately 114,000 metric tons/year is surplus available as saleable product), 1,200,000 metric tons/year of urea and 1,250,000 metric tonnes/year of methanol, all planned for the export market.

Information about the proposed process and designs were reviewed to identify the potential for pollution, or other effects on the environment. This was assessed based on the nature and state of released compounds, their location and mode of release, the likely mass and rate of released compounds, and the likely nature of effect. Once the locations were identified where impacts were likely to occur, the nature of the interaction with the environment, and the likely significance of impacts on the environment were evaluated using a matrix approach. The matrices are provided in Appendix V of the PEA Report (Appendix 1).

### C.4.2 Project Location

The proposed Ammonia/Urea and Methanol facility will be located within the Damietta Port Authority's Industrial Free Trade Zone. It is situated on the Mediterranean coast (Longitude 31° 45' E; and, Latitude 31° 28' N), approximately 8.5 Km west of the Nile's Eastern branch and about 70 Km west of the Port-Said port. The port covers a total area of approximately 9.3 $Km^2$, of which 6.2 $Km^2$ is land area and 3.1 $Km^2$ is water area. It includes an 11.3 Km long, 300 m wide approach area dredged to 15 m, with two sheltering breakwaters: one to the west at a length of 1.640 Km (140 m in land and 1,500 m in water) and the other to the east, 738 m long (238 m in land and 500 m in water). The approach area provides access to a barge channel consisting of two ports, one (1.35 Km long) links the barges dock to the sea and the other (3.75 Km long) links the Dock to the Nile Branch. The barge dock occupies an area of 62,500 $m^2$ and is equipped with a 250 m long berth with a water depth of 5 m. The rotation dock is 500 m in diameter and varies in depth from 14.5 m in front of the containers broth to 12 m in front of the general cargo berths.




**Schematic - Damietta Port**

As presented in the above schematic, the site (A) is bounded by SEGAS LNG facility (B) from the north western boundary, port container yard expansion area (C) from the eastern boundary and administration buildings area (D) from the southern boundary. Appendix II, shows the site layout indicating the location of the production plants and the distribution of its utilities within Damietta Port.

## C.4.3 Surrounding Geology and Soils[5]

Information regarding the surrounding geology and soils was determined from borehole samples collected from 4 boreholes drilled (Samsung-Arab contractors) at the Damietta Port east dock area. A description of the soil lithology is summarized in Table 4.3.3.

**Table 4.3.3 - Local Soil Lithology**

| | Description | Thickness |
|---|---|---|
| Fine to Medium Sand | The upper layer of the profile consists of fine, silty sands with traces of broken shells | 10.7 – 12.0 m |
| Soft Clay | Soft, darkish grey silty clay, locally medium darkish grey silty clay with lenses of sand | 19.5 m |
| Fine Greyish Sand | Silty medium to fine sands, with traces of broken shells and lenses of darkish grey silty clay | 4.5 - 4.7 m |
| Silty Clay | Very stiff, locally hard brown silty clay, silty clay with traces of gypsum | Bottom encountered at levels from 37.05 LLWL to 38.95 LLWL (Lowest Low Water Level) |

[5] From M W Kellogg EIA conducted for Damietta LNG Project.

| | Description | Thickness |
|---|---|---|
| Medium Sand | Calcareous medium to fine sand with traces of calcareous hard cemented sand | |

### C.4.4 Groundwater

At the proposed site area, groundwater is mainly contained in the coastal sand aquifer where the soft clay layer, underlying the silty sand layer, acts as an aquiclude. Groundwater levels in the project area are shallow and range between 0.4 to 1.85 mbgl (meters below ground level).

### C.4.5 Project Waste

The process produces various forms of waste, some of which have the potential to cause adverse environmental effects if compliance is not assured or if accidents occur. Effects of emissions and operating activities on the quality of soil, water and air were considered.

### C.4.6 Socioeconomic and Wildlife Considerations

The area proposed for development was surveyed to check for the presence of any important (National and International) wildlife species and to evaluate the likely effects of the proposed activities on them. Effects on local employment, the local economy and cultural aspects were also taken into account.

In terms of positive economic impact and employment, the project will enable Egypt to annually export approximately 114,000 metric tons of Ammonia, 1,200,000 metric tons of urea and 1,250,000 metric tons of methanol, generate foreign income and provide a great number of jobs both during the construction and operation phases. The socio-economic benefits of the project are thus largely positive. The PEA identifies other possible impacts on local biology, soil, air, and water quality.

### C.4.7 Conclusions

The PEA provides the basis for a detailed EIA in a later stage should the feasibility of the project be proven. In the detailed EIA a detailed site specific baseline assessment should be conducted, where suitable mitigation measures are recommended to reduce the potential adverse environmental impacts to acceptable levels, and recommendations made concerning ongoing environmental management of the project to ensure that environmental quality is sustained throughout its lifetime.

Based on this PEA, the assessment team concludes that the proposed methanol and ammonia/urea production complex is environmentally feasible, and a full EIA should be

conducted at the FEED[6] stage with a comprehensive baseline assessment and detailed environmental management plan (EMP).

## C.5 EMISSIONS AND MITIGATION STRATEGIES

### C.5.1 Operational Emissions

In general the production facilities for Ammonia, Granulated Urea and Methanol production do not generate waste streams which will create significant environmental problems. The feedstock used for the production facilities and as the source of energy is natural gas with a very low level of sulfur content. Air emissions generated will contain low levels of criteria contaminants, $SO_2$, NOx, CO, and particulate emissions which are well below the regulated air emission standards set by the Egyptian regulation covered by Law 4.

Based upon the Preliminary Environmental Impact Assessment Report (Section C.4), certain environmental issues have been identified. These issues are tabulated in this section along with the proposed mitigation and protective measures.

- Effluent Summary

The major sources of aqueous waste streams from all production facilities are process steam condensate which is treated within the process for recovery and reuse as makeup water to steam generation and process unit operations. The major source of wastewater is from the utility systems are the blowdowns from the seawater cooling tower, process and utility boilers and the backwash and effluents from water treatment. Apart from neutralization of demineralizer regenerant wastewater waste streams these streams will meet the contaminant levels specified under Law 4 of the Egyptian Code without further treatment. The exception to this is sanitary wastewater from the various plant buildings which will require treatment in an onsite package biological treatment system to meet water quality criteria required by Law 4.

| Methanol Process | | | |
|---|---|---|---|
| Source | Flow Rate | Components and Temperature | Environmental Mitigation Strategy |
| Saturator Blow Down | 3.5 (kg/MT MeOH) | Water<br>pH: 10 – 12<br>BOD (mg/l): <210<br>COD (mg/l): < 375<br>Methanol (mg/l): <250<br>Carbon dioxide (mg/l): <150<br>Methane (mg/l): <10<br>TSS (mg/l): <30 | Meets Egyptian regulations covered by Law 4. Discharge to Outfall Sewer where diluted by Seawater |
| Steam System Blow Down | 44 (kg/MT MeOH) | Water<br>pH: 9 – 10 | Meets Egyptian regulations covered |

[6] Front End Engineering Design

| | | | |
|---|---|---|---|
| | | BOD (mg/l): <10<br>COD (mg/l): <10<br>TSS (mg/l): <10 | by Law 4. Discharge to Cooling Tower |

| | | | |
|---|---|---|---|
| **Ammonia Process** | | | |
| Steam System Blow Down | 400 kg/hr | Water<br>COD (mg/l): < 10 | Meets Egyptian regulations covered by Law 4. Discharged to Cooling Tower |
| Process Air Compressor Condensate | 4100 kg/hr | Clean Water | Meets Egyptian regulations covered by Law 4. Discharged to Cooling Tower |
| **Utilities and Offsites** | | | |
| Sanitary System | 48700 kg/day (Approx 48.7 $m^3$/day) | Temperature (°C): Ambient | Sanitary Treatment System (settling of suspended solids, biological treatment, and chlorination) and discharged to Outfall Sewer |
| Cooling Tower Blowdown | 2360 t/hr | Water<br>(2 cycles of concentration) | Low Cycle of Concentration. Discharge to Outfall Sewer |
| Desalination Unit Reject | 1271 t/hr | Water | Low Cycle of Concentration. Discharge to Outfall Sewer |
| Boiler Blowdown | 0.6 t/h | Water | Meets Egyptian regulations covered by Law 4. Discharged to Cooling Tower |
| Demineralized Water Plant Effluent | 225 (kg/MT MeOH) | Water<br>Temperature: 45°F | Neutralized in Neutralization Tank and discharged to Outfall Sewer where diluted by Seawater |

- Emission Summary

| Methanol Process | | | |
|---|---|---|---|
| Source | Flow rate | Components | Environmental Mitigation Strategy |
| Reformer Flue Gas | 4,465 $Nm^3$/MT MeOH | Temperature (°C): 180<br>$O_2$: 1.7 mol%<br>$N_2$: 70.1 mol%<br>$CO_2$: 8.5 mol%<br>$H_2O$: 19.7 mol%<br>[b] $SO_2$: 0.45 ppmw<br>[a] NOx: See Note | Sulfur level of natural gas to be less than 8 ppmv, resulting in $SO_2$ emissions of 0.5 ppmv, below the Egyptian limit of 1100 ppmv.<br><br>Conventional burners are capable of controlling $NO_x$ to 150 ppmv, below Egyptian limit of 155 ppmv. |
| Boiler Flue Gas | 390 $Nm^3$/MT MeOH | $O_2$: 1.7 mol%<br>$N_2$: 70.1 mol%<br>$CO_2$: 8.5 mol%<br>$H_2O$: 19.7 mol%<br>[b] $SO_2$: 0.45 ppmw<br>[a] NOx: See Note | Sulfur level of natural gas to be less than 8 ppmv, resulting in $SO_2$ emissions of 0.5 ppmv, below the Egyptian limit of 1100 ppmv.<br><br>Conventional burners are capable of controlling $NO_x$ to 150 ppmv, below Egyptian limit of 155 ppmv. |
| Deaerator Vent | 10 $Nm^3$/MT MeOH | Temperature (°C): 109°C Steam | None Required |
| Converter Catalyst Oxidation Vent | Occurs for a period of 24 – 36 hours at catalyst change | Temperature (°C): 50<br>$O_2$: 2.0 mol%<br>$N_2$: 98.0 mol% | No Pollutants |
| Tanks:<br>- Crude Methanol Tank<br>- Refined Methanol Shift Tank Vent<br>- Methanol Product Storage Vent | Subject to equipment size | $N_2$ with low methanol | Floating roof type product tanks to minimize vapor emissions. |

| | | | |
|---|---|---|---|
| Miscellaneous Emissions:<br>- Flare Gases<br>- Firewater Pump Diesel Driver<br>- Sample Point Vents<br>- Atmospheric Vents | Subject to equipment size | Combustion products of natural gas / diesel<br><br>Small intermittent flows of process gas<br><br>Releases due to upset | Emission levels low and / or intermittent. |
| **Ammonia Process** | | | |
| $CO_2$ | 4,100 $Nm^3/hr$ | No Sulfur Compounds | High vent to disperse flow.<br><br>No Egyptian regulations which limit $CO_2$ emissions. |
| Oxygen Vent | 25,000 $Nm^3/hr$ | $O_2$: 59 vol%<br>$N_2$ + Ar: 41 vol% | No Pollutants |
| Dryer Vent | 9,600 $Nm^3/hr$ | No Pollutants | No Pollutants |
| **Utilities and Offsites** | | | |
| Gas Turbine Generator Exhaust | 326,349 $Nm^3/hr$ | Temperature (°C): 230<br>$O_2$: 12.3 mol%<br>$N_2$: 76.1 mol%<br>$CO_2$: 4.0 mol%<br>$H_2O$: 7.7 mol%<br>[a] NOx: See Note | Sulfur level of natural gas to be less than 8 ppmv, resulting in $SO_2$ emissions of ~0.5 ppmv, below the Egyptian limit of 1100 ppmv.<br><br>Conventional burners are capable of controlling $NO_x$ to 150 ppmv, below Egyptian limit of 155 ppmv. Provisions for water / steam injection. |
| Package Boiler | 37,806 $Nm^3/hr$ | Temperature (°C): 315<br>$O_2$: 2.5 mol%<br>$N_2$: 72.6 mol%<br>$CO_2$: 8.5 mol%<br>$H_2O$: 16.3 mol%<br>[b] $SO_2$: 0.45 ppmw<br>[a] NOx: See Note | Sulfur level of natural gas to be less than 8 ppmv, resulting in $SO_2$ emissions of 0.5 ppmv, below the Egyptian limit of 1100 ppmv.<br><br>Conventional burners are capable of controlling $NO_x$ to 150 ppmv, below Egyptian limit of 155 ppmv. Provisions for water / steam injection |
| | | | |

[a] Meets World bank standards for NOx emissions averages
[b] based on a maximum natural gas Sulphur content of 5ppm (vol)

- Noise

The plant has a significant number of major noise sources, including:

- Compressors
- Conveyors
- Gas turbines;
- Flares
- Skid units
- Heat exchangers

The Egyptian Legislation relating to noise related environmental issues is extremely stringent. The Egyptian Environmental Law (Law 4/1994) sets the criteria for noise levels in industrial areas as illustrated in the following table.

**Law 4 Allowable Noise Limits**

| Type of Area | Permissible Limit For Noise Intensity Decibel (a) | | | | | |
|---|---|---|---|---|---|---|
| | Day | | Evening | | Night | |
| | From | To | From | To | From | To |
| Industrial Area (Heavy Industries) | 60 | **70** | 55 | **65** | 50 | **60** |

The law is found to set different noise level criteria at different periods of the day/night within an industrial zone. The reason is that many of the industrial areas in Egypt are intermingled within residential areas, thus requiring more stringent criteria.

During meetings with EEAA officials, it was indicated that in cases where proper noise modeling provides evidence that no significant residential noise impacts would arise from the normal higher noise levels, the facility would be granted an approval for operation. To achieve this, additional noise insulation requirements will be enforced to insulate equipment, valves and piping that are sources of excessive noise.

- Solid Waste

The solid waste generated by the production facilities include spent catalyst, containing valuable metals, which will be returned to the catalyst manufacturers. Other process solid waste streams including catalyst, desiccants and ion exchange resins, stabilized biological sludge are inert none hazardous material that be disposed of at an offsite landfill along with miscellaneous trash/garbage sources generated at the facility.

## C.5.2 Construction Emissions

During the construction phase, there will be various categories of waste. This will in general comprise of waste from the following sources:

1. **Imported Equipment and Materials:** Wooden boxes, cartons, packing materials, plastic sheeting, etc.
2. **Materials:** Surplus concrete and cement, pile cut-off sections, waste pipe, structural steel, cables, paint cans, insulation, etc.
3. **Mobile Equipment:** Old tires, batteries, oil cans, waste oils/greases, filters, mechanical and panel parts, etc.
4. **Food Waste:** Food waste from canteen preparation and clean-up areas, tin cans, glass bottles, plastic bottles and wrapping, cartons, etc.
5. **Office Waste:** Paper, cartons, photocopy toner cartridges, etc.

Construction waste will be collected and segregated. It will be stored in bins and hoppers and will be disposed of in approved land fill areas, hazardous material handling facilities or recycled. In the case of hazardous or toxic waste handling plants not being available in Egypt, the EPC Contractor will be responsible for the export of such noxious waste to handling facilities outside of the country.

## TASK D COST ESTIMATES

Cost estimates have been prepared using the following input:

- Basic Engineering Data prepared by KBR for the 1,200 mtpd Ammonia, Utilities, and Offsites.
- Telephone quotations for major ammonia production equipment and utility equipment.
- Effluent and utilities data provided by ONE SYNERGY (a partnership incorporating Johnson Matthey, Davy Process Technology and Aker Kvaerner Inc.) to enable KBR to design and estimate the cost of the utilities.
- Construction data provided by KBR from other Egyptian projects.
- KBR Cost data from similar projects and estimates.
- Cost information on Methanol Technology from the Echem 3,000 mtpd methanol plant estimate data contained in the S. H. Lucas & Associates Desk Study for USTDA dated May 11, 2004.
- Aker Kvaerner Inc. provided a commodity percentage estimate split of the Echem methanol cost estimate.
- Site preparation and Marine Construction studies and cost estimates were prepared by Halcrow Group, KBR and ECMA.

### Estimate methodology

#### General

The Cost Estimate in Task "D" of the Methanol/Ammonia Feasibility Study was prepared in accordance with the US TDA Terms of Reference utilizing Granherne/KBR's corporate methods and proprietary estimating program.

In the case of the ammonia process units, KBR prepared process simulations from which sized equipment lists were generated. Bulk material and other costs were factored from the principal equipment estimates using KBR statistical cost estimating data.

GH has no non-confidential access to proprietary data for methanol technology. Consequently KBR was only able to access information supplied by the licensors or in the public domain. However, for the Johnson-Mathey methanol process, Johnson-Mathey with Aker-Kvaerner agreed to provide basic cost data (no process data) for the J-M LCM process. They did not accept to provide process or cost data on the conventional Improved Low Pressure process.

Using current cost estimating data from similar ammonia projects the following items were evaluated to determine the adjustments required to develop an estimating model which reflected the current project.

- Process technology
- Equipment count
- Equipment pricing
- Design basis variations
- Site conditions (soils, seismic, weather, temperature, etc.)
- Site locations country and regions
- Labor conditions
- Plot size and arrangement
- Buildings, facilities, utilities, infrastructure
- Schedule

Capital Cost Estimate

A Project Design Basis was prepared and process simulations were carried out. Based upon this, GH selected an estimate model for a plant of similar size and process. An equipment list and equipment piece count was generated and the estimate model was adjusted to reflect these process changes.

This defines the base estimate model developed to generate the capital cost estimate. The following describes the assumptions that were utilized to develop the factored estimates

Assumptions

Ammonia – 1200 mtpd

- The process group's sized equipment list was used to develop the individual equipment costs from vendor quotations for principal equipment. Where possible, actual purchase order values were used for similar equipment, adjusted as necessary. These costs included actual engineering and vendor cost "growth" which is more accurate than using vendor budgetary quotations.
- The equipment costs were included in the estimate model to generate factored bulk materials etc. and USGC man hours for HOS and construction.
- Forward escalation and contractor's overhead and profit was added.

Methanol LPM Process – 3,000 mtpd

- For reasons explained above, no process information was forthcoming from Johnson-Mathey
- Aker - Kvaerner (A-K) did not agree to provide detailed cost information
- A-K did however agree that the TIC of $278MM (excl contingency) included in the Echem RFP was an acceptable cost estimate.
- A-K provided a TIC commodity percentage split based on KBR estimating format
- A-K agreed that the estimate is on a Client Cost Basis
- Excludes Contingency and Escalation – added by KBR
- KBR adjusted A-K methanol unit cost to include items that were not in the estimate.

Common Utilities and Offsites

- The process information provided the data required to engineer and size the required common utilities equipment.
- Vendor quotations were received for Utility Equipment. Growth factors were applied.
- Offsite equipment such as storage tanks, buildings etc were sized and estimated from quotes and other statistical data.
- The marine terminal and site preparation estimate was based upon actual Egyptian unit rates provided by Halcrow.

Estimate Accuracy

The estimate is a factored estimate as required by TDA. It is considered that based upon the feasibility study degree of engineering, it has an overall accuracy (for the entire estimate – not just one part) of +/- 15-25%. This also means that if the equipment is +/-15%, the bulks are no better than +/- 25% and any one bulk item can and will vary more or less than this.

After the equipment has been priced the remainder of the cost elements is factored. The "factoring" encompasses several techniques for developing the costs from KBR's proprietary data base. The techniques entail the following:

- The cost elements available in the data base may be derived from current process units of different capacity, material, time frame and location. Adjustments are made to the element to meet the conditions required for the project
- Cost elements are based on quantity of equipment items by type
- Cost elements are based on percentages of equipment and bulk items

## Estimate Basis

The accuracy of the estimate in accordance with KBR guidelines is + 15%/-25%.

CONTROLLING DOCUMENTS:

The estimate is based on the following documents:

- Plot Plans:
- Preliminary Process Flow Diagrams (PFD) and Utility Flow Diagrams (UFD)
- Equipment List:
- Electrical Load Summary,
- EPC Project Master Schedule
- Escalation
- All costs are based on 4th Qtr 2004 pricing levels with forward escalation included below line per the project schedule.

**Pricing:**

- All costs are stated in U.S. Dollars.
- All material pricing is based on worldwide sourcing.
- 'In-house' pricing is used to represent current cost data from KBR projects and proposals. The Estimating Group is consistently involved in such data collection. These efforts include data collection from on-going projects which periodically provide actual cost data. Data is collected, compared and used for consideration on subsequent estimates.

PROJECT COSTS

- Import duties are not included in this estimate, other than document handling fees..
- Freight Costs are collected from actual ongoing Egyptian projects and are included for international and domestic transport:
- All Risk and Construction Insurance is included in this estimate.
- Costs for operation and maintenance spares are included in the estimate
- Costs for start-up and commissioning spares are included in the estimate
- 2 year capital spares are included

CONSTRUCTION/LABOR:

KBR Construction provided productivity and subcontractor hourly rates based on current work in the area – a productivity of 3.0 and an all-in subcontractor rate of US$9.70 + US$3.72/hr management was used.

GENERAL EXCLUSIONS

- Owner's contingency
- Environmental and other permitting
- Testing for, disposal, and remediation of any contaminated soils
- Security inside facility

The cost estimates contained in this study have been prepared by Granherne, KBR, their subcontractors and associates. They have been prepared using their best efforts and in accordance with the best estimating practices to meet the purpose of this Feasibility Study. Granherne, KBR and their subcontractors do not accept responsibility or liability for use of these estimates outside the parameters of this Feasibility Study.

## D.1 CAPITAL COST ESTIMATES

The summary Capital Cost Estimates (CAPEX) is shown in the following tables in this section:

Table 1 CAPEX for conventional 3,000 mtpd ONE SYNERGY LPM methanol unit with 50% of the estimated cost of the common utilities, offsites (including ship berth and sea water intake).

Table 2 CAPEX estimate for the 1,200 mtpd KBR ammonia process unit including 50% of the estimated cost of the common utilities, offsites (including ship berth and sea water intake).

Process Licensors proved reluctant to release process or cost data without having received royalty fees. This proved to be particularly true for methanol technology. Consequently, Granherne was unable to obtain sufficient methanol data to prepare equipment load sheets to obtain vendor quotations.

To work around this problem, Granherne requested expertise help from Aker Kvaerner Inc, Aker Kvaerner Inc. having undertaken several methanol studies and projects in the recent past. Aker Kvaerner Inc. confirmed that the Echem overall estimate for the 3,000 mtpd conventional methanol process was in the correct "ball park" and provided an approximate percentage commodity split of the estimate.

Granherne reviewed the methanol process unit cost breakdown and adjusted it where KBR considered that cost items were missing or where they believed that there was a change in project scope. The revised process unit cost is shown in Table 1.

KBR designed the common utilities and offsites for the methanol and ammonia production and estimated their cost for the whole complex. Telephone quotations for major equipment were obtained where engineering data could be prepared to provide the vendors with sufficient design information.

**Table 1 – CAPEX Costs Estimate – 3,000 mtpd ONE SYNERGY LPM Methanol Production**

| Table 1 – MEOH CAPEX<br>USD x 1000 | | | | |
|---|---|---|---|---|
| Description | 3,000 mtpd MEOH Unit<br>4Q04 | 50% of Common MEOH/$NH_3$ Offsites and Utilities<br>4Q04 | 50% of Marine Installation & Site Preparation Costs 4Q04 | TOTAL METHANOL<br>USD x 1000 |
| **Home Office Services:** | | | | |
| USA | 20,534 | 7,676 | 731 | 28,940 |
| Non USA high Value Engineering Centers | 4,602 | 1,723 | 165 | 6,491 |
| **Equipment:** | 0 | 0 | - | 0 |
| Furnaces | 5,772 | 152 | - | 5,925 |
| Exchangers | 18,705 | 1,576 | - | 20,281 |
| Columns/Converter | 39,337 | 0 | - | 39,337 |
| Tanks | 0 | 96 | - | 96 |
| Rotating Machinery | 12,282 | 8,433 | 440 | 21,156 |
| Mechanical Equip. | 1,287 | 18,724 | - | 20,011 |
| Packaged Equip. | 0 | 7,327 | 816 | 8,143 |
| Fire & Safety | 0 | 0 | - | 0 |
| Licensor Fees, Catalyst & Chemicals | 14,710 | 0 | - | 14,710 |
| **Bulk Materials:** | 0 | 0 | - | 0 |
| Site Prep/Piling/Civils | 6,199 | 1,897 | 217 | 8,314 |

| Description | 3,000 mtpd MEOH Unit 4Q04 | 50% of Common MEOH/$NH_3$ Offsites and Utilities 4Q04 | 50% of Marine Installation & Site Preparation Costs 4Q04 | TOTAL METHANOL USD x 1000 |
|---|---|---|---|---|
| | | **Table 1 – MEOH CAPEX** USD x 1000 | | |
| Electrical/Controls | 7,960 | 10,586 | 223 | 18,769 |
| Piping | 17,610 | 7,403 | 1,293 | 26,305 |
| Buildings/steel | 4,737 | 945 | 10 | 5,692 |
| Paint/Insul/Grout | 1,904 | 46 | - | 1,950 |
| **Mat'l. Related:** | 0 | 0 | - | 0 |
| Spares | 4,543 | 1,271 | 44 | 5,858 |
| Shipping Insurance Prep & Freight | 20,093 | 9,061 | 472 | 29,626 |
| VSMs | 133 | 147 | 16 | 297 |
| **Subcontracts:** | 0 | 0 | - | 0 |
| Mechanical | 2,103 | 3,088 | - | 5,191 |
| Tanks | 0 | 9,011 | - | 9,011 |
| Marine | 0 | 0 | 16,439 | 16,439 |
| Civils/Structural | 0 | 7,590 | 6,267 | 13,857 |
| Electrical | 0 | 0 | - | 0 |
| Paint/Insulation | 0 | 2,733 | 208 | 2,942 |
| **Construction Services:** | 0 | 0 | - | |
| Subcontract Labor | 27,886 | 16,788 | 2,062 | 46,737 |
| Management | 10,695 | 6,438 | 791 | 17,924 |
| CAR Insurance | 1,078 | 614 | 151 | 1,843 |
| **Operations:** | 0 | 0 | - | 0 |
| Project Completion | 2,696 | 1,534 | 377 | 4,607 |
| Start-Up/Commissioning | 4,314 | 2,454 | 604 | 7,372 |
| **Escalation:** | 0 | 0 | - | 0 |
| 4Q04 to 1Q06+33 mths | 28,790 | 16,919 | 4,467 | 50,176 |
| | | | | |
| **TOTALS** | **257,969** | **144,235** | **35,796** | **438,000** |

## Table 2 – CAPEX Costs Estimate – 1,200 mtpd KBR Ammonia Process Unit and Combined Methanol/Ammonia Utilities and Offsites

| | Table 2 - $NH_3$ CAPEX USD x 1000 | | | |
|---|---|---|---|---|
| Description | 1,200 mtpd $NH_3$ Unit 4Q04 | 50% of Common $NH_3$/MEOH Offsites and Utilities 4Q04 | 50% of dedicated Marine Installation & Site Preparation Costs 4Q04 | TOTAL Ammonia USD x 1000 |
| **Home Office Services:** | | | | |
| USA | 11,618 | 7,676 | 731 | 20,025 |
| Non USA high Value Engineering Centers | 2,605 | 1,723 | 165 | 4,493 |
| **Equipment:** | | | | |
| Furnaces | 547 | 152 | - | 700 |
| Exchangers | 3,116 | 1,576 | - | 4,692 |
| Columns/Converter | 6,479 | 0 | - | 6,479 |
| Tanks | 512 | 96 | - | 609 |
| Rotating Machinery | 10,049 | 8,433 | 440 | 18,923 |
| Mechanical Equip. | 0 | 18,724 | - | 18,724 |
| Packaged Equip. | 29,239 | 7,327 | 816 | 37,382 |
| Fire & Safety | 0 | 0 | - | 0 |
| **Bulk Materials:** | | | | |
| Site Prep/Piling/Civils | 530 | 1,897 | 217 | 2,645 |
| Electrical/Controls | 2,836 | 10,586 | 223 | 13,645 |
| Piping | 4,440 | 7,403 | 1,293 | 13,136 |
| Buildings/steel | 524 | 945 | 10 | 1,480 |
| Paint/Insul/Grout | 0 | 46 | - | 46 |
| **Mat'l. Related:** | | | | |
| Spares | 4,056 | 1,271 | 44 | 5,370 |
| Shipping Insurance Prep & Freight | 10,003 | 9,061 | 472 | 19,536 |
| VSMs | 753 | 147 | 16 | 916 |
| **Subcontracts:** | | | | |
| Mechanical | 0 | 3,088 | - | 3,088 |
| Tanks | 0 | 9,011 | - | 9,011 |
| Marine | 0 | 0 | 16,439 | 16,439 |
| Civils/Structural | 1,042 | 7,590 | 6,267 | 14,900 |
| Electrical | 0 | 0 | 0 | 0 |

| Description | 1,200 mtpd $NH_3$ Unit 4Q04 | 50% of Common $NH_3$/MEOH Offsites and Utilities 4Q04 | 50% of dedicated Marine Installation & Site Preparation Costs 4Q04 | TOTAL Ammonia USD x 1000 |
|---|---|---|---|---|
| | **Table 2 - $NH_3$ CAPEX** USD x 1000 | | | |
| Paint/Insulation | 2,020 | 2,733 | 208 | 4,962 |
| **Construction Services:** | | | | |
| Subcontract Labor | 16,034 | 16,788 | 2,062 | 34,885 |
| Management | 6,149 | 6,438 | 791 | 13,378 |
| CAR Insurance | 574 | 614 | 151 | 1,338 |
| **Operations:** | | | | |
| Project Completion | 1,435 | 1,534 | 377 | 3,346 |
| Licensor Fees, Catalyst & Chemicals | 2,452 | 0 | 0 | 2,452 |
| Start-Up/Commissioning | 2,295 | 2,454 | 604 | 5,354 |
| **Escalation:** | | | | |
| 4Q04 to 1Q06+33 mths | 14,401 | 16,919 | 4,467 | 35,788 |
| | | | | |
| **TOTALS** | 133,710 | 144,235 | 35,796 | 313,740 |

## Cost Reduction Opportunities

As indicated at the beginning of Task D factored estimates are based on models of previous projects with only a limited amount of engineering. GH/KBR has in prior projects identified that a decrease in capital cost is achievable through a structured value engineering effort. GH has identified the following cost areas where opportunities may be available to reduce capital cost:

- Escalation. Although steel prices have stabilized recently, bulks in general have been historically increasing at close to 20%. Negotiations may allow escalation to drop significantly
- The use of sea water cooling is assumed for the Damietta Port location resulting in a relatively high capital cost. If adequate fresh water was available this would lower the capital cost.
- Vendor pricing. Vendor phone budget quotes for a study such as this are generally higher than firm price bid figures. No equipment or bulk buy-down was included

- Methanol process information. The lack of information from One Synergy precludes an accurate estimate. With proper information from the licensor, both ISBL and OSBL equipment sizing can be better defined resulting in, potentially, a lower capital cost.
- The power generation system could be optimized and the option of purchasing power investigated.
- The nitrogen generator could be eliminated and replaced with purchased liquid nitrogen.
- Eliminating the vapor return line for ammonia loading will reduce cost.

### D.1.1 Telephone Quotations

Methanol Process Licensors proved reluctant to release process or cost data until process license fees are paid (at the EPC phase). Consequently, KBR was unable to prepare methanol technology equipment load sheets with sufficient detail to enable equipment cost enquiries to be prepared. Where telephone quotations could not be obtained for such process equipment, KBR relied on the commodity percentage split of the Echem estimate, provided by Aker Kvaerner Inc.

Telephone quotations were obtained for the KBR designed Utility equipment and Ammonia Process equipment where sufficient detail was available to generate equipment specifications. This included quotations for compressors, turbines, generators, methanol and ammonia loading arms, storage tanks, air separation unit, nitrogen wash unit, cooling towers, etc.

Table 3, 4 and 5 provide equipment cost (*as provided by vendors*) for the ISBL (Ammonia, Methanol) and OSBL equipment shown on the flow sheets.

TABLE 3 – AMMONIA ISBL EQUIPMENT COST

| Item | | Description | Cost MUS$ |
|---|---|---|---|
| MB | 102-B | Start-up Heater | 501 |
| MC | 105-C | MDEA Stripper Reboiler | 67 |
| MC | 107-C | MDEA Stripper Condenser | 63 |
| MC | 110-C | Lean Solution Cooler | 22 |
| MC | 112-C | Solution Interchanger | 27 |
| MC | 120-C | Ammonia Unitized Chiller | 714 |
| MC | 121-C | Converter Feed/Effluent Exchanger | 351 |
| MC | 150-C | Steam Superheater | 309 |
| MC | 123-C2A | Conv. Effluent Steam Generator | 297 |
| MC | 123-C2B | Conv. Effluent Steam Generator | 272 |
| MC | 124-C | Converter Effluent Cooler | 172 |
| MC | 127-C | Ammonia Refrigerant Condenser | 339 |
| MC | 128-C | Refrig. Comp. Third Stage Intercooler | 38 |
| MC | 130-C | Syn Gas Compressor Suction Chiller | 45 |

| TABLE 3 – AMMONIA ISBL EQUIPMENT COST | | | |
|---|---|---|---|
| | Item | Description | Cost MUS$ |
| MC | 130-CA | Syn Gas Compressor Suction Chiller | 45 |
| MC | 134-C | Syn Gas Circulator Kickback Cooler | 60 |
| MD | 105-D | NH3 Synthesis Converter | 4,493 |
| MD | 101-E | CO2 Absorber | 365 |
| MD | 102-E | CO2 Stripper | 806 |
| MD | 103-E | Water Wash Column | 266 |
| MD | 102-F | Absorber Overhd K..O Drum | 22 |
| MD | 104-F | Syn Gas Comp. Suction Drum | 45 |
| MD | 106-F | Ammonia Separator | 251 |
| MD | 107-F | Ammonia Letdown Drum | 34 |
| MD | 109-F | Ammonia Refrigerant Receiver | 57 |
| MD | 114-F | MDEA Storage Tank | 44 |
| MD | 115-F | MDEA Sump | 16 |
| MJ | 103-J | Synthesis Gas Circulator | 3,530 |
| MJ | 105-J | Ammonia Refrigerant Compressor | 4,150 |
| MJ | 107-JA,JB,JC | Solution Pumps | 345 |
| MJ | 110-J | MDEA Sump Pump | 9 |
| MJ | 111-J | MDEA Make-up Pump | 9 |
| MJ | 116-J / JA | Contact Cooler Circ. Pump | 120 |
| MJ | 124-J / JA | Cold Ammonia Product Pump | 50 |
| MJ | 195-J / JA | Wash Water Pump | 28 |
| ML | 102-L | MDEA Solution Filter | 5 |
| ML | 104-L | Nitrogen Wash Unit | 8,470 |
| ML | 105-L | Air Separation Unit | 18,243 |
| ML | 115-L | MDEA Sump Filter | 5 |

| TABLE 4 - METHANOL ISBL EQUIPMENT COST | | |
|---|---|---|
| ITEM NO. | DESCRIPTION | Cost |
| 101-B | Steam reformer Furnace | Aker –Kvaerner did not provided |
| 102-B | Stack | |
| 101-C | Reformer Effluent Steam Generator | |
| 102-C | Reformer Effluent BFW Heater | |
| 103-C | Reformer Effluent Water Cooler | |
| 104-C | Compressor Recycle Cooler | |
| 105-C | Reactor Feed/Effluent Interchanger | |
| 107-C | Topping Column reboiler | |
| 108-C | Topping Column Overhead Condenser | |
| 109-C | Refining Column Reboiler | |
| 110-C | Refining Column Overhead Condenser | |
| 111-C | Methanol Converter Effluent Water Cooler | |
| 101-DA/DB | Desulfurizers | |
| 102-D | Pre-Reformer | |
| 103-D | Methanol Converter | |
| 108-D | Hydrotreater | |
| 101-E | Topping Column | |
| 102-E | Refining Column | |
| 101-F | Reformer Steam Drum | |
| 103-F | Crude Methanol Separator | |
| 105-F | Synthesis Converter steam drum | |
| 101-J | Forced Draft Fan | |
| 101-JT | Steam Turbine for 101-J | |
| 102-J | Induced Draft Fan | |
| 102-JT | Turbine for 102-J | |
| 103-J | Synthesis Gas Compressor | |
| 103-JT | Turbine for 103-J | |
| 103-JTC | Surface Condenser | |
| 104-J | HP BFW Pump | |
| 104-JT | Turbine for 104-J | |
| 104-JA | Spare for 104-J | |
| 104-JAM | Motor for 104-JA | |
| 108-J | Loop circulator | |
| 108-JM | Motor for 108-J | |

| ITEM NO. | TABLE 5 – OSBL EQUIPMENT COST<br>DESCRIPTION | Cost M US$ |
|---|---|---|
| 901MB | Methanol/Ammonia Process Flare | 284 |
| 902MB | Methanol Storage Flare | 284 |
| 903MB | Ammonia Storage Flare | 284 |
| 901MCA/B/C | Fresh Water/Seawater Heat Exchangers | 1,500 |
| 925MC | Steam Condenser | 2,606 |
| 930MC | Deaerator Feedwater Heater | 45 |
| 901MD | Fresh Cooling Water Chemical Injection Pot | 10 |
| 902MD | Plant Air Receiver | 14 |
| 910MD | Deaerator | 240 |
| 910MF | Ammonia Storage Tank | 8,410 |
| 910MFRA/B | Ammonia Storage Refrigeration Package | 1,172 |
| 915MFA/B | Methanol Storage Tanks | 7,200 |
| 915MFRA/B | Methanol Storage Refrigeration Package | 446 |
| 916MF | Methanol Day Tank | 730 |
| 920MF | Desalinated Water Storage Tank | 148 |
| 925MF | Potable Water Storage Tank | 148 |
| 930MF | Fresh Cooling Water Expansion Tank | 31 |
| 961MF | Methanol/Ammonia Process Flare Knock Out Drum | 20 |
| 962MF | Methanol Storage Flare Knock Out Drum | 20 |
| 970MF | Wastewater Surge Tank | 148 |
| 901MJA/B | Seawater Pumps | 180 |
| 901MJA/B | Motors for Seawater Pumps | Incl |
| 910MJA/B | Desalinated Water Pumps | 22 |
| 910MJA/B | Motors for Desalinated Water Pumps | Incl |
| 912MJA/B | Potable Water Pumps | 14 |
| 912JA/B | Motors for Potable Water Pumps | Incl |
| 913MJA/B | Service Water Pumps | 14 |
| 913MJA/B | Motors for Service Water Pumps | Incl |
| 915MJA/B | Fire Water Pumps | 248 |
| 915MJA | Motor for Fire Water Pump | Incl |
| 915MJDE | Diesel Engine for Fire Water Pump | Incl |
| 916MJ | Fire Water Jockey Pump | 30 |
| 916MJA | Motor for Jockey Pump. | Incl |
| 920MJA/B | Boiler Feedwater Supply Pumps | 75 |
| 920MJA/B | Motors for Boiler Feedwater Supply Pumps | Incl |
| 923MJA/B | Steam Condensate Pumps | 40 |
| 923MJA/B | Motors for Steam Condensate Pumps | Incl |

| TABLE 5 – OSBL EQUIPMENT COST | | |
|---|---|---|
| ITEM NO. | DESCRIPTION | Cost M US$ |
| 925MJA/B | BFW Pumps for Package Boiler | 452 |
| 925MJA/B | Motors for BFW Pumps for Package Boiler | Incl |
| 926MJA/B | BFW Pumps for HRSG | 452 |
| 926MJA/B | Motors for BFW Pumps for HRSG | Incl |
| 930MJA/B/C/D/E | Seawater Circulation Pumps | 2,065 |
| 930MJA/B/C/D/E | Motors for Seawater Circulation Pump | Incl |
| 931MJA/B/C/D/E | Fresh Cooling Water Circulation Pumps | 1400 |
| 931MJA/B/C/D/E | Motors for Fresh Cooling Water Circulation Pumps | Incl |
| 940MJA/B | Methanol Loading Pumps | 922 |
| 940MJA/B | Motors for Methanol Loading Pumps | Incl |
| 945MJA/B | Ammonia Loading Pumps | 424 |
| 945MJA/B | Motors for Ammonia Loading Pumps | Incl |
| 940MJA/B | Wastewater Pumps | 50 |
| 940MJA/B | Motors for Wastewater Pumps | Incl |
| 950MJA/B | Gas Turbine Generator Set | 22,414 |
| 951MJA/B | Steam Turbine Generator Set | 9,122 |
| 955MJ | Emergency Generator | 650 |
| 901ML | Plant Air Compressor Package | 200 |
| 901MLM | Motor for Plant Air Compressor Package | Incl |
| 903ML | Instrument Air Dryer Package | 54 |
| 905ML | Nitrogen Generator | 1,868 |
| 910ML | Desalination Unit | 10,696 |
| 930MLA/B/C | Methanol Loading Arms | 677 |
| 935MLA/B | Ammonia Loading Arm | 432 |
| 901MU | Chlorinator Package for Intake Basin | 350 |
| 902MU | Chlorinator Package for Potable Water | 25 |
| 903MU | Chlorinator Package Cooling Tower | Incl |
| 907MU | Seawater Cooling Tower | 5,752 |
| 910MUA/B | Package Boilers | 6,120 |
| 921MUA/B | HRSG's | 2,800 |
| 930MU | Condensate Polisher Unit | 750 |

### D.1.2 Detailed Estimate

The Front End Engineering and Design (FEED) Estimate, the Detailed Design, Engineering and Procurement Estimate and the Construction Management Services Estimate, *including startup* and commissioning, (CM) are shown in Table 6. They are extracted from the Overall Cost Estimate shown in Tables 1 and 2.

### D.1.3 Factored Estimate

#### D.1.3.1 1,200 mtpd Ammonia and Common OSBL

The estimate is factored from telephone quotations for major equipment, where such data was available, and from equipment and previous project cost data of similar nature. Forward cost escalation was included in Table 1 which moved the cost from the date of the estimate data collection (fourth quarter 2004) to the proposed date of EPC award (first quarter 2006) and through the mid point of the EPC contact duration of 33 months. The estimate includes the cost of the common ammonia/methanol utilities and offsites. Granherne prepared estimates for the utilities and offsites from telephone quotations, quotations for similar equipment and from statistical data from similar plants. The accuracy of this estimate is considered to be in the region of +25% to -15%.

#### D.1.3.2 3,000 mtpd Methanol Process Unit Only

Without licensing agreements, Process Licensors would not release process or engineering data to enable KBR to prepare mechanical load sheets for the methanol process unit. Consequently, telephone quotations for budget equipment prices for the methanol process plant could not be prepared. To work around this problem, the estimate data for the methanol process unit is based upon the Echem estimate summary included in the S.H. Lucas and Associates scoping document which was attached to the RFP. This estimate was reviewed by KBR and compared to Chem Systems published methanol plant TIC cost data. It was also reviewed by Aker Kvaerner Inc. who confirmed that the estimate was of the correct order of magnitude. Aker Kvaerner Inc. has recently been involved in several methanol projects and proposals and was able to offer a percentage commodity break-down of the assessed TIC cost. The methanol process unit cost was stripped from the ISBL/OSBL cost, and commodity percentages were applied.

Where provided, costs were inclusive of process, utilities and offsites, GH used their best judgment to segregate the process unit CAPEX costs.

GH adjusted the methanol process plant TIC to align with non-process related current cost information, such as construction and shipping costs, spare parts, insurance, project completion costs, commissioning and forward escalation.

KBR engineered the common methanol/ammonia utilities and offsites and prepared cost estimates based upon telephone quotations, data from similar projects and factoring.

#### D.1.3.3 Site Preparation and Marine Installations

The Halcrow Group, ECMA and KBR undertook engineering studies and provided engineering and cost data input to prepare the estimate for the marine terminal and the sea water intake basin. The rate based estimate was based upon current (4Q04) subcontractor rates for the respective work. Allowances for mechanical equipment, such as loading arms, in the Halcrow estimate have been stripped out to leave civil work scope only. These commodity costs have been included in the utility summaries.

## D.2 SUMMARIZED COST ESTIMATES

Tables 1 and 2 show the summarized cost estimates for the integrated methanol, ammonia with common OSBL, and the marine/site preparation for Phase I of the project.

### D.2.1 Total Installed Cost Estimate

Tables 1 and 2 show the total installed cost (TIC) estimates for the process units, utilities and offsite equipment and the marine/site preparation.

### D.2.2 Estimate Breakdown

The estimate tables (Tables 1 and 2) segregate the costs for each process unit. The utility and offsite system breakdown related to each process unit is also shown along with the estimated cost for the site preparation and the dedicated marine terminal.

### D.2.3 FEED, DDEP, and CM Services

These services, along with the commissioning and start-up services are shown in Table 6.

**Table 6 – FEED, Detailed Design and Engineering and Procurement Services (DDEP) and Construction Management (CM) Services**

| Table 6 – FEED, DDEP and CM Services – USD x 1000 | | | |
|---|---|---|---|
| ITEM | 1,200 mtpd Ammonia and 50% of Shared Utilities/Offsites including 50% of Marine Installations 4Q04 | 3,000 mtpd Methanol and 50% of Shared Utilities/Offsites including 50% of Maine Installations 4Q04 | TOTAL |
| **FEED:** | | | |
| **Contract Management:** | | | |
| Project Management, Administration, Cost, Estimating and Planning | 1,068 | 1,449 | **2,517** |
| **Engineering:** | | | |
| Design Engineering and Field Support | 3,497 | 4,745 | **8,242** |
| **Procurement:** | | | |
| Purchasing, Inspection, and Document Management | 423 | 574 | **997** |
| **Construction & Plant Services:** | | | |
| Construction | 291 | 395 | **686** |
| Plant Services | 152 | 206 | **358** |
| **Others:** | | | |
| Financial, Legal, EI&S etc. | 121 | 165 | **286** |
| **Process Licensor:** | | | |
| Commitment for Process Licensor Fees to prepare Basic Process package including Chemicals and | 4,820 | 12,310 | **17,130** |

## Table 6 – FEED, DDEP and CM Services – USD x 1000

| ITEM | 1,200 mtpd Ammonia and 50% of Shared Utilities/Offsites including 50% of Marine Installations 4Q04 | 3,000 mtpd Methanol and 50% of Shared Utilities/Offsites including 50% of Maine Installations 4Q04 | TOTAL |
|---|---|---|---|
| Catalysts | | | |
| **Total FEED** | 10,373 | 19,845 | **30,218** |
| **DDEP:** | | | |
| **Contract Management:** | | | |
| Project Management, Administration, Cost, Estimating and Planning | 2,237 | 3,035 | **4,484** |
| **Engineering:** | | | |
| Design Engineering and Field Support | 13,131 | 17,817 | **22,563** |
| **Procurement:** | | | |
| Purchasing, Inspection, and Document Management | 2,572 | 3,490 | **4,064** |
| **Construction & Plant Services:** | | | |
| Construction | | | |
| Plant Services | 1,165 | 1,581 | **1,977** |
| **Others:** | 860 | 1,166 | **1,372** |
| Legal, Financial, EIT and others. | 542 | 735 | **900** |
| **Total DDEP** | 36,360 | 27,825 | **35,360** |
| **Total CM** | 19,822 | 25,428 | **45,250** |
| **Total Services including FEED** | 56,182 | 53,253 | **109,438** |

### D.2.4 License, Catalysts and Chemicals

These costs are identified in Tables 1, 2, and 6.

### D.2.5 Currency Breakdown

Tables 7and 8 provide an estimate of currency breakdown in equivalent US Dollars. This table reflects the proposed Financing Plan and the limitations in use/flexibility that some of lenders are likely to impose.

**Table 7 – Currency Distribution – Methanol**

| Description | Table 7 – Currency Split - Integrated 3,000 mtpd Methanol, and 50% Offsites/Utilities/Marine<br>Sourced from USA | Sourced Elsewhere | Sourced from Europe | Sourced from U.A.E (Egypt) | TOTAL |
|---|---|---|---|---|---|
| **Home Office Services:** | | | | | |
| USA | 23,152 | 5,788 | | | 28,940 |
| Non USA high Value Engineering Centers | 5,193 | 1,298 | | | 6,491 |
| **Equipment:** | | | | | |
| Furnaces | 4,740 | | 1,185 | | 5,925 |
| Exchangers | 10,140 | | 10,140 | | 20,281 |
| Columns/Converter | 19,668 | | 19,668 | | 39,337 |
| Tanks | 86 | | 10 | | 96 |
| Rotating Machinery | 12,694 | | 8,462 | | 21,156 |
| Mechanical Equip. | 16,009 | | 4,002 | | 20,011 |
| Packaged Equip. | 3,257 | | 4,886 | | 8,143 |
| Fire & Safety | 0 | | | | 0 |
| Licensor Fees, Catalyst & Chemicals | | | | | 14,710 |
| **Bulk Materials:** | | | | | |
| Site Prep/Piling/Civils | | | | 8,314 | 8,314 |
| Electrical/Controls | 7,508 | | 7,508 | 3,754 | 18,769 |
| Piping | 5,261 | | 18,414 | 2,631 | 26,305 |
| Buildings | 285 | | | 5,408 | 5,692 |
| Paint/Insul/Grout | 390 | | 390 | 1,170 | 1,950 |
| **Matl. Related:** | | | | | |
| Spares | 2,343 | | 3,222 | 293 | 5,858 |

| Description | Table 4 – Currency Split - Integrated 3,000 mtpd Methanol, and 50% Offsites/Utilities/Marine<br>Sourced from USA | Sourced Elsewhere | Sourced from Europe | Sourced from U.A.E (Egypt) | TOTAL |
|---|---|---|---|---|---|
| Shipping Insurance Prep & Freight | 11,850 | | 16,294 | 1,481 | 29,626 |
| VSMs | 178 | | 119 | | 297 |
| **Subcontracts:** | | | | | 0 |
| Mechanical | 519 | 519 | 260 | 3,893 | 5,191 |
| Tanks | 6,758 | | | 2,253 | 9,011 |
| Marine | 2,466 | | 1,644 | 12,329 | 16,439 |
| Civils/Structural | 1,386 | 1,386 | | 11,086 | 13,857 |
| Electrical | | | | | 0 |
| Paint/Insulation | 147 | 147 | | 2,647 | 2,942 |
| **Construction Services:** | | | | | |
| Subcontract Labor | | | | 46,737 | 46,737 |
| Management | 10,754 | 3,585 | | 3,585 | 17,924 |
| CAR Insurance | | | | 1,843 | 1,843 |
| **Operations:** | | | | | 0 |
| Project Completion | 3,686 | 230 | | 691 | 4,607 |
| Start-Up/Commissioning | 4,423 | 1,474 | | 1,474 | 7,372 |
| **Escalation:** | | | | | |
| 4Q04 to 1Q06+33 mths | 30,106 | 10,035 | 5,018 | 5,018 | 50,176 |
| **TOTALS** | 182,999 | 24,463 | 101,221 | 114,606 | 438,000 |

## Table 8 – Currency Distribution - Ammonia

| Description | Table 8 – Currency Split - 1,200 mtpd Ammonia Process Unit and Offsites/Utilities<br>*Equivalent USD x 1000*<br>Sourced from USA | Sourced Elsewhere | Sourced from Europe | Sourced from U.A.E (Egypt) | TOTAL |
|---|---|---|---|---|---|
| **Home Office Services:** | | | | | |
| USA | 16,020 | 4,005 | | | 20,025 |
| Other | 3,595 | 899 | | | 4,493 |
| **Equipment:** | | | | | 0 |
| Furnaces | 560 | | 140 | | 700 |
| Exchangers | 2,346 | | 2,346 | | 4,692 |
| Columns/Converter | 3,239 | | 3,239 | | 6,479 |
| Tanks | 548 | | 61 | | 609 |
| Rotating Machinery | 11,354 | | 7,569 | | 18,923 |
| Mechanical Equip. | 14,980 | | 3,745 | | 18,724 |
| Packaged Equip. | 14,953 | | 22,429 | | 37,382 |
| Fire & Safety | 0 | | | | 0 |
| **Bulk Materials:** | | | | | |
| *Site Prep/Piling/Civils* | | | | 2,645 | 2,645 |
| Electrical/Controls | 5,458 | | 5,458 | 2,729 | 13,645 |
| Piping | 2,627 | | 9,195 | 1,314 | 13,136 |
| Buildings | 74 | | | 1,406 | 1,480 |
| Paint/Insul/Grout | 9 | | 9 | 27 | 46 |
| **Matl. Related:** | | | | | |
| Spares | 2,148 | | 2,954 | 269 | 5,370 |
| Shipping Insurance Prep & Freight | 7,815 | | 10,745 | 977 | 19,536 |
| VSMs | 550 | | 366 | | 916 |
| **Subcontracts:** | | | | | |
| Mechanical | 309 | 309 | 154 | 2,316 | 3,088 |
| Tanks | 6,758 | | | 2,253 | 9,011 |
| Marine | 2,466 | | 1,644 | 12,330 | 16,439 |
| Civils/Structural | 1,490 | 1,490 | | 11,920 | 14,900 |
| *Electrical* | | | | | 0 |
| Paint/Insulation | 248 | 248 | | 4,466 | 4,962 |

| Description | Table 8 – Currency Split - 1,200 mtpd Ammonia Process Unit and Offsites/Utilities<br>Equivalent USD x 1000<br>Sourced from USA | Sourced Elsewhere | Sourced from Europe | Sourced from U.A.E (Egypt) | TOTAL |
|---|---|---|---|---|---|
| **Construction Services:** | | | | | |
| Subcontract Labor | | | | 34,885 | 34,885 |
| Management | 8,027 | 2,676 | | 2,676 | 13,378 |
| CAR Insurance | | | | 1,338 | 1,338 |
| **Operations:** | | | | | |
| Project Completion | 2,677 | 167 | | 502 | 3,346 |
| Licensor Fees, Catalyst & Chemicals | 2,452 | | | | 2,452 |
| Start-Up/Commissioning | 3,212 | 1,071 | | 1,071 | 5,354 |
| **Escalation:** | | | | | |
| 4Q04 to 1Q06+33 mths | 21,473 | 7,158 | 3,579 | 3,579 | 35,788 |
| **Contingency** | | | | | |
| **TOTALS** | 135,385 | 18,022 | 73,634 | 86,700 | 313,740 |

## D.2.6 Utility Costs

### D.2.6.1 Natural Gas

Natural gas is supplied to the production complex as feedstock and as fuel gas for the process. This gas is derived from offshore gas reservoirs in the Mediterranean Sea and distributed within Egypt by the Egyptian Natural Gas Holding Company (EGAS). Costs of natural gas have been advised by EGAS as being within the range of $0.75 to $1.25 per MMBTU, the detailed mechanism for the pricing to be concluded in the Gas Sales and Purchase Agreement (Egyptian Natural Gas Holding Company letter to ECHEM dated April 29, 2004).

Echem has suggested that for the purpose of this Report, the following gas pricing should be used:

*Years 1 thru 5* *$1.00 MMBTU Base price*

*6 thru10* *Base price plus a premium of 0.01 $ per 1 $ increase in product price, with a ceiling of $1.25 MMBTU*

*11 thru 15 Base price plus a premium of 0.01 $ per 1 $ increase in product price, with a ceiling of $1.50 MMBTU*

*16 thru 20 Base price plus a premium of 0.01 $ per 1 $ increase in product price, with a ceiling of $2.00 MMBTU*

*21 thru 25 Base price plus a premium of 0.01 $ per 1 $ increase in product price, with no ceiling*

D.2.6.2 Other Utilities

Water, steam, power, and other utilities are produced within the production complex. Such costs are shown on the attached tables that are used in the calculation of Operating Cost Estimates (OPEX).

D.2.6.2.1 Methanol Production

**Methanol Plant Production Cost Estimate**
**Nameplate Capacity: 3,000 MT of Methanol**

| | | | Methanol Plant | |
|---|---|---|---|---|
| **Item** | **Units** | **US $ Cost/Unit** | **Usage/MT** | **$/MT** |
| Natural Gas (Note 1) | MMBtu(HHV) | 1.00 | 43.6 | 43.58 |
| Purge Gas Export to NH3 Unit | MMBtu(HHV) | 1.00 | 14.2 | (14.16) |
| Waste Gas Import from NH3 Unit | MMBtu(HHV) | 1.00 | 4.2 | 4.22 |
| Electricity (Note 2) | kWh | 0.013 | 40 | 0.52 |
| Sea Water Circulation | M3 | 0.02 | 144 | 2.88 |
| Fresh Water Circulation | M3 | 0.01 | 81 | 0.81 |
| Steam Export,MP | MT | 4.00 | 0.000 | 0.00 |
| Demin Water Makeup | M3 (Note 3) | 1.3 | 1.1 | 1.43 |
| Catalyst& Chemicals | | | | 2.27 |
| **Feed+utility costs** | | | | **41.54** |
| Operating Labor | | | | 1.54 |
| Maintenance - Parts & Labor | 1.5% of TIC | | | 7.00 |
| Taxes & Ins | 0.5% of TIC | | | 2.33 |
| Direct OH | 45% of Operating labor | | | 0.69 |
| General Plant OH | 30% of Direct Fixed Cost | | | 3.47 |
| **Total Fixed Cost** | | | | **15.04** |
| **Total Production Cost** | | | | **56.58** |

**Notes:**
1) Natural Gas consumption for Methanol ISBL and Package Boilers
2) Electrical cost is for self generated power and includes fuel + maintenance
3) Demin.Water makeup is from Desalination Plant

### D.2.6.2.2 Ammonia Production Costs

**Ammonia Plant Production Cost Estimate**
**Nameplate Capacity: 1,200 MT of Ammonia**

| Item | | | Ammonia Plant | |
|---|---|---|---|---|
| | Units | US $ Cost/Unit | Usage/MT | $/MT |
| Purge Gas From Methanol Plant | MMBtu(HHV) | 1.00 | 35.4 | 35.41 |
| Waste Gas Export to Methanol Plant | MMBtu(HHV) | 1.00 | 10.5 | (10.55) |
| Electricity (Note 1) | kWh | 0.013 | 467 | 6.07 |
| Sea Water Circulation | M3 | 0.02 | 130 | 2.60 |
| Fresh Water Circulation | M3 | 0.01 | 81 | 0.81 |
| Steam Export, MP | MT | 4.00 | 0.000 | 0.00 |
| BFW Makeup | M3 | 1.3 | 0.34 | 0.44 |
| Catalyst& Chemicals | | | | 1.50 |
| **Feed+utility costs** | | | | **36.28** |
| Operating Labor | | | | 1.89 |
| Maintenance - Parts & Labor | 1.5% of TIC | | | 11.37 |
| Taxes & Ins | 0.5% of TIC | | | 3.79 |
| Direct OH | 45% of Operating labor | | | 0.85 |
| General Plant OH | 30% of Direct Fixed Cost | | | 5.37 |
| **Total Fixed Cost** | | | | **23.27** |
| **Total Production Cost** | | | | **59.55** |

**Notes:**
1) Electrical cost is for self generated power and includes fuel + maintenance

### D.2.7 Owner's Capitalized Costs

An estimate of Owner's Capitalized Costs is as follows:

| US Dollars x 1000 | | |
|---|---|---|
| **ITEM** | **Ammonia** | **Methanol** |
| **Catalyst and Chemicals (Initial Fill)** | **Included in TIC CAPEX** | **Included in TIC CAPEX** |
| **Annual Land Rental** | **$2,971,309/2 =** | **$2,971,309/2 =** |
| **$2.80/m$^2$ x 1,061,182** | **$1.48** | **$1.48** |
| **Owners Staffing Including Recruitment and Training** | **$1.0** | **$1.0** |
| **Laboratory Equipment, Furniture etc.** | **$0.50** | **$0.70** |
| **Maintenance Equipment and Tools** | **$0.90** | **$1.25** |
| **Communication Equipment, Computers and Office Furniture** | **$1.00** | **$0.50** |
| **Mobile Equipment** | **$1.00** | **$0.50** |
| **TOTAL** | **$5.88** | **$5.43** |

### D.2.8 Annual Operating Costs (OPEX)

The annual operating costs (OPEX) include the costs of chemicals and catalysts, maintenance costs, spare parts, general and administrative costs and operations labor. It does not include the port charges and shipping costs associated with the export of the product.

#### D.2.8.1 Chemicals and Catalysts

| | |
|---|---|
| 3,000 mtpd Methanol | $2.27 per tonne product |
| 1,200 mtpd Ammonia | $1.50 per tonne product |

#### D.2.8.2 Maintenance Costs

Maintenance costs are generally derived from statistical data and vary between 1.0 – 2.0 of the TIC, adjusted for local conditions. These are approximated as follows:

| | |
|---|---|
| 3,000 mtpd Methanol | $7.44 per tonne product |
| 1,200 mtpd Ammonia | $14.33 per tonne product |
| Marine Installations | Included in Land Rental |

Operating costs for the port handling of export product is not included.

D.2.8.3 Spare Parts

The CAPEX estimate includes the cost of "capital" spare parts such as compressor and turbine rotors, spare exchanger tube bundles, etc.) as well as the general spare parts likely to be used during the start-up and commissioning phases. The annual consumption of spare parts is usually a statistical percentage of the equipment costs; this being between 1.5 – 2.0 percent and very much depends on the maintenance program.

| | |
|---|---|
| 3,000 mtpd Methanol and Utilities | $ 1,513,000 |
| 1,200 mtpd Ammonia and Utilities | $ 2,112,000 |

D.2.8.4 General and Administrative Costs

These costs will vary regionally, depending upon the general practice in the operating plant/country.

D.2.8.5 Operations Labor

The following table outlines the estimated total labor requirement by phase. It is assumed that all staffing and labor will be by local nationals.

## ECHEM INTEGRATED UNITS STAFFING REQUIREMENTS
## PERSONNEL POSITION DESCRIPTIONS

| | PHASE 1 | | | PHASE 2 | | | PHASE 3 | | | ALL PHASES | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total Req'd | Rate | Total | Total Req'd | Rate | Total | Total Req'd | Rate | Total | Total Req'd | Total |
| Board of Directors | | | | | | | | | | | |
| *Managing Director* | 1 | | 0 | 0 | | 0 | 0 | | 0 | 1 | 0 |
| Managing Director's Office Staff | 2 | | 0 | 0 | | 0 | 0 | | 0 | 2 | 0 |
| Plant General Manager | 1 | | 0 | 0 | | 0 | 0 | | 0 | 1 | 0 |
| **Safety & Security Manager** | 1 | | 0 | 0 | | 0 | 0 | | 0 | 1 | 0 |
| Safety & Security Manager's Office Staff | 2 | | 0 | 0 | | 0 | 0 | | 0 | 2 | 0 |
| *Plant Security Services Superintendent* | 1 | | 0 | 0 | | 0 | 0 | | 0 | 1 | 0 |
| Plant Security Services Clerk (Badge Preparation etc.) | 2 | | 0 | 0 | | 0 | 0 | | 0 | 2 | 0 |
| Security Officers (1 x 4) | 4 | | 0 | 0 | | 0 | 0 | | 0 | 4 | 0 |
| Security Gate Guards (5 x 4) | 20 | | 0 | 0 | | 0 | 0 | | 0 | 20 | 0 |
| Security Patrol Guards (4 x 4) | 16 | | 0 | 0 | | 0 | 0 | | 0 | 16 | 0 |
| Health, Safety and Environmental Services Superintendent | 1 | | 0 | 0 | | 0 | 0 | | 0 | 1 | 0 |
| Safety and Environmental Supervisor | 1 | | 0 | 0 | | 0 | 0 | | 0 | 1 | 0 |
| *Plant Safety HSE Trainers (3)* | 2 | | 0 | 1 | | 0 | 0 | | 0 | 3 | 0 |
| Plant Senior Daytime Safety and Environmental Inspectors (2) | 1 | | 0 | 1 | | 0 | 0 | | 0 | 2 | 0 |
| Process Area Safety and Environmental Inspectors (2 x 4) | 4 | | 0 | 4 | | 0 | 0 | | 0 | 8 | 0 |
| Utilities Area Safety and Environmental Inspectors (1 x 4) | 4 | | 0 | 0 | | 0 | 0 | | 0 | 4 | 0 |
| Offsites Area Safety and Environmental Inspectors (1 x 4) | 4 | | 0 | 0 | | 0 | 0 | | 0 | 4 | 0 |
| Emergency Hazards Control Supervisor | 1 | | 0 | 0 | | 0 | 0 | | 0 | 1 | 0 |
| Fire Brigade Personnel (4 x 4) | 6 | | 0 | 6 | | 0 | 4 | | 0 | 16 | 0 |
| Ambulance Drivers (1 x 4) | 4 | | 0 | 0 | | 0 | 0 | | 0 | 4 | 0 |
| **Assistant General Manager - Technical Services** | 1 | | 0 | 0 | | 0 | 0 | | 0 | 1 | 0 |
| Assistant General Manager's Office Staff | 2 | | 0 | 0 | | 0 | 0 | | 0 | 2 | 0 |
| **Operations Manager** | 1 | | 0 | 0 | | 0 | 0 | | 0 | 1 | 0 |
| Operation Manager's Office Staff | 2 | | 0 | 0 | | 0 | 0 | | 0 | 2 | 0 |
| Assistant Operations Manager | 1 | | 0 | 0 | | 0 | 0 | | 0 | 1 | 0 |
| Complex Shift Superintendents (1 x 4) | 4 | | 0 | 0 | | 0 | 0 | | 0 | 4 | 0 |
| *Integrated Process Units Superintendent* | 1 | | 0 | 0 | | 0 | 0 | | 0 | 1 | 0 |
| Integrated Unit-1 Shift Supevisor 1 (1 x 4) | 4 | | 0 | 0 | | 0 | 0 | | 0 | 4 | 0 |
| Integrated Unit-1 DCS Panel Operator (1 x 4) | 8 | | 0 | 0 | | 0 | 0 | | 0 | 8 | 0 |
| Integrated Unit-1 - Field Operators (5 x 4) | 20 | | 0 | 0 | | 0 | 0 | | 0 | 20 | 0 |
| Integrated Unit-1 Vacation / Shift Relief Staff | 2 | | 0 | 0 | | 0 | 0 | | 0 | 2 | 0 |
| Integrated Unit-2 Shift Supevisor 1 (1 x 4) | 0 | | 0 | 4 | | 0 | 0 | | 0 | 4 | 0 |
| Integrated Unit-2 DCS Panel Operator (1 x 4) | 0 | | 0 | 8 | | 0 | 0 | | 0 | 8 | 0 |
| Integrated Unit-2 - Field Operators (5 x 4) | 0 | | 0 | 20 | | 0 | 0 | | 0 | 20 | 0 |
| Integrated Unit-2 Vacation / Shift Relief Staff | 0 | | 0 | 2 | | 0 | 0 | | 0 | 2 | 0 |

| ECHEM INTEGRATED UNITS STAFFING REQUIREMENTS<br>PERSONNEL POSITION DESCRIPTIONS | PHASE 1 | | | PHASE 2 | | | PHASE 3 | | | ALL PHASES | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total Req'd | Rate | Total | Total Req'd | Rate | Total | Total Req'd | Rate | Total | Total Req'd | Total |
| integrated Unit-3 Shift Supevisor 1 (1 x 4) | 0 | | 0 | 0 | | 0 | 4 | | 0 | 4 | 0 |
| Integrated Unit-2 DCS Panel Operator (1 x 4) | 0 | | 0 | 0 | | 0 | 8 | | 0 | 8 | 0 |
| Integrated Unit-3 - Field Operators (5 x 4) | 0 | | 0 | 0 | | 0 | 20 | | 0 | 20 | 0 |
| Integrated Unit-3 Vacation / Shift Relief Staff | 0 | | 0 | 0 | | 0 | 2 | | 0 | 2 | 0 |
| | | | | | | | | | | | |
| Utilities / Offsites / Marine Area Superintendent | 1 | | 0 | 0 | | 0 | 0 | | 0 | 1 | 0 |
| | | | | | | | | | | | |
| Utilities Area Shift Supervisors (1 x 4) | 4 | | 0 | 0 | | 0 | 0 | | 0 | 4 | 0 |
| Utilities Area DCS Panel Operators (1 x 4) | 4 | | 0 | 4 | | 0 | 0 | | 0 | 8 | 0 |
| Power Generation Area Field Operators (1 x 4) | 4 | | 0 | 4 | | 0 | 0 | | 0 | 8 | 0 |
| Water, Inst Air, Steam, Nitrogen Systems Field Oper.(1 x 4) | 4 | | 0 | 4 | | 0 | 0 | | 0 | 8 | 0 |
| Utilities Area Vacation / Shift Relief Staff | 1 | | 0 | 1 | | 0 | 0 | | 0 | 2 | 0 |
| | | | | | | | | | | | |
| Offsites / Marine Area Shift Supervisors (1 x 4) | 4 | | 0 | 0 | | 0 | 0 | | 0 | 4 | 0 |
| Offsites Area DCS Panel Operators (1 x 4) | 4 | | 0 | 4 | | 0 | 0 | | 0 | 8 | 0 |
| Product Loading, Waste Treatment, Flares Sys.Field Oper. (1 x 4) | 4 | | 0 | 4 | | 0 | 0 | | 0 | 8 | 0 |
| Product Storage (Tank Farm) Area Field Oper.(1 x 4) | 4 | | 0 | 4 | | 0 | 0 | | 0 | 8 | 0 |
| Offsite Area Vacation / Shift Relief Staff | 2 | | 0 | 1 | | 0 | 0 | | 0 | 3 | 0 |
| | | | | | | | | | | | |
| Production Planning Superintendent | 1 | | 0 | 0 | | 0 | 0 | | 0 | 1 | 0 |
| Economics and Scheduling Engineers (1) | 1 | | 0 | 0 | | 0 | 0 | | 0 | 1 | 0 |
| Production Planning Coordinators | 1 | | 0 | 1 | | 0 | 0 | | 0 | 2 | 0 |
| | | | | | | | | | | | |
| Maintenance Manager | 1 | | 0 | 0 | | 0 | 0 | | 0 | 1 | 0 |
| Maintenance Manager's Office Staff | 2 | | 0 | | | 0 | | | 0 | 2 | 0 |
| | | | | | | | | | | | |
| Maint. Shift / General Craft Supervisor | 1 | | 0 | 0 | | 0 | 0 | | 0 | 1 | 0 |
| Process Area Shift Instrument Tech. (1 x 4) | 4 | | 0 | 0 | | 0 | 0 | | 0 | 4 | 0 |
| Utilities / Offsites Area Shift Instrument Tech. (1 x 4) | 4 | | 0 | 0 | | 0 | 0 | | 0 | 4 | 0 |
| Plant Shift Electrical Tech.(1 x 4) | 4 | | 0 | 0 | | 0 | 0 | | 0 | 4 | 0 |
| Plant Shift Piping Mechanics (3 x 4) | 8 | | 0 | 4 | | 0 | 0 | | 0 | 12 | 0 |
| Plant Shift Maint. Tool Room Techs. (1 x 4) | 4 | | 0 | 0 | | 0 | 0 | | 0 | 4 | 0 |
| Daytime Workers - Plumbing Craftsmen | 2 | | 0 | 0 | | 0 | 0 | | 0 | 2 | 0 |
| Daytime Workers - Masonry Craftsmen | 2 | | 0 | 0 | | 0 | 0 | | 0 | 2 | 0 |
| Daytime Workers - Carpentery Craftsmen | 2 | | 0 | 0 | | 0 | 0 | | 0 | 2 | 0 |
| Daytime Workers - Painting / Insulation Craftsmen | 4 | | 0 | 0 | | 0 | 0 | | 0 | 4 | 0 |
| Daytime Workers - Scaffolding Craftsmen | 8 | | 0 | 0 | | 0 | 0 | | 0 | 8 | 0 |
| Vacation / Shift Relief Staff | 8 | | 0 | 0 | | 0 | 0 | | 0 | 8 | 0 |
| | | | | | | | | | | | |
| Mechanical Systems Superintendent | 1 | | 0 | 0 | | 0 | 0 | | 0 | 1 | 0 |
| Rotating Equipment Supervisor | 1 | | 0 | 0 | | 0 | 0 | | 0 | 1 | 0 |
| Power Generation System Specialist | 1 | | 0 | 0 | | 0 | 0 | | 0 | 1 | 0 |
| Gas Turbines Specialist | 1 | | 0 | 0 | | 0 | 0 | | 0 | 1 | 0 |
| Process Pumps, Compressors Specialist | 1 | | 0 | 0 | | 0 | 0 | | 0 | 1 | 0 |
| Millwrights | 1 | | 0 | 1 | | 0 | 0 | | 0 | 2 | 0 |
| Machinists | 1 | | 0 | 1 | | 0 | 0 | | 0 | 2 | 0 |
| Lubrication Technicians | 1 | | 0 | 1 | | 0 | 1 | | 0 | 3 | 0 |
| Helpers | 2 | | 0 | 2 | | 0 | 0 | | 0 | 4 | 0 |

## ECHEM INTEGRATED UNITS STAFFING REQUIREMENTS
## PERSONNEL POSITION DESCRIPTIONS

| | PHASE 1 | | | PHASE 2 | | | PHASE 3 | | | ALL PHASES | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total Req'd | Rate | Total | Total Req'd | Rate | Total | Total Req'd | Rate | Total | Total Req'd | Total |
| Static / Piping Equipment Supervisor | 1 | | 0 | 0 | | 0 | 0 | | 0 | 1 | 0 |
| Pipe Fitters / Boiler-Makers | 2 | | 0 | 2 | | 0 | 0 | | 0 | 4 | 0 |
| Welders (General, Stainless Steel, Aluminum) | 1 | | 0 | 1 | | 0 | 0 | | 0 | 2 | 0 |
| Helpers | 2 | | 0 | 2 | | 0 | 2 | | 0 | 6 | 0 |
| | | | | | | | | | | | |
| Instruments/Electrical Maintenance Superintendent | 1 | | 0 | 0 | | 0 | 0 | | 0 | 1 | 0 |
| *Instrumentation Systems Supervisor* | 1 | | 0 | 0 | | 0 | 0 | | 0 | 1 | 0 |
| Integrated Units Day Shift Inst. Techs. (2) | 1 | | 0 | 1 | | 0 | 0 | | 0 | 2 | 0 |
| *Utilities Area Day Shift Inst. Techs. (2)* | 1 | | 0 | 1 | | 0 | 0 | | 0 | 2 | 0 |
| Offsite / Marine Area Day Shift Inst. Techs. (2) | 1 | | 0 | 0 | | 0 | 0 | | 0 | 1 | 0 |
| *Instrument Shop Control / Relief Valve Techs. (2)* | 1 | | 0 | 1 | | 0 | 0 | | 0 | 2 | 0 |
| Instrument Shop Electronics Equipment Techs. (2) | 2 | | 0 | 0 | | 0 | 0 | | 0 | 2 | 0 |
| *Instrument Shop Analyzer Technicians (1)* | 1 | | 0 | 0 | | 0 | 0 | | 0 | 1 | 0 |
| DCS System Specialist | 1 | | 0 | 0 | | 0 | 0 | | 0 | 1 | 0 |
| *DCS System Technicians* | 2 | | 0 | 0 | | 0 | 0 | | 0 | 2 | 0 |
| | | | | | | | | | | | |
| *Electrical Systems Supervisor* | 1 | | 0 | 0 | | 0 | 0 | | 0 | 1 | 0 |
| Day Shift Electrical Technicians (2) | 1 | | 0 | 1 | | 0 | 0 | | 0 | 2 | 0 |
| *Electronic Equipment Repair Techs. (2)* | 2 | | 0 | 0 | | 0 | 0 | | 0 | 2 | 0 |
| Electrical Shop High/Low Voltage Equipment Techs. | 1 | | 0 | 0 | | 0 | 0 | | 0 | 1 | 0 |
| *Radio / Communications Equipment Repair Techs. (2)* | 2 | | 0 | 0 | | 0 | 0 | | 0 | 2 | 0 |
| Air Conditioning / HVAC Systems Repair Techs. (2) | 2 | | 0 | 0 | | 0 | 0 | | 0 | 2 | 0 |
| | | | | | | | | | | | |
| Rigging / Transportation Shop Superintendent | 1 | | 0 | 0 | | 0 | 0 | | 0 | 1 | 0 |
| *Rigging Systems Supervisor* | 1 | | 0 | 0 | | 0 | 0 | | 0 | 1 | 0 |
| Riggers | 3 | | 0 | 3 | | 0 | 0 | | 0 | 6 | 0 |
| Crane Operators | 1 | | 0 | 1 | | 0 | 0 | | 0 | 2 | 0 |
| Light Eqp.(Back-Hoes/Tractor,Fork Lift) Operators | 1 | | 0 | 0 | | 0 | 0 | | 0 | 1 | 0 |
| | | | | | | | | | | | |
| Transportation Shop Supervisor | 1 | | 0 | 0 | | 0 | 0 | | 0 | 1 | 0 |
| Bus / Automobile Operators (2) | 2 | | 0 | 0 | | 0 | 0 | | 0 | 2 | 0 |
| Heavy Equipment (Cranes etc.) Mechanics (2) | 2 | | 0 | 0 | | 0 | 0 | | 0 | 2 | 0 |
| Auto Mechanics (Diesel / Gasoline) | 2 | | 0 | 0 | | 0 | 0 | | 0 | 2 | 0 |
| Auto Electrician (1) | 1 | | 0 | 0 | | 0 | 0 | | 0 | 1 | 0 |
| Oilers / Helpers (3) | 3 | | 0 | 0 | | 0 | 0 | | 0 | 3 | 0 |
| | | | | | | | | | | | |
| Maintenance Planning Superintendent | 1 | | 0 | 0 | | 0 | 0 | | 0 | 1 | 0 |
| Plant Maintenance Planning Engineers | 1 | | 0 | 1 | | 0 | 0 | | 0 | 2 | 0 |
| Maintenance Coordinators (Integrated Units, Util, Offsites) (3) | 2 | | 0 | 1 | | 0 | 0 | | 0 | 3 | 0 |
| Maintenance Materials Coordinators (Mech., Inst./Elect.) (3) | 3 | | 0 | 0 | | 0 | 0 | | 0 | 3 | 0 |
| Maintenance Work-Order Processors / Schedulers | 2 | | 0 | 1 | | 0 | 0 | | 0 | 3 | 0 |
| Preventive Maintenance Coordinators | 2 | | 0 | 1 | | 0 | 0 | | 0 | 3 | 0 |
| Computerized Maint. Mgmt. Sys.(CMMS) Specialist | 1 | | 0 | 0 | | 0 | 0 | | 0 | 1 | 0 |
| | | | | | | | | | | | |
| **Technical Department Manager** | 1 | | 0 | 0 | | 0 | 0 | | 0 | 1 | 0 |
| Technical Department Office Staff | 2 | | 0 | 0 | | 0 | 0 | | 0 | 2 | 0 |
| | | | | | | | | | | | |
| Engineering Services Superintendent | 1 | | 0 | 0 | | 0 | 0 | | 0 | 1 | 0 |
| Process Engineers (Process, Utility, Offsite/ Marine Systems) | 3 | | 0 | 0 | | 0 | 0 | | 0 | 3 | 0 |

| ECHEM INTEGRATED UNITS STAFFING REQUIREMENTS<br>PERSONNEL POSITION DESCRIPTIONS | PHASE 1 | | | PHASE 2 | | | PHASE 3 | | | ALL PHASES | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total Req'd | Rate | Total | Total Req'd | Rate | Total | Total Req'd | Rate | Total | Total Req'd | Total |
| Process Optimization Engs. (Process, Utility, Offsite/ Marine Sys.) | 2 | | 0 | 0 | | 0 | 0 | | 0 | 2 | 0 |
| Senior New Projects Engineer | 1 | | 0 | 0 | | 0 | 0 | | 0 | 1 | 0 |
| Environmental Engineers (2) | 1 | | 0 | 0 | | 0 | 0 | | 0 | 1 | 0 |
| Mech. Engineer - Static Equipment (2) | 1 | | 0 | 0 | | 0 | 0 | | 0 | 1 | 0 |
| Instrumentation Engineers (DSC / General Instr.) (2) | 2 | | 0 | 0 | | 0 | 0 | | 0 | 2 | 0 |
| Information Technology Specialists (2) | 2 | | 0 | 0 | | 0 | 0 | | 0 | 2 | 0 |
| Computer Technicians (4) | 4 | | 0 | 0 | | 0 | 0 | | 0 | 4 | 0 |
| Mech. Engineers - Rotary Equip.(Condition Monitoring Specialist) | 1 | | 0 | 0 | | 0 | 0 | | 0 | 1 | 0 |
| Electrical Engineers | 1 | | 0 | 0 | | 0 | 0 | | 0 | 1 | 0 |
| Draftsmen / CAD Operators (2) | 1 | | 0 | 1 | | 0 | 0 | | 0 | 2 | 0 |
| | | | | | | | | | | | |
| Inspection Services Superintendent | 1 | | 0 | 0 | | 0 | 0 | | 0 | 1 | 0 |
| Rotary Equipment Inspectors (2) | 1 | | 0 | 1 | | 0 | 0 | | 0 | 2 | 0 |
| Static Equipment Inspectors (2) | 1 | | 0 | 1 | | 0 | 0 | | 0 | 2 | 0 |
| Piping Systems Inspectors (2) | 1 | | 0 | 1 | | 0 | 0 | | 0 | 2 | 0 |
| Electrical / Instrumentation Equipment Inspectors | 1 | | 0 | 1 | | 0 | 0 | | 0 | 2 | 0 |
| Metalurgical Laboratory Specialist (1) | 1 | | 0 | 0 | | 0 | 0 | | 0 | 1 | 0 |
| | | | | | | | | | | | |
| Laboratory Services Superintendent | 1 | | 0 | 0 | | 0 | 0 | | 0 | 1 | 0 |
| Water Systems Analysts (1 x 4) | 4 | | 0 | 0 | | 0 | 0 | | 0 | 4 | 0 |
| Liquid Hydrocarbons Analysts (1 x 4) | 4 | | 0 | 0 | | 0 | 0 | | 0 | 4 | 0 |
| Gas Analysts (Chromatographs) (1 x 4) | 4 | | 0 | 0 | | 0 | 0 | | 0 | 4 | 0 |
| Sample Collectors (2 x 4) | 4 | | 0 | 4 | | 0 | 0 | | 0 | 8 | 0 |
| Laboratory Vacation / Shift Relief Staff | 1 | | 0 | 1 | | 0 | 0 | | 0 | 2 | 0 |
| | | | | | | | | | | | |
| Document / Records Center Superintendent | 1 | | 0 | 0 | | 0 | 0 | | 0 | 1 | 0 |
| Document Control Clerks | 2 | | 0 | 0 | | 0 | 0 | | 0 | 2 | 0 |
| Technical Dept. Printing Room Operator | 1 | | 0 | 0 | | 0 | 0 | | 0 | 1 | 0 |
| | | | | | | | | | | | |
| **Assistant General Manager - Administration Services** | 1 | | 0 | 0 | | 0 | 0 | | 0 | 1 | 0 |
| Assistant General Manager's Office Staff | 2 | | 0 | 0 | | 0 | 0 | | 0 | 2 | 0 |
| | | | | | | | | | | | |
| Assistant Manager Administration Services | 1 | | 0 | 0 | | 0 | 0 | | 0 | 1 | 0 |
| | | | | | | | | | | | |
| **Finance Department Manager** | 1 | | 0 | 0 | | 0 | 0 | | 0 | 1 | 0 |
| Finance Manager's Office Staff | 2 | | 0 | 0 | | 0 | 0 | | 0 | 2 | 0 |
| Accounting Superintendent | 1 | | 0 | 0 | | 0 | 0 | | 0 | 1 | 0 |
| General Accountants | 2 | | 0 | 0 | | 0 | 0 | | 0 | 2 | 0 |
| Accounting Assistants | 2 | | 0 | 1 | | 0 | 0 | | 0 | 3 | 0 |
| Payroll Administration Accountant | 1 | | 0 | 0 | | 0 | 0 | | 0 | 1 | 0 |
| Payroll Administration Assistants | 2 | | 0 | 1 | | 0 | 0 | | 0 | 3 | 0 |
| | | | | | | | | | | | |
| **Procurement / Warehouse Services Manager** | 1 | | 0 | 0 | | 0 | 0 | | 0 | 1 | 0 |
| Procurement /Warehouse Manager's Office Staff | 2 | | 0 | 0 | | 0 | 0 | | 0 | 2 | 0 |
| | | | | | | | | | | | |
| Procurement Superintendent | 1 | | 0 | 0 | | 0 | 0 | | 0 | 1 | 0 |
| Customs / Logistics Coordinator | 1 | | 0 | 0 | | 0 | 0 | | 0 | 1 | 0 |
| Purchasing Agents (Local / Foreign) | 2 | | 0 | 0 | | 0 | 0 | | 0 | 2 | 0 |
| Sub-Contracts Administrator | 1 | | 0 | 0 | | 0 | 0 | | 0 | 1 | 0 |

| ECHEM INTEGRATED UNITS STAFFING REQUIREMENTS<br>PERSONNEL POSITION DESCRIPTIONS | PHASE 1 | | | PHASE 2 | | | PHASE 3 | | | ALL PHASES | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total Req'd | Rate | Total | Total Req'd | Rate | Total | Total Req'd | Rate | Total | Total Req'd | Total |
| └ Sub-Contracts Administrator Assistants (2) | 2 | | 0 | 0 | | 0 | 0 | | 0 | 2 | 0 |
| *(Subcontracts: Catering, Bldg. Services, House Keeping, Transportation, Turnarounds)* | | | | | | | | | | | |
| ├ Warehouse Superintendent | 1 | | 0 | 0 | | 0 | 0 | | 0 | 1 | 0 |
| ├ Material Control Coordinators | 3 | | 0 | 0 | | 0 | 0 | | 0 | 3 | 0 |
| ├ Inventory Control (Order/Receive/Stock) Agents | 3 | | 0 | 0 | | 0 | 0 | | 0 | 3 | 0 |
| ├ Materials Issue Clerks | 3 | | 0 | 0 | | 0 | 0 | | 0 | 3 | 0 |
| ├ Fork-Lift Operator | 1 | | 0 | 0 | | 0 | 0 | | 0 | 1 | 0 |
| ├ *Delivery Truck Operator* | 1 | | 0 | 0 | | 0 | 0 | | 0 | 1 | 0 |
| └ Reproduction / Print Room Coordinator | 1 | | 0 | 0 | | 0 | 0 | | 0 | 1 | 0 |
| └ Print Room Operators | 2 | | 0 | 0 | | 0 | 0 | | 0 | 2 | 0 |
| **└ Human Resource Manager** | 1 | | 0 | 0 | | 0 | 0 | | 0 | 1 | 0 |
| ├ Human Resource Dept. Office Staff | 2 | | 0 | 0 | | 0 | 0 | | 0 | 2 | 0 |
| ├ *Expatriate Services Coordinator* | 1 | | 0 | 0 | | 0 | 0 | | 0 | 1 | 0 |
| ├ Expatriate Travel / Visa Services Agent | 1 | | 0 | 0 | | 0 | 0 | | 0 | 1 | 0 |
| └ *Expatriate Recruiting / Personnel Services Clerk* | 1 | | 0 | 0 | | 0 | 0 | | 0 | 1 | 0 |
| ├ Local Personnel Services Coordinator | 1 | | 0 | 0 | | 0 | 0 | | 0 | 1 | 0 |
| ├ Local Staff Recruiting Services Clerk | 2 | | 0 | 0 | | 0 | 0 | | 0 | 2 | 0 |
| └ Local Staff Personnel Services Clerks (2) | 2 | | 0 | 0 | | 0 | 0 | | 0 | 2 | 0 |
| ├ Industrial Relations Manager | 1 | | 0 | 0 | | 0 | 0 | | 0 | 1 | 0 |
| ├ Training and Personnel Development Manager | 1 | | 0 | 0 | | 0 | 0 | | 0 | 1 | 0 |
| ├ Training and Personnel Development Dept. Office Staff (2) | 2 | | 0 | 0 | | 0 | 0 | | 0 | 2 | 0 |
| ├ Operations Trainer / Coordinator | 1 | | 0 | 0 | | 0 | 0 | | 0 | 1 | 0 |
| ├ Operations Class Room Trainers (4) | 4 | | 0 | 0 | | 0 | 0 | | 0 | 4 | 0 |
| └ Operations OJT Trainers (4) | 4 | | 0 | 0 | | 0 | 0 | | 0 | 4 | 0 |
| ├ Maintenance Trainer / Coordinator | 1 | | 0 | 0 | | 0 | 0 | | 0 | 1 | 0 |
| ├ *Maintenance Class Room Trainers (4)* | 4 | | 0 | 0 | | 0 | 0 | | 0 | 4 | 0 |
| └ Maintenance Field Craft Trainers (4) | 4 | | 0 | 0 | | 0 | 0 | | 0 | 4 | 0 |
| ├ Engineering Trainers (3) | 3 | | 0 | 0 | | 0 | 0 | | 0 | 3 | 0 |
| ├ Educational Training Coordinator | 1 | | 0 | 0 | | 0 | 0 | | 0 | 1 | 0 |
| └ Educational Training Staff (4) | 4 | | 0 | 0 | | 0 | 0 | | 0 | 4 | 0 |
| └ Career Development Coordinator | 1 | | 0 | 0 | | 0 | 0 | | 0 | 1 | 0 |
| └ Assessment & Proficiency Staff | 2 | | 0 | 0 | | 0 | 0 | | 0 | 2 | 0 |
| **└ Medical Services Manager (Doctor)** | 1 | | 0 | 0 | | 0 | 0 | | 0 | 1 | 0 |
| ├ Medical Nurses (1 x 4) | 4 | | 0 | 0 | | 0 | 0 | | 0 | 4 | 0 |
| └ Medical Records Clerks | 2 | | 0 | 0 | | 0 | 0 | | 0 | 2 | 0 |
| **GRAND TOTAL / MONTH** | 426 | | 0 | 111 | | 0 | 41 | | 0 | 578 | 0 |

# TASK E FINANCIAL AND BENEFIT ANALYSIS

## E.1 FINANCING STRATEGY

### E.1.1 Basic Strategy and Approach

Based upon the Grantee's specific objectives regarding financing and implementation (see text box below), a limited recourse project financing approach will be most appropriate for the project. A limited recourse approach would entail the creation of a special purpose vehicle ("SPV") to own and operate the project assets. Under such a structure, the SPV would serve as the borrower for long-term debt financing, and lenders would rely primarily on the project's assets and cash flows for repayment and collateral. Some supplemental credit support would typically be required from the project's key stakeholders, including the owner(s) of the SPV and the EPC contractor, during the start-up phase.

***Priorities for Project Financing and Implementation***

- To obtain financing at the lowest possible combined cost on an all-in cost basis;
- To reduce the amount of capital required from Echem and/or the level of contingent risk to be assumed by Echem; and
- To obtain financing as quickly as possible and under a structure that will facilitate rapid implementation of the project.

The creation of an SPV would also enable the participation of outside equity investors on a project-specific basis. Most importantly, it would limit recourse to the Grantee and other potential shareholders. The recommended financing strategy would include the types of capital outlined below.

### E.1.2 Senior Debt

Limited recourse senior debt for petrochemical projects can typically provide for up to 70 percent of a project's total cost, including capitalized soft costs such as transaction fees and interest during construction. Loan tenors are typically long-term and tied to a combination of risk factors, including (i) the duration and sensitivity of project's offtake and supply contracts, (ii) the general appetite of the capital markets for country-specific risk, and (iii) other risk factors as discussed in Task F.

Based on the "base case" economics of the Integrated Methanol/Ammonia project, the following indicative key terms and conditions for senior debt can be expected:

| | |
|---|---|
| *Amount*: | 60-70% of total project costs |
| *Currency*: | USD or EUR |
| *Tenor*: | 10-12.5 years, including a 2.5-year grace period on principal for construction |
| *Amortization*: | 40 equal quarterly payments of principal |
| *Interest Rate*: | LIBOR + 100-150 basis points per annum |
| *Covenants*: | - Minimum debt service coverage ratio of 1.0x – 1.5x<br>- Maximum debt to equity ratio of 1.7:1 – 2:1<br>- No payment of dividends until certain financial tests are met |
| *Contingent Support*: | Contingent guarantees from the Grantee, the EPC contractor and others until physical, operational, legal, and financial tests are met |

Such a financing effort should be a syndicated loan effort led by a major commercial bank (the "Lead Arranger") with experience in underwriting and arranging project finance loans to the petrochemical industry. Given the size of the financing, one or more other commercial banks may be involved as "Co-Arrangers" on the deal as well. It is important that the underwriting commitments from the Lead Arranger(s) be detailed and strong to ensure rapid and successful placement of the debt and facilitate a timely start of construction. The Grantee might consider enlisting the services of a financial advisor in this regard to help optimize the terms and conditions of such underwriting commitments and the speed up the financing process.

### E.1.3 Equity and Subordinated Debt

Some of the equity-like capital requirement is expected to be met by equity contributions from the Grantee, while the remainder is being sought from third parties. Equity requirements for Phases II and III should be less of an issue as they could potentially be funded from cash from earnings retained within the SPV. The Grantee should pursue the following options to reduce its own funding requirement:

(i) ***In-kind contributions*** from the Grantee that are legitimate project costs, such as land and the cost of project development, can be counted as equity contributions on the basis of fair market value or actual cost (typically whichever is lower), and can thus be used to reduce the amount of cash equity required from the Grantee under a 60/40 debt to equity split of project costs with lenders.

(ii) ***Subordinated debt*** from third parties can also be counted against the equity contributions required by lenders, though it is important that such capital be very

clearly junior to the senior lenders in terms of rights to both cash flow and collateral. While subordinated debt is priced higher than senior debt (typically a few percentage points higher on the interest rate, plus some form of profit-sharing as a return enhancement), it can reduce the required level of "pure" equity contributions and thus reduce the amount of ownership dilution that the Grantee would suffer as a result of bringing in outside investors. The availability and terms of subordinated debt would ultimately depend upon project economics, but based on the current base case analysis, the project should be able to support a meaningful amount of this type of capital.

(iii) ***Splitting the project into two separate projects***, as may currently be under consideration by the Grantee, may facilitate raising equity as it would allow potential investors to invest in a single plant with a particular product output. This would be especially attractive to "strategic" corporate investors interested in building productive capacity in the region.

### E.1.4 Targeted Sources of Financing

#### E.1.4.1 Commercial Lenders

Local and international commercial lenders should be the primary target for senior debt financing. Based upon their financial resources and experience in underwriting major syndicated project finance loans, the Lead Arranger will most likely be an international commercial bank based outside of Egypt. Local commercial lenders could also play an important role as they could assist the Lead Arranger in assessing country risk and related tax and regulatory issues, and could potentially provide an EGP-denominated working capital loan to the SPV if necessary and appropriate. The Grantee should begin the selection of a Lead Arranger by issuing a Request for Proposals once the scope and cost of the project has been finalized (or nearly finalized). Following is an initial short-list of lenders with experience in large-scale petrochemical project finance:

Martin Wuerth, Managing Director
Global Project & Structured Finance, Oil & Gas
Bayerische Hypo- und Vereinsbank AG
Am Tucherpark 1 80538 Munich, Germany
Telephone: (+49) 89 378 48895 Fax: (+49) 89 378 41518
E-mail: martin.wuerth@hvb.de

Rana Karadsheh-Haddad, Investment Officer
International Finance Corporation
2121 Pennsylvania Avenue Washington, DC 20433
Telephone: 202 473 5527

Fax: 202 974 4325/4
E-Mail: Rkaradsheh@ifc.org

Mr. Bradley McAboy
WestLB AG
Global Specialised Finance
Energy Team Europe, Middle East, Africa
Herzogstrasse 15
40217 Düsseldorf, Germany
Tel.: +49 211 826 4589
Fax: +49 211 826 5396
Email : Bradley_Mc_Aboy@WestLB.de

Dr. Jürgen Franke
WestLB AG
Global Specialised Finance
Energy Team Europe, Middle East, Africa
Herzogstrasse 15
40217 Düsseldorf, Germany
Tel.: +49 211 826 5227
Fax: +49 211 826 5396
Email: dr_juergen_franke@WestLB.de

### E.1.4.2 Export Credit Agencies (ECAs)

Egypt is open to financing using credits and/or guarantees provided by several Export Credit Agencies. While this may be a less expensive way to finance the projects, there is usually considerable effort required from the borrower to satisfy the application and loan requirements. This may cause some delays in meeting schedule dates. However, with advance planning, we would recommend that this course be pursued. Considering the likely sources of equipment and services required for the Project, ECAs from the US and Europe could be approached.

### E.1.4.3 Equity Sources

The Grantee should pursue equity or subordinated debt from private sector investors. Private-sector sources of equity or quasi-equity capital can generally be broken down into two categories: institutional or "financial" investors that manage pools of capital for purposes of generating a return, and corporate or "strategic" investors that would invest in the project as part of an overall corporate strategy. Potential financial investors would include equity investment funds interested in Africa. Most of these private equity funds invest on a portfolio basis and do

not participate in the day-to-day management of companies. Based on the current market, they would typically seek returns in the range of 10-15 percent per year for a project of this nature. Strategic investors, which could include the project's suppliers and offtakers, would play a more active role in the company, and financial returns on investment may be more variable as these investors may look at economic benefit in a broader context.

### E.1.5 Recommended Financing Plan

Based upon the analysis above, here is the recommended financing plan based on a conceptual cost estimate of USD 916.9 million for Phase I.

***ILLUSTRATIVE FINANCING PLAN (USD millions)****

| | **USD (millions)** |
|---|---|
| **Type of Debt:** | ***Methanol/Ammonia**** |
| Senior Debt – Syndicated Commercial Bank Loan possibly supported by ECAs | $550.15 |
| Equity – Strategic Investors/Grantee*** | $366.77 |
| TOTAL | $916.9 |

* Based on approximate project costs

** Includes marine terminal

*** Includes in-kind contributions

## E.2 INTRODUCTION TO THE FINANCIAL MODEL

### E.2.1 Overview

The financial model shown in Appendix 4 has been set up to analyze the economics of the project scenarios, or cases, outlined below. A scenario function is included on the "Assumptions" tab to allow the user to toggle between these scenarios.

Case 1: Integrated Methanol Process Unit with Ammonia Synthesis and common utilities and offsites that uses natural gas as feedstock to produce the methanol.

Unless noted otherwise, all figures are expressed in thousands of U.S. dollars (including some cost inputs that are expressed in Egyptian pounds and then converted to dollars). Assumption inputs are indicated by either blue font or pale yellow boxes.

### E.2.2 Timing of Construction Assumptions

The construction period assumption is expressed in months and remains the same for all three phases. The construction period for Phase I begins at Year 0. Funds are drawn down over quarters as shown in the construction curve assumptions box. The construction curve can be adjusted to change the drawdown timing and amount. Although the base case assumes total planned capacity will double and triple through the implementation of three phases, it is possible to isolate Phase I performance by entering a "0" in the corresponding Phase II and III assumptions boxes.

### E.2.3 Total Project Cost Assumptions

Assumptions related to the construction of the project are divided into hard costs (ISBL/OSBL and marine loading terminal) and non-financing related soft costs (working capital and land), denoted in equivalent USD. The ISBL/OSBL costs for Phase I are also used for Phases II and III but are adjusted for inflation. The Marine Loading Terminal cost for Phases III, on the other hand, is different than that from Phase I and II, because much of the infrastructure required to build an additional terminal will be provided during the first phase. Costs entered into the pale yellow shaded assumption boxes are transferred into the Construction Summary box to the left, from which they are automatically sent to the drawdown sheet. The drawdown period for all costs related to the physical construction of the plants is linked to the construction period, which is also summarized on the construction summary box. A cost over/under run assumption adjusts construction hard costs and some soft costs by an assumed percentage to account for possible changes in construction costs from current estimates. Finally, financing-related costs, including interest during construction, debt service reserve account, and transaction costs, are estimated based on the other costs outlined above in combination with financing assumptions outlined in Section 2.8 below.

### E.2.4 Production Assumptions

Production capacity is denoted in metric tons per day. It is transferred from the production assumptions box to the production sheet, where it is factored by assumptions for the total number of operating days, a capacity factor, and inflation. Capacity is assumed to be lower during the first year of operations for each phase because of possible inefficiencies that may result from the initial ramp-up. Thereafter, a capacity factor below 100 percent but above first year capacity reflects the possibility of unplanned upsets during normal operations. Because of required planned maintenance every four years, the model assumes the plant will experience a certain number of planned outage days every several years.

### E.2.5 Product Price Assumptions

Sales prices for the three cases are assumed based upon forecasts conducted as part of Task A. Constant-dollar price forecasts are hard coded in the sales price assumptions box and

adjusted for inflation in the income statement until year 10. After this point, sales prices are adjusted for U.S. dollar inflation using the year 10 prices as the base price.

### E.2.6 Cost of Goods Sold (COGS) Assumptions

Cost of goods sold is an all-in cost estimate measured in USD/metric ton. COGS include feedstock, electricity, seawater/freshwater circulation, steam export, demineralized water makeup, catalysts and chemicals. Please note that these figures are also adjusted for inflation.

### E.2.7 Operating Expense Assumptions

Likewise, operating expense assumptions are calculated on an all-in cost basis denominated in equivalent USD – as some expenses will likely be paid in local currency – and may be entered independently for each case. Operating expenses include direct labor, routine maintenance, and overhead.

### E.2.8 Senior Debt Financing

When the proportion of debt financing is entered into the assumptions box, the model automatically assigns the remainder (i.e., 1 – debt financing percentage) to equity financing. The interest rate is determined using assumptions for (i) the base rate, plus (ii) a lender risk premium. Different interest rates may be used for construction and post-construction periods to reflect potential perceived risk differentials. Financing assumptions are the same for each phase, though the grace period for each phase can be altered independently. Also, the model can accommodate debt service calculation on either a level-principal or mortgage-style basis.

### E.2.9 Currency and Inflation

Inflation rate assumptions for the USD are direct inputs for years 0 through 3, with a standard annual rate for each applied thereafter.

### E.2.10 Working Capital Assumptions

Accounts receivable on the balance sheet are calculated by multiplying average daily revenue by the average accounts receivable days outstanding. Accounts payable and inventory are derived by dividing cost of goods sold by average days payable and inventory days outstanding, respectively. The dividend payout ratio assumption sets the amount that is paid out as dividends to equity holders as a percentage of net income. Dividends are paid out only if net income is positive.

### E.2.11 Depreciation

## E.2.11 Depreciation

Hard costs (e.g., ISBL, OSBL, and loading terminal) and capitalized financing costs (financing and transaction fees) are depreciated on a straight line basis over an assumed number of years.

## E.2.12 Table of Financial Model Assumptions

The results of the financial modeling are based on the assumptions in the following tables.

(Please see Appendix 4 for a larger size copy of the Assumption Table).

**Note:**

The project IRR is an approximation of the project's rate of return based upon project free cash flow. To arrive at free cash flow, interest expense is added to operating cash flow less any interest savings from interest expense. Thereafter, investing cash flow and equity financing soft costs are netted out and the terminal value at the end of the project is added. The terminal value is the project's projected net cash flow at the end of the project. If the project IRR is below the cost of capital, the project would not be considered acceptable.

The equity IRR is an approximation of the project's equity rate of return. In this case, equity investments are subtracted from equity dividends and project-ending terminal value to arrive at equity net cash flow. If the equity IRR is below the cost of equity, the project would not be considered acceptable.

# Financial Model Assumptions – Methanol/Ammonia

**ECHEM**
**Project Summary**
**Integrated Methanol/Ammonia Plant**
Plant uses natural gas as feedstock to produce methanol and excess hydrogen to produce ammonia
***USD '000s***

| Construction Summary | |
|---|---|
| EPC Contract Award | 1Q2006 |
| Construction Period (mos) | 33.00 |
| (Possible Values: 24-36) | |
| *Production Phase 1 Starts* | *2.75* |
| Construction Phase 2 Begins* | 8.00 |
| Production Phase 2 Starts* | 10.75 |
| Construction Phase 3 Begins* | 15.25 |
| Production Phase 3 Starts* | 18.00 |
| Plant Type | |
| | |
| Project Hard Costs | USD |
| ISBL & OSBL | 680,149 |
| Owner's Hard Costs | 12,000 |
| Shipping Terminal | 71,591 |
| **Total Hard Costs** | **763,740** |
| Project Soft Costs | |
| Working Capital | 16,604 |
| Land Rental During Construction | 7,700 |
| Owner's Soft Costs | 27,600 |
| Interest During Construction | 46,566 |
| Financing & Transaction Fees | 11,705 |
| *Debt Service Reserve Account* | *42,981* |
| **Total Soft Costs** | **163,185** |
| | |
| **Total Costs** | **916,826** |

* Fractional year for production start = part of next year

| Construction Curve | |
|---|---|
| Qtr 1 | 15% |
| Qtr 2 | 9% |
| Qtr 3 | 10% |
| Qtr 4 | 15% |
| Qtr 5 | 10% |
| Qtr 6 | 10% |
| Qtr 7 | 10% |
| Qtr 8 | 10% |
| Qtr 9 | 5% |
| Qtr 10 | 5% |
| Qtr 11 | 5% |
| Qtr 12 | 0% |

| Construction Cost Assumptions | |
|---|---|
| Cost | 0% |
| | USD |
| ISBL & OSBL | 680,149 |
| *Marine Loading Terminal* * | 71,591 |
| Total Hard Costs | 751,740 |
| Working Capital | 16,604 |
| Land Rental During Constr. | 7,700 |

* Marine Loading Terminal Cost for Phase 1 Only

| Site Preparation, Marine Loading Terminal & Sea Water Intake Basin Cost | |
|---|---|
| Cost per Phase | USD |
| Phase 1 | 71,591 |
| Phase 2 | - |
| Phase 3 | 15,000 |

| Owner's Cost | |
|---|---|
| Plant Set-up Costs | 10,000 |
| Cairo Office Costs | 2,000 |
| **Owner's Hard Costs** | 12,000 |
| | |
| Project Development | 15,000 |
| Project Management Team | 10,000 |
| Customs Clearance | 400 |
| Commercial Relations | 500 |
| Safety Incentive | 200 |
| Ind. Engineer | 2,000 |
| **Owner's Soft Costs** | 28,100 |
| | |
| **Total Owners' Cost** | 40,100 |

| Timing of Construction Assumptions | |
|---|---|
| Construction Start Date (Year) | |
| Phase 2 (Yes = 1, No = 0)* | 0 |
| Phase 3 (Yes = 1, No = 0)* | 0 |

* Construction start years must not be zeroed out if No = 0 is selected

| Production Assumptions | | |
|---|---|---|
| Methanol Capacity (MTD) | 3,000 | |
| Ammonia Capacity (MTD) | 1,200 | |
| | | |
| Capacity Factor - 1st Year of Operations | 90% | |
| Capacity Factor - Thereafter | 95% | |
| Potential Operating days | 365 | |
| Planned Outage Days | 44 | |
| Planned Outage Days Every | 4 | years |

| Annual COGS & Operating Expense Assumptions | | |
|---|---|---|
| **COGS** | | |
| Methanol Feed and Utility Costs ($ / MT) | | 41.54 |
| Ammonia Feed and Utility Costs ($ / MT) | | 36.28 |
| **Operating Expenses** | | |
| *Methanol Fixed Costs ($ / MT)* | | 15.04 |
| Ammonia Fixed Costs ($ / MT) | | 23.27 |
| Land Rental | $ | 2,800 |
| Selling, General & Administrative | $ | 1,500 |
| Quarterly Review * | $ | 500 |

| Currency and Inflation Assumptions | | | | |
|---|---|---|---|---|
| | Const. Start | Year 1 | Year 2 | Thereafter |
| Inflation Rate p.a. (US) | 2.50% | 2.60% | 2.70% | 2.90% |

| Sales Price Assumptions (Current USD) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 | Year 6 | Year 7 | Year 8 | Year 9 | Year 10 | Year 11 |
| **Methanol Sa** | 103 | 108 | 114 | 119 | 121 | 122 | 124 | 125 | 127 | 129 | 135 |
| | | | | | | | | | | | |
| **Ammonia Sa** | 199 | 191 | 211 | 195 | 178 | 162 | 145 | 129 | 131 | 132 | 137 |

| Senior Debt Financing Assumptions | |
|---|---|
| % Debt financing | 60% |
| Base Rate | 4.50% |
| Construction Risk Premium | 1.50% |
| Interest Rate During Construction | 6.00% |
| Post Construction Risk Premium | 1.50% |
| Post Construction Interest Rate | 6.00% |
| Debt Risk Premium | 0.00% |
| All-in-Cost Debt | 6.00% |
| Cost of Equity | 11.20% |
| Equity Risk Premium | 1.80% |
| All-in-Cost Equity | 13.00% |
| *Discount Rate (WACC)* | *8.80%* |
| Commitment Fee | 0.50% |
| Up-front Fee | 1.0% |
| Transaction Costs | 0.5% |
| Repayment Term (years) | 10 |
| Payment Style (Level = 0, Mortgage = 1) | 0 |
| Debt Service Reserve (months) | 6 |
| Debt Service Reserve Interest Rate | 3.0% |

| Working Capital & Other | |
|---|---|
| Days Receivable | 30 |
| Days Payable | 15 |
| Inventories | 10 |
| Tax Rate | 0% |
| Dividend Payout (% of NI) | 100% |
| Minimum Cash Balance | 1,000 |

| Depreciation Assumptions | |
|---|---|
| Asset | Life |
| Buildings | 25 |
| Capitalized Financing Costs | 10 |
| Remaining Life | 10 |
| Terminal Value Year | 25 |

## E.3 SENSITIVITY ANALYSIS

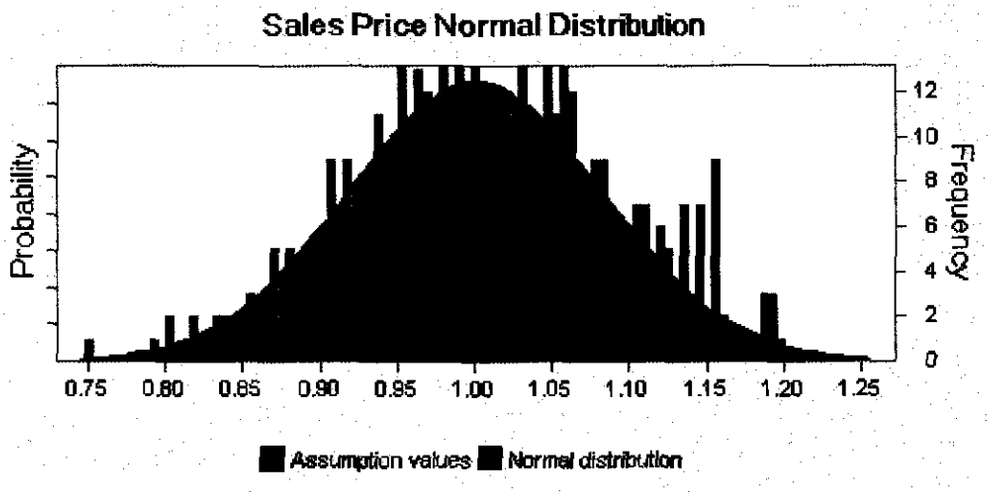
### E.3.1 Sensitivity Analysis Methodology

Sensitivity analysis in this study is used to determine what assumptions have the greatest effect on certain key indicators of a project's cashflow and profitability. In this case, average debt service coverage ratio (DSCR), Equity internal rate of return (IRR) and net present value (NPV) have been identified as the most useful indicators to potential lenders equity investors and other stakeholders. DSCR was chosen because of its importance to lenders, as it gives a measure of the Grantee's ability to service principal and interest payments from annual cashflow. IRR, on the other hand, is important to equity investors, who receive dividends in return for equity investments. NPV is important to all stakeholders because it illustrates the project's overall profitability. The cost of capital is used when calculating the project NPV and a negative NPV indicates that the project is unacceptable. The following table illustrates the base case performance indicators that will be analyzed in this section:

| Base Case Methanol/Ammonia | |
|---|---|
| Ave. DSCR | 1.53 |
| Equity IRR | 14.3% |
| Project NPV | 355,377 |
| Cost of Capital | 8.80% |

**Sales Price**

The probability distribution selected to analyze sales price sensitivity is a normal distribution, because sales price could as likely be above the mean as it could be below the mean (symmetrical about the mean). In this case, the assumption is that sales price has a range of ±25 percent (see graph below) with a mean of 1.0. Additionally, the distribution uses a confidence interval of 99.8percent (three standard deviations). In dollar terms, if sales price is $100 per MT (the mean), the distribution assumes that sales price could be as low as $75 (three standard deviations to the left) and as high as $125. As the graph shows, the frequency will increase, as the sales price gets closer to the mean. This method is appropriate because even though there is a possibility that sales price deviates by ±25 percent, it is more likely to be in the vicinity of the mean.

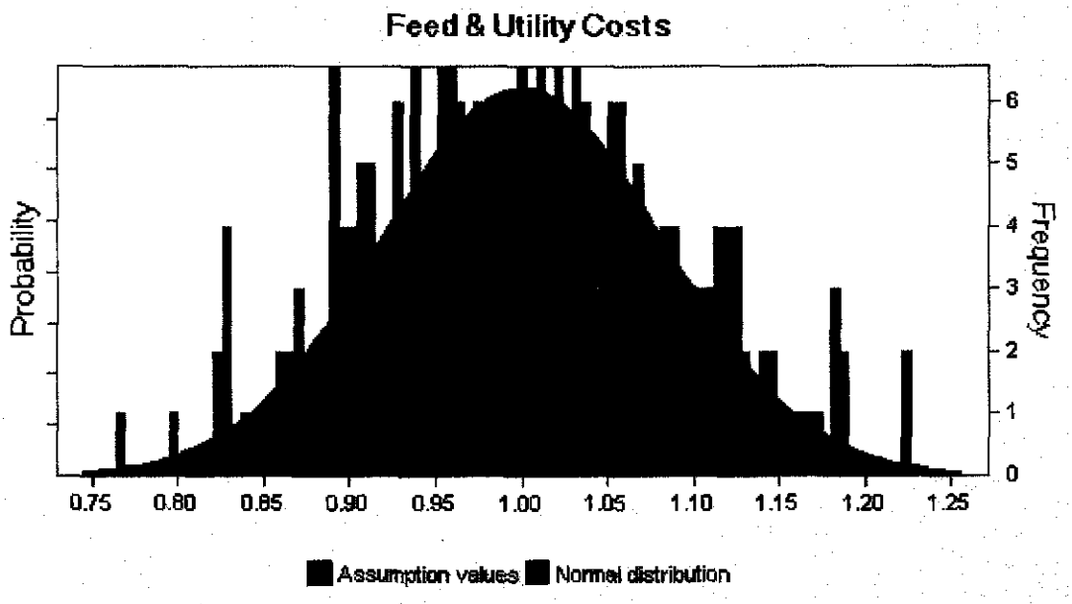



Sales price sensitivities yield rather significant changes in the DSCR, IRR and NPV. Price changes, ranging from a 25 percent increase to a 25 percent decrease, were paralleled by equally extreme fluctuations in DSCR, IRR and NPV. As revealed by the adjacent table, however, NPV proved to be more sensitive to price changes than DSCR and IRR. When price dropped by 25 percent, NPV decreased by 146 percent to negative $163 million.

| Sales Price Sensitivities | | | | | | |
|---|---|---|---|---|---|---|
| Price | DSCR | % Change | IRR | % Change | NPV | % Change |
| +25% | 2.26 | 48.2% | 22.8% | 59.5% | 873,910 | 145.9% |
| +15% | 1.97 | 29.0% | 19.5% | 36.3% | 666,497 | 87.5% |
| +5% | 1.68 | 9.7% | 16.1% | 12.3% | 459,083 | 29.2% |
| 0% | 1.53 | - | 14.3% | - | 355,377 | - |
| -5% | 1.38 | -9.7% | 12.5% | -12.7% | 251,670 | -29.2% |
| -15% | 1.08 | -29.1% | 8.7% | -39.5% | 44,256 | -87.5% |
| -25% | 0.78 | -48.6% | 5.1% | -64.6% | (163,157) | -145.9% |

### Feed & Utility Costs

Methanol and ammonia feed costs have a mean of $41.54 per MT and $36.28 per MT, respectively. There is a possibility that these costs will change by as much as +/- 25% and a normal distribution is appropriate.



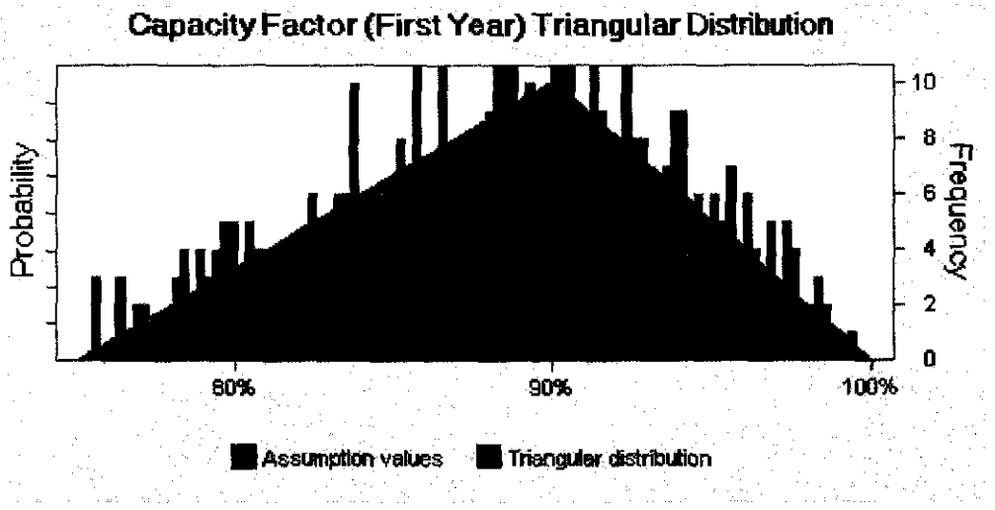

Feed & utility costs are closely related to the NPV because any change will directly impact gross margin and affect operating cash flow. As a result, it is not surprising that a 25% increase in feed costs will reduce NPV by 47.7 percent to $186 million. DSCR and IRR do not show such a strong degree of sensitivity, even though the IRR decreases to 11.3 percent when feed costs increase by 25 percent.

| Feed & Utility Cost Sensitivities | | | | | | |
|---|---|---|---|---|---|---|
| Feed Costs | DSCR | % Change | IRR | % Change | NPV | % Change |
| +25% | 1.29 | -15.8% | 11.3% | -20.9% | 185,890 | -47.7% |
| +15% | 1.38 | -9.5% | 12.5% | -12.4% | 253,685 | -28.6% |
| +5% | 1.48 | -3.2% | 13.7% | -4.1% | 321,479 | -9.5% |
| 0% | 1.53 | - | 14.3% | - | 355,377 | - |
| -5% | 1.58 | 3.2% | 14.9% | 4.0% | 389,274 | 9.5% |
| -15% | 1.67 | 9.5% | 16.0% | 12.0% | 457,069 | 28.6% |
| -25% | 1.77 | 15.8% | 17.2% | 19.9% | 524,863 | 47.7% |

**Capacity Factor - Year 1**

When assumption values do not fall symmetrically to each side of the mean because they are skewed, a triangular distribution is appropriate. Here, the parameters are minimum, likeliest and maximum. The most likely number of items falls between the minimum and the maximum values, forming a triangular-shaped distribution. The capacity factor during year 1 of plant operation is currently 90 percent (mean). There is a possibility that it can decrease to 75 percent (minimum) if operations during the first year are obstructed due to teething problems and other related issues. If operations run perfectly smooth, capacity factor may go up to 100

percent (maximum). The triangular distribution, which is skewed to the left, reflects the increased probability of capacity factors below 90 percent during the first year of operations.

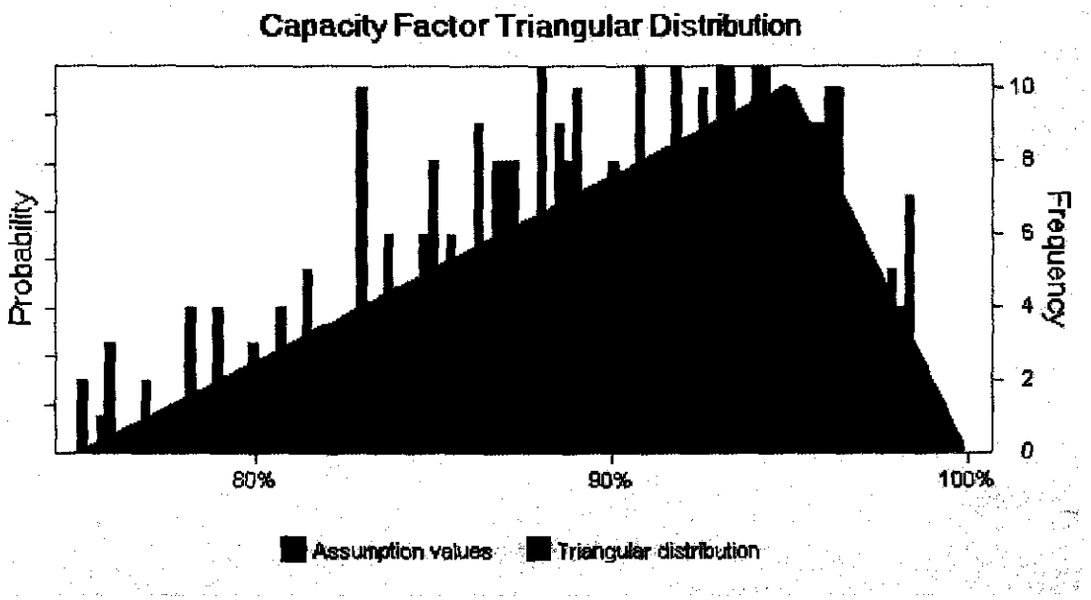



Changes in the firm's efficiency during the first year– whether it should operate at its optimum performance, or operate at a rather low capacity – have a very small effect on DSCR, IRR and NPV. Assuming that the firm operates at 90 percent efficiency in its first year, enhancing its performance produces modest changes to either metric. Should capacity fall to 75 percent, DSCR falls by only 1.3 percent to 1.51.

| Capacity Factor Sensitivities (Year 1) | | | | | | |
|---|---|---|---|---|---|---|
| Capacity F. | DSCR | % Change | IRR | % Change | NPV | % Change |
| 100% | 1.54 | 0.9% | 14.4% | 0.5% | 357,717 | 0.7% |
| 95% | 1.53 | 0.4% | 14.4% | 0.2% | 356,547 | 0.3% |
| 90% | 1.53 | - | 14.3% | - | 355,377 | - |
| 85% | 1.52 | -0.4% | 14.3% | -0.2% | 354,207 | -0.3% |
| 80% | 1.51 | -0.9% | 14.3% | -0.5% | 353,037 | -0.7% |
| 75% | 1.51 | -1.3% | 14.2% | -0.7% | 351,867 | -1.0% |

### Capacity Factor Thereafter

As with the first year capacity factor, subsequent capacity factor sensitivities are also calculated using a triangular-shaped distribution, but in this case the mean is 95 percent and not 90 percent. The minimum and maximum capacity factors for this sensitivity are 75 percent and 100 percent, respectively.

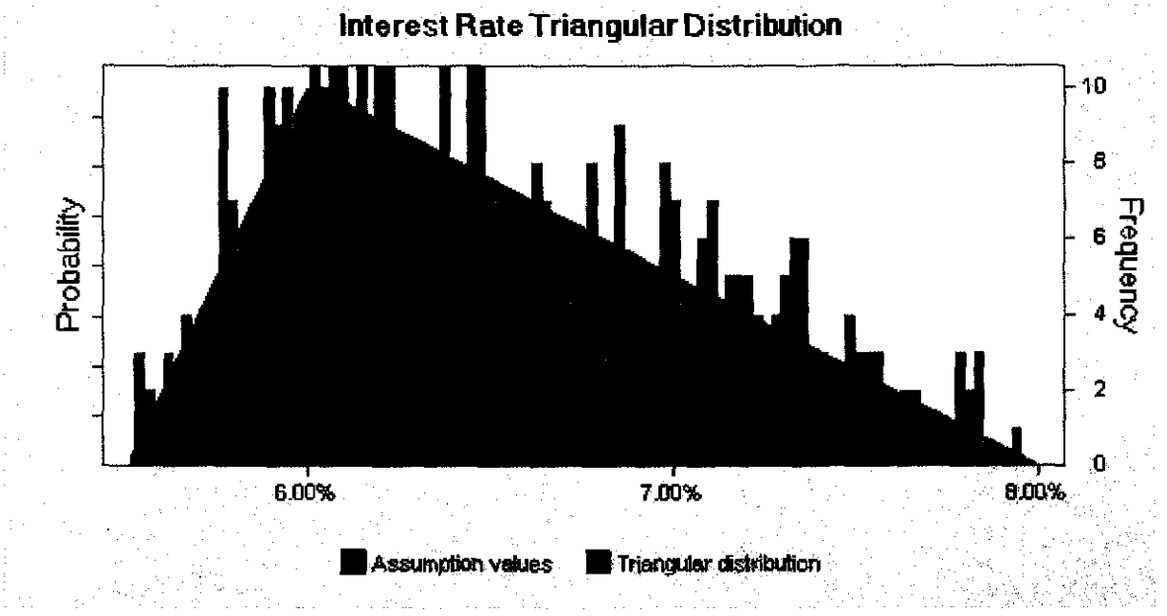



As seen in the table below, reducing the capacity factor to 75 percent will reduce the DSCR and IRR by 20.1 percent and 28.5 percent, respectively. The NPV at 75 percent capacity falls by 64 percent to $129 million.

| Capacity Factor Sensitivities (After Year 1) | | | | | | |
|---|---|---|---|---|---|---|
| Capacity F. | DSCR | % Change | IRR | % Change | NPV | % Change |
| 100% | 1.60 | 5.0% | 15.3% | 6.7% | 412,509 | 16.1% |
| 95% | 1.53 | - | 14.3% | - | 355,377 | - |
| 90% | 1.45 | -5.0% | 13.3% | -6.9% | 298,244 | -16.1% |
| 85% | 1.37 | -10.1% | 12.3% | -13.9% | 241,112 | -32.2% |
| 80% | 1.30 | -15.1% | 11.3% | -21.1% | 183,980 | -48.2% |
| 75% | 1.22 | -20.1% | 10.2% | -28.5% | 126,848 | -64.3% |

**Interest Base Rate**

The most likely interest base rate assumed in the financial model is 6.0 percent (mean). The triangular distribution further assumes that the minimum and maximum base rate will be 5.5 percent and 8.0 percent, respectively.

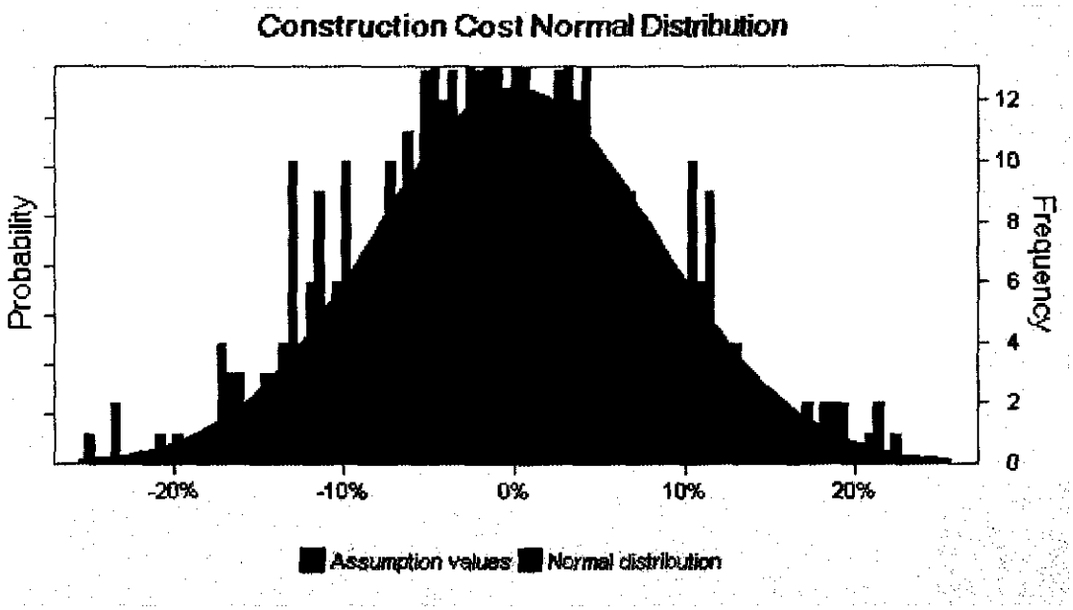



Interest rate fluctuations produce insignificant changes in DSCR and IRR. For example, when the interest base rate rises to 8 percent, the firm's ability to serve its debt decreases by only 7.7 percent to 1.41. The NPV, on the other hand, falls by 36 percent when interest rates rise to 8 percent. This is because a hike in interest rates will also increase the project's cost of capital, and thus reduce the project's profitability.

| Interest Rate Sensitivities | | | | | | |
|---|---|---|---|---|---|---|
| Interest Rate | DSCR | % Change | IRR | % Change | NPV | % Change |
| 8.0% | 1.41 | -7.7% | 13.5% | -5.5% | 226,026 | -36.4% |
| 7.5% | 1.44 | -5.9% | 13.7% | -4.2% | 255,823 | -28.0% |
| 7.0% | 1.47 | (0.04) | 0.14 | (0.03) | 287,245.23 | (0.19) |
| 6.5% | 1.50 | -2.0% | 14.1% | -1.4% | 320,394 | -9.8% |
| 6.0% | 1.53 | - | 14.3% | - | 355,377 | - |
| 5.5% | 1.56 | 2.1% | 14.5% | 1.4% | 392,307 | 10.4% |

### Construction Cost

The project is assumed to finish within the expected budget with a mean of 0 percent. To reflect the possibility the project will finish below or above the budget, the normal distribution assumes a ±25 percent change in budget costs from the mean.

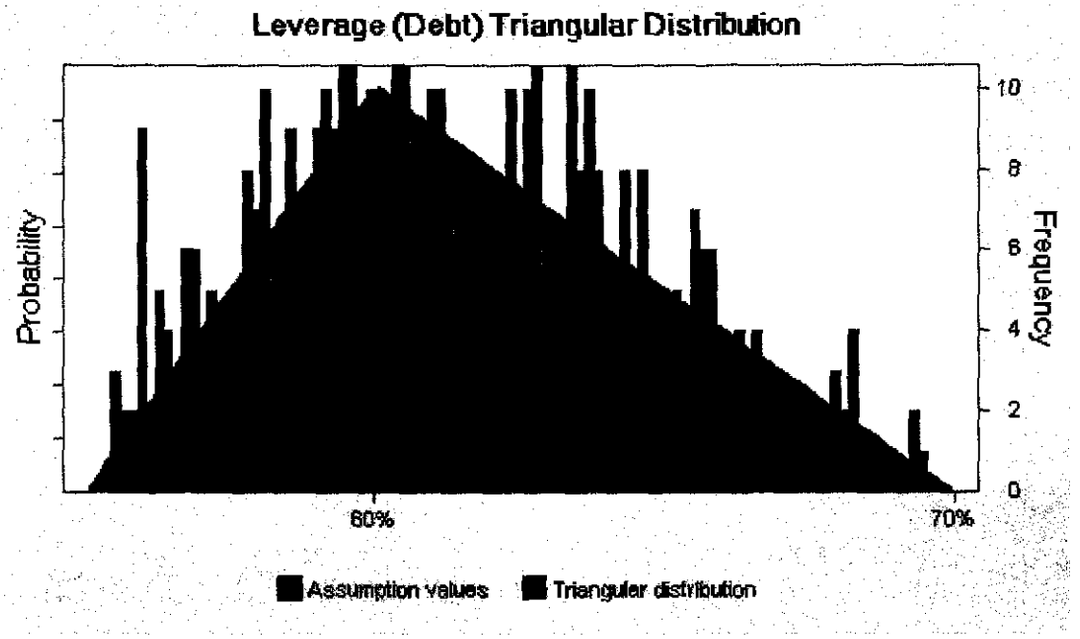



The table below demonstrates that running over or under budget greatly affects both DSCR, IRR and NPV. At both extremes, IRR is shown to be slightly more sensitive than DSCR to budgetary changes. NPV, however, decreases by almost twice as much as IRR, when construction costs are 25 percent above budget. While the NPV remains positive at $208 million, construction costs must be budgeted properly to ensure project profitability.

| Construction Cost Sensitivities | | | | | | |
|---|---|---|---|---|---|---|
| Cost | DSCR | % Change | IRR | % Change | NPV | % Change |
| -25% | 1.93 | 26.4% | 19.1% | 33.3% | 502,966 | 41.5% |
| -15% | 1.75 | 14.3% | 16.9% | 18.2% | 443,930 | 24.9% |
| -5% | 1.59 | 4.4% | 16.0% | 12.0% | 384,894 | 8.3% |
| 0% | 1.53 | - | 14.3% | - | 355,377 | - |
| +5% | 1.47 | -4.0% | 14.6% | 1.9% | 325,859 | -8.3% |
| +15% | 1.36 | -11.1% | 12.2% | -14.6% | 266,823 | -24.9% |
| +25% | 1.26 | -17.3% | 11.0% | -22.9% | 207,787 | -41.5% |

**Leverage**

Currently, the leverage is 60 percent (mean). This triangular distribution assumes that the minimum debt percentage is 55 percent and the maximum debt percentage is 70 percent.

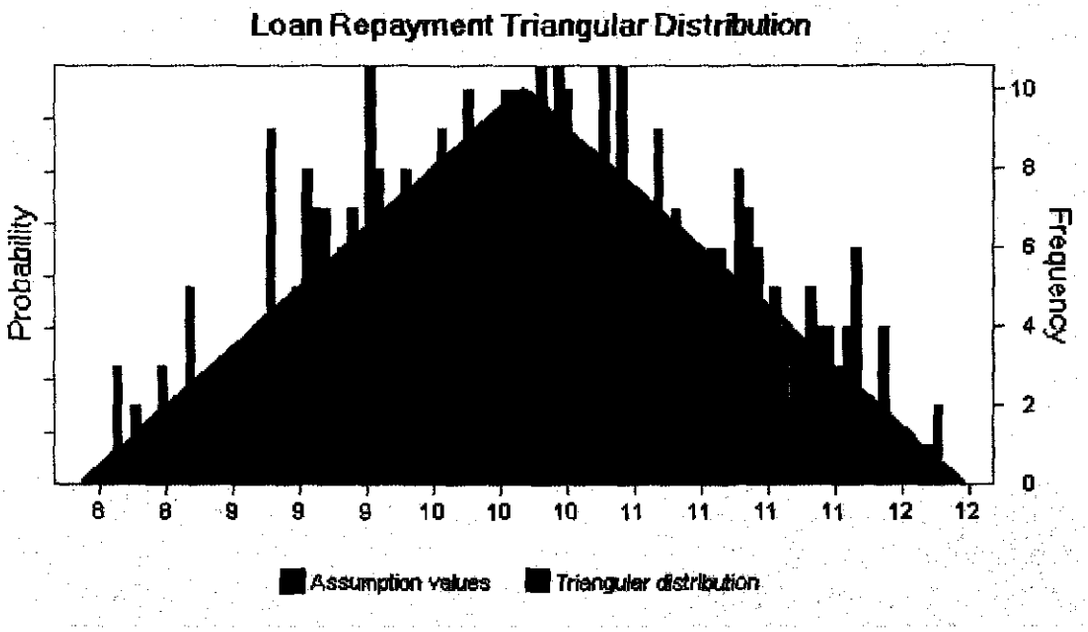



Leverage is one of the only assumptions that shows negative correlation between the IRR and DSCR. The more debt the project takes on, the more cash flow must be set apart to service principal and interest. In this case, IRR improves because a greater dividend stream is achieved with a smaller proportion of equity contributions. NPV also changes when the debt to equity proportions change. Because equity is more expensive than debt, an increase in leverage will improve the project's profitability (and NPV) but make it less appealing to lenders.

| Leverage (Debt) Sensitivities | | | | | | |
|---|---|---|---|---|---|---|
| Leverage | DSCR | % Change | IRR | % Change | NPV | % Change |
| 70% | 1.28 | -16.0% | 15.0% | 4.9% | 444,788 | 25.2% |
| 65% | 1.40 | -8.6% | 14.6% | 2.3% | 398,659 | 12.2% |
| 60% | 1.53 | - | 14.3% | - | 355,377 | - |
| 55% | 1.68 | 10.2% | 14.0% | -2.0% | 314,745 | -11.4% |

**Loan Repayment Term**

The financial model estimates a loan repayment term of 10 years, excluding the 33-month construction period. The minimum and maximum repayment term in this triangular distribution is 8 years and 12 years, respectively.




Changing the length of the repayment term produces modest changes to both the DSCR and IRR, although the DSCR is more than twice as sensitive to the alterations. Increasing the duration for repayment by two years increases a firm's ability to repay its debt by 10.5 percent, while increasing the return to investment by merely 4.7 percent. NPV will not change because the project cash flow looks at profitability on an unlevered project cash flow basis.

| Loan Repayment Term Sensitivities | | | | | | |
|---|---|---|---|---|---|---|
| Years | DSCR | % Change | IRR | % Change | NPV | % Change |
| 12 | 1.69 | 10.5% | 15.0% | 4.7% | 355,377 | 0.0% |
| 11 | 1.61 | 5.5% | 14.7% | 2.6% | 355,377 | 0.0% |
| 10 | 1.53 | - | 14.3% | - | 355,377 | - |
| 9 | 1.50 | -1.8% | 13.9% | -2.7% | 355,377 | 0.0% |
| 8 | 1.33 | -12.6% | 13.5% | -5.8% | 355,377 | 0.0% |

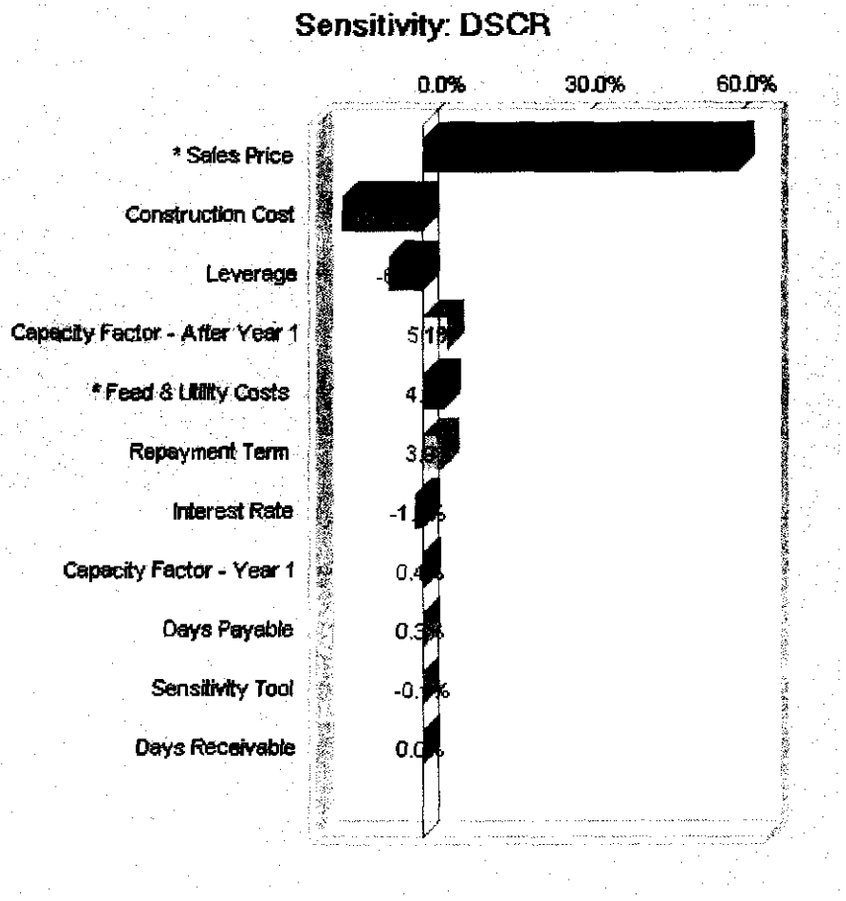
## E.3.2 Sensitivity Analysis Results

All of the above-mentioned assumptions and other relevant assumptions were run with ***Crystal Ball*** to ascertain the impact all assumptions have on debt service coverage ratio, internal rate of return and net present value. The charts below depict these assumptions and show their relative sensitivity to the DSCR, IRR and NPV. The base is 0 percent and the percentages attributed to each assumption show the magnitude of impact on both profitability measures. For example, the 43.8 percent sensitivity of the sales price on the DSCR is explained by a change in sales price over a range of ±25 percent. The reason the assumptions lie to either side of the base is explained by the impact an assumption change has on DSCR. For instance, a shift to the right of the base indicates a positive impact on DSCR. That is, an increase in sales prices

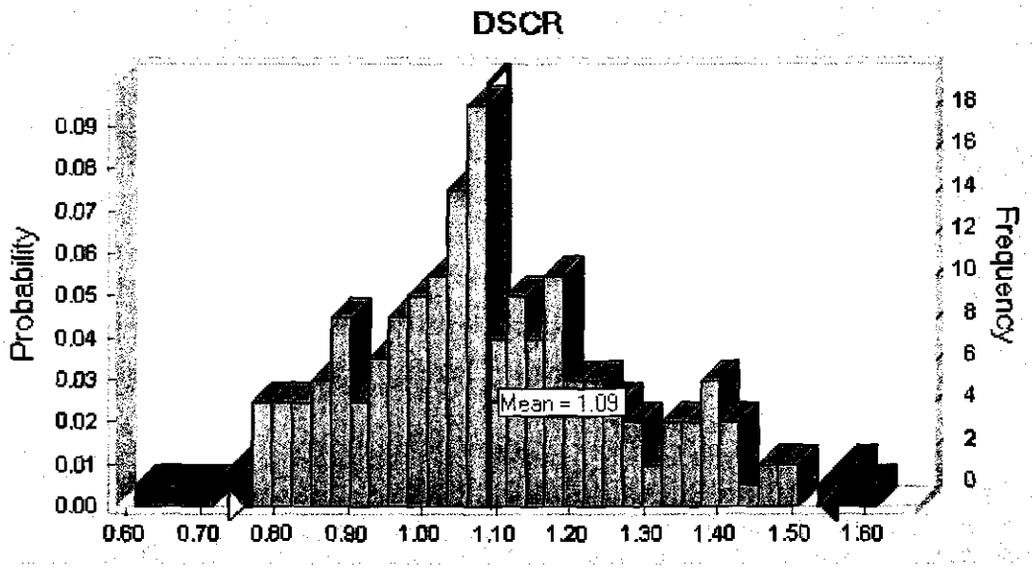
will have a positive effect on DSCR. However, if feed costs increase, the project will have to pay more funds for gas and its DSCR will decrease.

**DSCR Sensitivity**

The most sensitive assumption to the DSCR is sales price, representing over one half of total sensitivity (62.0 percent). Construction cost and leverage, with 15.9 percent and 6.5 percent of total sensitivity, respectively, are the second and third most influential assumptions. Other significant assumptions are capacity factor after year 1 with 5.1 percent and feed and utility costs with 4.4 percent. The remaining assumptions have a negligible effect on DSCR.

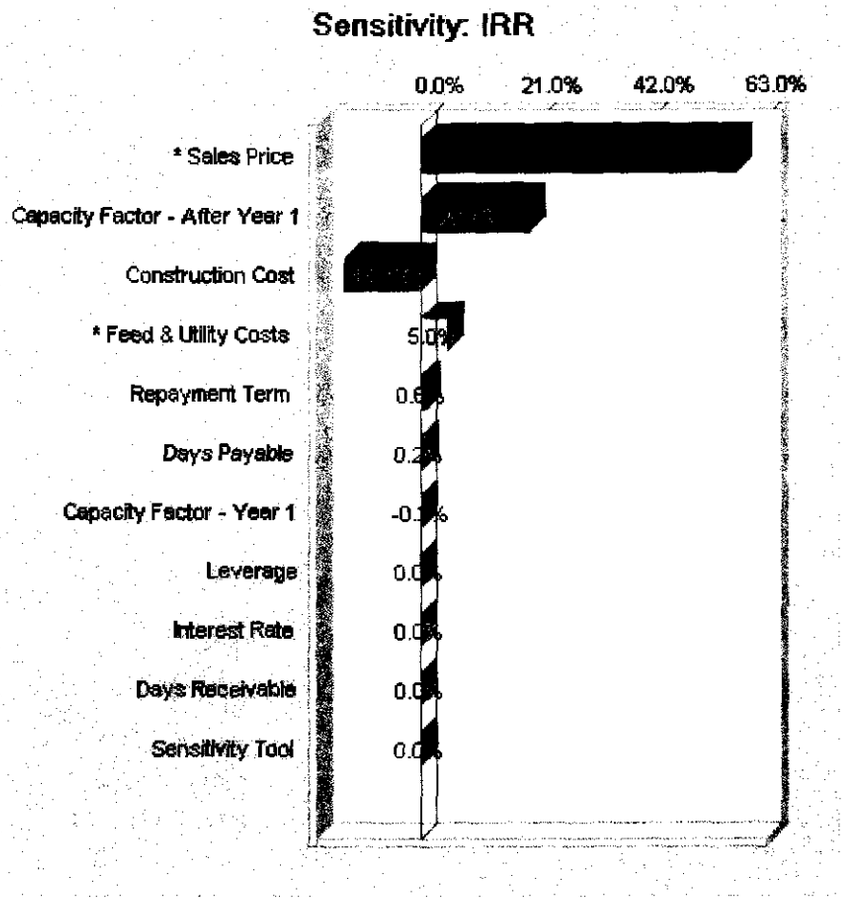



The graph below depicts the overall effects the assumption ranges have on DSCR. The data shows that with a certainty of 95 percent, the DSCR will be in between 0.8 and 1.55, with a mean of 1.09. As mentioned previously, the assumption standard deviations were set conservatively to analyze their impact on DSCR on a worst-case scenario basis.

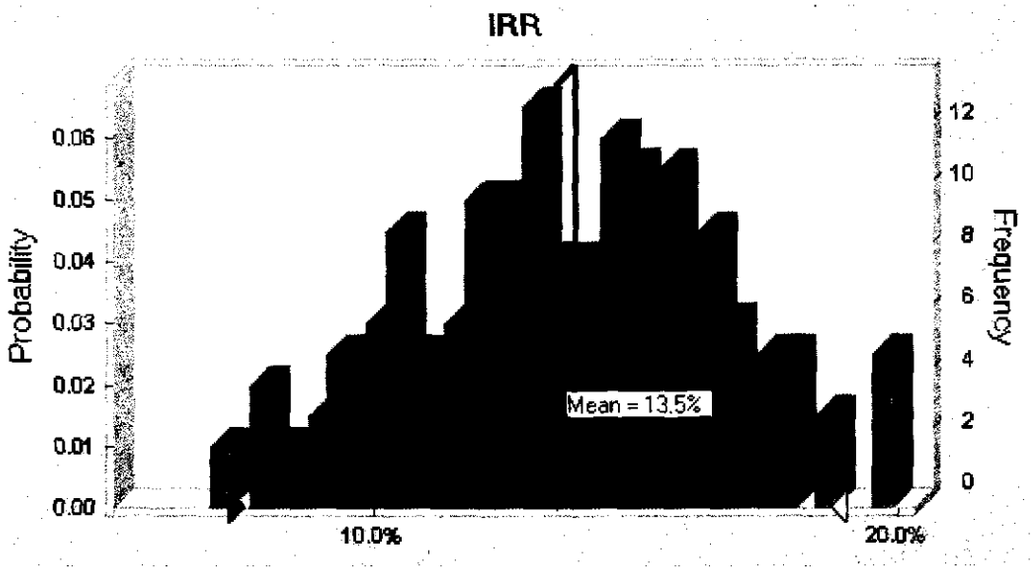



***IRR Sensitivity***

The following graph shows the degree of sensitivity assumptions have on IRR. When compared to the DSCR results, it becomes apparent that DSCR and IRR are positively correlated. That is, when the DSCR increases, the IRR will follow suit and vice versa. Therefore, it is not surprising to see that most of the same assumptions that have a strong effect on DSCR also have a significant effect on IRR. Sales price tops the list for both dependent variables and it impacts the IRR by 59.1 percent. Capacity factor after year 1 (20.1 percent) and construction costs (14.7 percent) impact the IRR more that DSCR, mainly because creditors receive the same fixed interest payments regardless of cost overrun and capacity factor, whereas equity investors receive fewer dividends.

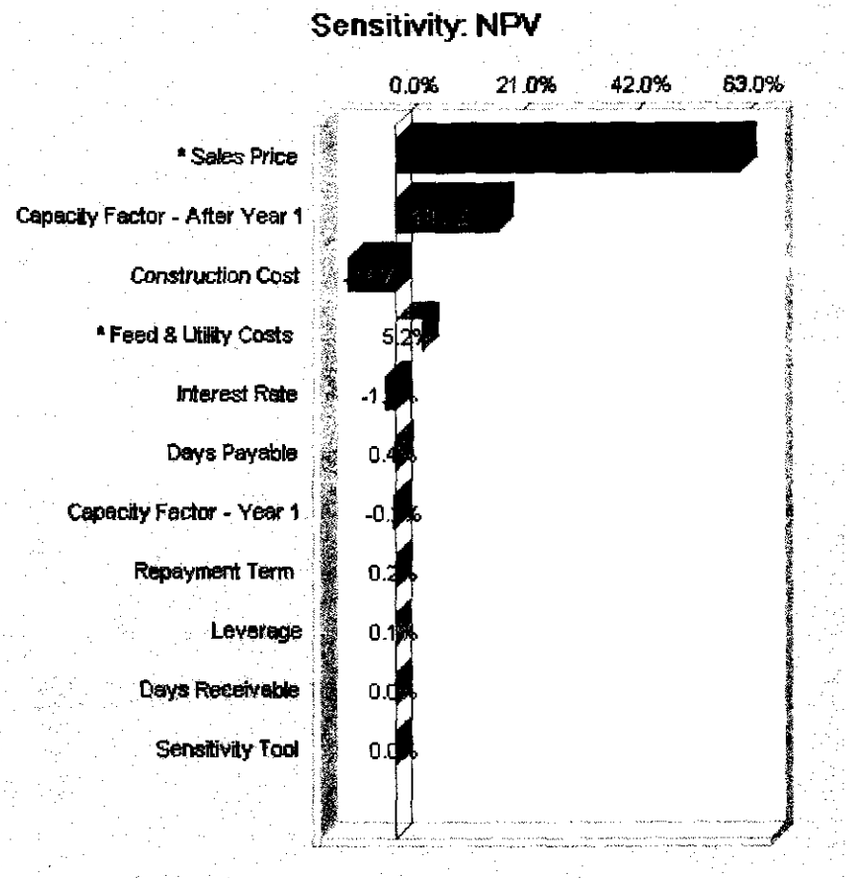



The graph below depicts the overall effects the assumption ranges have on IRR. The data shows that with a certainty of 95 percent, the IRR will be in between 7 and 18 percent, with a mean of 13.5 percent. As mentioned previously, the assumption standard deviations were set conservatively to analyze their impact on IRR on a worst-case scenario basis, thus, IRR is likely to be within a higher range.

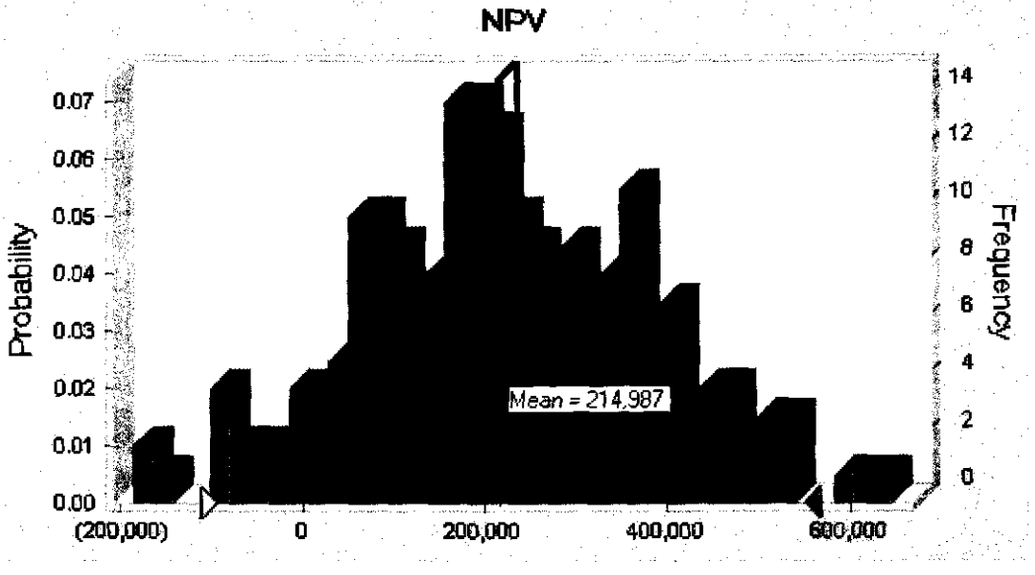



**NPV Sensitivity**

At 64.1 percent, NPV (like DSCR and IRR) is most sensitive to changes in sales price. Whereas the construction cost ranked second for the IRR and DSCR, the NPV is more sensitive to fluctuating capacity factors after year 1. This is explained by the direct relationship between costs of goods sold, revenues and profitability, which are all measures of particular importance to the NPV. Along the same lines, feed and utility costs (which also directly influence revenues) will also affect NPV more directly than the DSCR and IRR, and thus, ranks fourth. Whereas the construction cost has a stronger impact on DSCR and IRR, the NPV is still significantly affected when construction costs fluctuate. Section F.4 will take this analysis further and show how the top four assumptions impact the DSCR, IRR and NPV in economic terms.




The graph below depicts the overall effects the assumption ranges have on NPV. The data shows that with a certainty of 95 percent, the NPV will be in between negative $80,000 and $580,000, with a mean of $214,987.



## E.4 Developmental Impact Analysis

### E.4.1 Impact on trade balance

#### E.4.1.1 Imports

During the 33-month construction phase, approximately 73% of the required labor and fixed assets used for the construction of the plant and marine loading terminal will be imported into the country, mainly from Europe and the US. Services, such as legal and financial consulting services, will also be imported during construction. To operate the plant, the Project will import chemicals, catalyst and routine maintenance parts replacement categorized as "Operating Costs". During the life of the Project total imports are expected total approximately $756 million. The table below summarizes the foreign goods and services to construct the methanol and ammonia plant.

| Total Imports | |
|---|---|
| ISBL/OSBL, Terminal | US$ 550.4 million |
| Operating Costs | 194.1 million |
| Financing Fees | 11.7 million |
| TOTAL | US$756.2 million |

#### E.4.1.2 Exports

Echem expects to retain 15% of the methanol and ammonia for domestic consumption, leaving the remaining 85% available for export. With 3,000 MTD for methanol and 1,200 MTD of ammonia being produced and commodity prices to remain strong over the next several years, the Grantee expects to increase Egypt's export revenue by almost $215 million per year for each phase of the Project.

#### E.4.1.3 Trade Balance

Per phase, the Project will realize an overall trade surplus by exporting more production during operations and importing relatively less capital during construction. Assuming approximately $756 million worth of goods and services will be imported during construction and operations during each phase, and the Project will generate $6.2 billion in revenues over the next 25 years (including construction period), the net effect on the trade balance will be an increase of $5.4 billion.

Regarding the annual impact on the trade balance, the Project will contribute to a short-term increase in imports during the construction period, thereby negatively impacting the trade balance. However, on average the Project will improve the current account balance by over $52 million per year. Egypt historically has been a net importer of goods and services, although it has improved its trade deficit steadily over the past several years. In 2004, Egypt achieved export revenue of $10.5 billion. After construction of the facility is complete, and assuming annual export revenue of $213 million for each phase of the Project, the Egypt's total exports will increase by approximately 2.0% per year, resulting in an improvement the country's overall trade balance.

### E.4.2 Financial Flows

#### E.4.2.1 Inflows

*Hard Currency Revenue.* An average $150 million per phase will enter the country through the offtaker purchase of methanol. The Project will also generate approximately $65 million of ammonia revenue per year from a separate offtake agreement. Total annual inflow of hard currency (US dollars or Euros) will increase foreign exchange by the equivalent of approximately $215 million.

*Direct Investment.* The Project will be financed through a combination of debt and equity, most likely from international investors. The majority of the $550 million in debt financing will likely come from outside the country, such as international financial institutions (IFIs) or commercial banks. In addition, both Methanex and Agrium have also expressed interest in contributing substantial equity alongside the Grantee toward construction of the plant. Initial talks have

suggested outside investors could potentially contribute as much as 80%, or approximately $335 million, of the total needed equity.

### E.4.2.2 Outflows

*Dividends.* Once the Project becomes profitable, any remaining cash will be distributed to the shareholders in the form of dividends. With key equity partners expected to be non-Egyptian companies, some of these dividends will flow out of the country. Based on projections, annual average dividends out of the country as expected to be approximately $70 million, which will be divided proportionately among the stakeholders.

*Suppliers.* Foreign suppliers will continue to support the project during its operations. Catalysts will be replaced every four years during major overhauls, and other spare parts will be required for routine servicing and unexpected technical problems. The EPC contractor and other foreign contractors will continue to be involved to supervise the ongoing maintenance of the plant and provide operational support as a whole.

*Debt Service.* The Project will begin making principal and interest payments to lenders. For each phase of the Project, the annual debt service is projected to be approximate $30 million per year in constant dollars. Given that the Project will be in large part financed by multinational financial institutions, a significant percentage of debt service will flow out of the country.

### E.4.2.3 Impact on Exchange Rate and Hard Currency Reserves

The Project will support the local exchange rate against by increasing the reserves available to pay debt service and other third-party payables. With sufficient reserves available, there will not be a need to sell the pound in exchange for hard currency, which would reduce the demand for Egyptian currency and depreciate the exchange rate. The increase in reserves will also take foreign currency out of market circulation and indirect appreciation of the pound.

### E.4.3 Effects on upstream/downstream industries

Industries that indirectly support the construction and ongoing operations of the Project will also experience similar benefits. The transportation sector will be a vital player in delivering raw materials to the plant and also carrying the product away for distribution and sale. Other non-

technical services, such as banking and legal services, will also experience increased business activity as a result.

#### E.4.3.1 Transportation Sector

Railroad and trucks will be key to delivering the plant on time. During construction, raw materials will be transported via rail and roadway from the point of production to the project site. After production begins, the shipping industry will be also play an integral part in exporting the methanol and ammonia abroad. At least 85% of the plant's output will be available for export, which will exit the country on vessels at the nearby marine port terminal. The new plant will not only increase demand for marine transport vessels but also for increased crew to support the export of the products. The vessels could either be operated by local or expatriate crews and, therefore, could have positive employment impact both locally and abroad.

#### E.4.3.2 Natural Gas Industry

Increased demand for feedstock will provide a boost to the country's natural gas industry. The project will diversify the supplier's customer base, which will reduce its credit exposure to any individual customer and reduce Egas' general reliance on the export market.

#### E.4.3.3 Agricultural Product Distribution

Local fertilizer manufacturers and distributors will have increased access to ammonia with 15% of total ammonia production to be retained for domestic consumption. Local manufacturers will realize raw material savings by not needing to import the ammonia, instead using locally produced ammonia to be purchased at a lower cost (at least partly through transportation savings). These savings could be passed along to the end consumer, such as the local agriculture sector. Cheaper inputs also mean increased profitability for the fertilizer manufacturers.

### E.4.3.4 Financial Services

Although most of the debt financing will originate from international banking institutions, local Egyptian banks are also expected to enter into any syndicated loans structures to finance the Project. Local banks will also be heavily involved in the ongoing financial support of the Project, including facilitating payments to suppliers, receiving payments from offtakers, and managing routine operating expenditures.

### E.4.3.5 Professional Services

Throughout the life of the Project, other professional services such as accounting, legal, and tax services will be needed to manage the non-technical aspects of plant operations. Most of the legal services will be required upfront during the documentation and closing phases of the financing process, as well as some routine services rendered throughout operation. Third-party accounting and tax services will be required on a periodic basis to conduct reviews of the plant's performance and prepare financial statements as demanded by the investment community.

## E.4.4 Developmental impact

### E.4.4.1 Job creation

*Direct Employment.* The Project will increase local employment significantly during the construction phase, not only in the direct construction of the plant but also in the upstream and downstream industries that will support its construction. Both the construction and operation periods will generate new jobs with a range of experience and skillsets, including opportunities for unskilled and skilled labor force. The total number of jobs created during each phase is summarized in the table below:

| | Management | | Professional/ Technical | | Unskilled Labor | |
|---|---|---|---|---|---|---|
| | Construction | 5th Year | Construction | 5th Year | Construction | 5th Year |
| Phase 1 | 5 | 3 | 25 | 6 | 30 | 9 |
| Phase 2 | 5 | 3 | 25 | 6 | 30 | 9 |
| Phase 3 | 5 | 3 | 25 | 6 | 30 | 9 |
| TOTAL | 15 | 9 | 75 | 18 | 90 | 27 |

The plant will operate in three 8-hour shifts, with six operators per shift operating the plant. Three of the operating labor will be either technical or management level, with the remainder dedicated to the actual operations of the plant. Each phase generates 78 new jobs for a total of 234 new jobs by the beginning of Phase 3 production.

*Indirect Employment.* In addition to people employed directly by the project company, various subcontractors, suppliers, and customers of the project will experience increased employment as a result of the project. During construction, for example, the level of civil works activity and transportation and supply of construction materials will create substantial employment opportunities in the local market for both semi-skilled and unskilled labor.

Long-term indirect employment will be created by the need for transportation of raw materials and finished products. Other support services, including professional and financial services, will also be needed to support the project company. Permanent indirect job creation in Egypt (at companies such as Egas) is expected to be as much as 1,500 permanent jobs.

### E.4.4.2 Employee Training and Technology Transfer

Employees will receive substantial on-the-job training to ensure the plant operates efficiently and safely. Training programs will be mandatory and directed at specific employee responsibilities. This could include production procedures, handling of power generation facilities, and materials handling.

The methanol production technology envisaged to be used in the Project has not yet been introduced in the country and, therefore, local engineers and plant operators will gain new

knowledge and understanding regarding the application of this technology. Training will also focus on knowledge transfer of the new technology, including fundamental understanding of plant processes and maintenance.

### E.4.4.3 Strengthening of Infrastructure

In addition to the physical plant, the Project includes construction of a marine loading terminal to allow the methanol and ammonia to be easily loaded onto ships and transported to their final destinations. The port will also allow other businesses to use their port facilities for trade, thereby strengthening the overall regional infrastructure. A small on-site power generator will also be installed to provide power directly to the plant. This will free up the demand that would have otherwise needed to be met by the local electricity company. With the on-site generator, that unused electricity can now be redistributed back into the community for local consumption.

# TASK F RISK ASSESSMENT AND MITIGATION ANALYSIS

## F.1 and F.2 POTENTIAL RISK ELEMENTS

### F.1.1 Market Variables

Demand for the methanol and ammonia as intermediate goods is inextricably linked to the production of common final goods, such as plastics, consumables and fertilizer. A downward trend in demand for those goods could significantly impact demand for methanol and ammonia. Price also influences demand and manufacturers could begin substituting methanol or ammonia for cheaper alternatives, should market prices rise substantially. Competition from large petrochemical corporations could also decrease the Grantee's market share.

With regard to market demand, it is unlikely that the overall demand for methanol or ammonia will decrease significantly, since they are both vital to the production of many common household goods and fertilizers. Demand for the final products will always be expected to be high and therefore any demand risk is perceived to be low. In addition, many multinational companies are beginning to shift their production expansion to regions – such as the Middle East and Africa – where there is a feedstock advantage. In this regard, the Grantee could benefit from increased demand from new production capacity being established in close proximity.

Mitigation Strategy: To mitigate demand and price risk, offtake contracts should be structured on a long-term, take-or pay basis, with a pricing structure that can offset any risks relating to unexpected drops in the spot market. One possible structure would be partially-floating prices tied to market prices, but entailing adjustment "collars" on prices (i.e., maximum percentage changes that prices can move in any given time period). As noted below, the project appears to be capable of bearing a certain degree of price risk.

### F.1.2 and F.1.3 Investment Costs, Construction and Completion Risk

Construction risk includes the risk that a) the project is not completed, b) the project is completed late, or c) the project is completed over budget. Such construction and timing issues can translate into increased risk to the overall cost of the investment. Given the greenfield nature of the first phase of the project, construction risk to the Grantee is potentially significant. In addition to negative impacts on debt service coverage and return on equity, the Grantee could be subject to further economic harm depending upon the terms of its gas supply (i.e., take-or-pay) and performance clauses in its offtake contracts. Principal and interest payments will also be expected to begin even if the grace period expires before construction is completed.

Mitigation Strategy: The Grantee should manage this risk by structuring the EPC contract on a fixed-price, date-certain basis and should consider the following options with respect to mitigating construction risk:

i) Selection of an EPC contractor with a strong track record, ample financial resources, and experience working in potentially remote locations;

ii) Selection of a project site on or near existing infrastructure, including port facilities and access roads, to reduce ancillary construction requirements;

iii) Inclusion of strong provisions in the EPC contracts for delays caused by the contractor and its sub-contractors (i.e., liquidated damages commensurate with economic losses due to delay—see Task F, Part II) and recourse for non-performance;

iv) Inclusion of a cost overrun contingency provision in the uses of funds;

v) Establishment of a milestone payment structure under the EPC contract, with escrowed retention payments until final acceptance;

vi) Requiring the contractor to purchase insurance coverage for environmental risks;

vii) Selection of an independent engineer to monitor progress and ensure satisfactory completion of milestones;

viii) Careful monitoring of, and provision of assistance to, the EPC contractor via on-the-ground technical staff; and

ix) Inclusion of its gas supplier and/or offtaker(s) as equity partners to align interests, and careful attention to performance requirements in gas supply and offtake

### F.1.4 Technology

Modern technology employed in methanol and ammonia production is generally based upon recent advances and often proprietary. The risk of production losses due to technology failure is a risk that should be considered carefully.

Mitigation Strategy: The Grantee should select a technology and technology provider with a strong track record of implementations and significant financial resources. In addition, the Grantee should require extended warranties under the EPC contracts to further mitigate technology risk.

### F.1.5 Plant Sustained Operating Performance

Since the project's revenues are directly linked to its methanol and ammonia production, the Grantee's ability to operate and produce at a reasonable cost will have a significant impact on results of operations. Higher cost of operations could translate into tighter margins, which effectively could constrain their ability repay debt. In addition, a lack of technical knowledge and proficiency could result in a) unplanned outages at the facility that will lower revenue and cash flow, b) cause damage to equipment due to a lack of proper maintenance, and c) create safety hazards for employees.

Mitigation Strategy: The local operating team should have a minimum basic level of petrochemical industry experience, and at least 60 percent of the plant operators will have formal technical training and management expertise. The project team should be augmented during each of the initial operating phases by the EPC contractor, who will provide warranty support for the initial operating phase. In addition, the Grantee's standard procedure for the project should include the purchase of mechanical breakdown insurance. Construction of the project using an appropriate design will also reduce the risk of unforced outages.

### F.1.6 Competition

Competition from large petrochemical corporations could decrease the Grantee's market share. In addition, many multinational companies may begin to shift their production expansion to regions where there is a feedstock advantage.

Mitigation Strategy: In order to minimize competition risk, the Grantee should conduct a preliminary analysis of comparable pricing structures for major competitors in the industry. Based on the findings, the Grantee should then secure offtake agreements on a long-term, take-or-pay basis for both methanol and ammonia products, thereby fully mitigating any risk exposure from external competition.

**Offtaker Risk**

Offtaker risk includes risk of late payment or other defaults in the offtaker agreement. Assigning one offtaker for each product fully exposes the Grantee to the creditworthiness of a single entity. In the event of delayed payment or nonpayment, the Grantee will have difficulty or be unable to meet its own financial obligations.

*Mitigation Strategy:* The Grantee should consider the following strategies to reduce offtaker risk:

i) Selection of offtakers who are large multinational corporations and are unlikely to encounter difficulties in meeting their payment obligations;

ii) Structuring of the agreements on a take-or-pay basis for a combined 100 percent of the output;

iii) Selection of multiple offtakers to dilute dependency associated with a single offtaker; and

iv) Requiring offtakers to post credit enhancements to support timely payments under the offtake agreement, such as an escrow account or standby letter of credit.

### F.1.7 Feedstock Supply Risk

The Grantee is dependent upon the technical, operational, and financial stability of the gas supplier for a reliable and consistent stream of gas deliveries. Furthermore, Egas' policy on natural gas reserves currently stipulates that one-third of the reserves be used for internal consumption. If EGas shifted its policy to a more export-oriented approach to consumption, this could threaten the Project's feedstock supply. Similarly, the project envisions the sale of gas to the Grantee at what could be interpreted as a subsidized rate. Should the gas supplier or other relevant entities change their current outlook on this issue, the project could suffer negative economic consequences arising from a higher gas price. In general, however, typical price movements should not have a strong negative effect on the Grantee, as product prices are generally linked to the price of natural gas.

*Mitigation Strategy:* Gas delivery risk should be mitigated by identifying one or more alternative fuel suppliers in the case of a primary supply interruption, as well as identifying the nature and cost of alternative fuel delivery (assuming that a pipeline would not be available for this purpose). In addition, the Grantee should seek strong supply agreement provisions covering price movements, including price adjustment collars. Other mitigation strategies for feedstock risk are described in more detail below.

### F.1.8 Margin and Price

An increase in the price of feedstock could increase production costs, thereby shrinking profit margins for the Project. Local inflation could reduce spending capacity by consumable and fertilizer manufacturers. Variable operating costs, such as wages and electricity prices, would also be impacted by inflation and reduce operating margins.

Mitigation Strategy: The Grantee should be sure to mirror the indexation or escalation terms of its gas supply contract with its offtake agreements to mitigate inflation risk. The Project is also largely protected from any negative impacts from local inflation (should local inflation outpace USD or EUR inflation) since most of its product will be purchased through hard currency offtake agreements and exchange rate adjustments should counteract the disparity in inflation.

### F.1.9 Political Risk

Political risk includes political violence (including insurgency and terrorism), currency inconvertibility, expropriation, and breach of contract. Even though Egypt has a relatively stable political history on a sovereign level, the recent unrest throughout the Middle East could increase tensions within the country and the region in general.

Mitigation Strategy: The Grantee is owned by the Government of Egypt and as such is not subject to traditional political risk.

### F.1.10 Interest Rate Risk and Foreign Exchange

**Interest Rate**

An increase in world interest rates could significantly increase the debt service burden for a variable rate loan. With world interest rates recently at an all-time low, it is projected that rates will steadily increase over the medium- to long-term.

Mitigation Strategy: Interest rate risk should be mitigated by securing fixed interest rate debt. While today's 6-month LIBOR base rate is approximately 2.3 percent, a fixed LIBOR rate for a 12.5-year loan with level principal payment could be secured at a 4.5 percent level.* This would eliminate interest rate risk to the borrower in an environment where interest rates are expected to rise.

**Foreign Exchange Risk**

Acquiring US dollar-denominated debt while sourcing equipment from Europe could result in a currency mismatch should the dollar depreciate further against the euro, thereby making payments to suppliers more expensive. Similarly, if the Egyptian pound appreciates against the US dollar or euro, operating expenses paid in local currency would also become more expensive for the Project, which will receive its revenue in hard currency. Adverse effects in the exchange rate between the US dollar and Egyptian pound could have a negative impact on the ability of the project to service its debt and provide equity returns to international investors.

Mitigation Strategy: The Grantee should obtain debt financing denominated in two currencies (USD and EUR) in a ratio matched to the Project costs and, given the anticipated size of the loan; lenders should be willing to consider a bifurcated currency structure. Historically, the Egyptian pound has continued to depreciate against the US dollar and this trend is not expected to change; however, any possible appreciation against the US dollar or euro is likely to be slight and would not adversely impact the Project. Also, with offtaker payments and the capital

* Assuming weighted average life of the loan in 7.5 years, interest rate is based on corresponding US-dollar swap rate.

structure both expected to be denominated in hard currency, the Project can expect to be protected from the risk of losses from foreign exchange rate fluctuations.

## F.3 MITIGATION STRATEGIES ON AN OPPORTUNITY COST BASIS

During the sensitivity analysis of the Project's financial structure, key inputs were identified as having the most significant impact on the debt service coverage ratio (DSCR), internal rate of return (IRR), and net present value (NPV) for the project. The risks highlighted below were deemed to be the most sensitive factors associated with the project and, therefore, special attention should be given to its overall impact on the project.

**Price Risk:** Fluctuations in prices could present the most significant risk to the project. Under normal assumptions, the project has a DSCR of 1.53, equity IRR of 14.3 percent, and an NPV of $355 million. However, if the offtaker and the Grantee enter into a take or pay contract that does not include a ceiling/floor provision and the weighted average price for both products drops 25 percent below the current market price (during the project's life), the DSCR would drop to 0.78, the IRR to 5.1 percent, and the NPV to negative $163 million. It is important to note that in this case, the DSCR will fall below 1 and the project will have difficulty in covering its debt. With a NPV of negative $163 million, the project is not deemed feasible if price drops by 25%.

To mitigate this risk, the take or pay contract should set pricing collars above and below the spot price. The price collar should be within ±15 percent of spot price to ensure that the Grantee has sufficient funds to service its debt even if prices decrease by 15 percent. The opportunity cost of this structure occurs if prices surpass the ceiling collar because the Grantee will forgo revenue inflows that would have been earned under a pure spot price contract. However, if the opposite occurs, the project will have hedged price risk properly.

**Construction Risk:** During the cost overrun sensitivity analysis, a change of ±25 percent was evaluated to determine the impact on DSCR, IRR and NPV. While the percent of change was highly sensitive to the degree of cost overrun or underrun scenarios, the model demonstrated that the Project would still have sufficient funds to service its debt (DSCR of 1.26), even in the event of a 25 percent overrun in construction costs. Both the IRR (11.0%) and NPV ($208 million) also indicate that the project will still be profitable in the event of such a cost overrun.

Including performance incentives in the construction contractor agreement can hedge the risk of cost overrun. If, for example, construction costs are 15 percent higher than expected, the contractor must reduce construction fees by a certain percentage of the cost overrun. Thus, the Grantee can use these funds to cover the budget shortfall. If the opposite holds true, the contractor would receive a certain percentage of the net cost savings, and the remainder would be returned to equity investors as dividends or used to finance the project internally.

**Fuel Supply Risk:** Feed & utility costs are closely related to the NPV because any change will directly impact gross margin and affect operating cash flow. As a result, it is not surprising that a 25% increase in feed costs will reduce NPV by 47.7 percent to $186 million. DSCR and IRR do not show such a strong degree of sensitivity, but nonetheless the IRR would decrease by 20.9 percent to 11.3 percent, and the DSCR would decrease by 15.8 percent to 1.29.

One way to hedge against this risk is to enter into a gas purchasing agreement that allows adjusting gas prices to market prices after the caps are expired. The benefit to the project arises if market prices are well below escalated gas prices. From this point on, the Grantee will only be exposed to market risk. On the flipside, if product prices had stayed low during years 1-20 and the market price at this point is well above the effective gas price, the project will see its fuel price increase.

**Capacity Factor Risk:** When conducting a sensitivity analysis for production capacity, it was found that in a worst case scenario when production is only at 75 percent running capacity (as opposed to the base case of 95 percent), the DSCR, and IRR would remain relatively strong, albeit decreasing by 20.1 percent and 28.5 percent, respectively. While the NPV will still remain well above 0, the number will fall 64.3 percent below the projected NPV to $127 million.

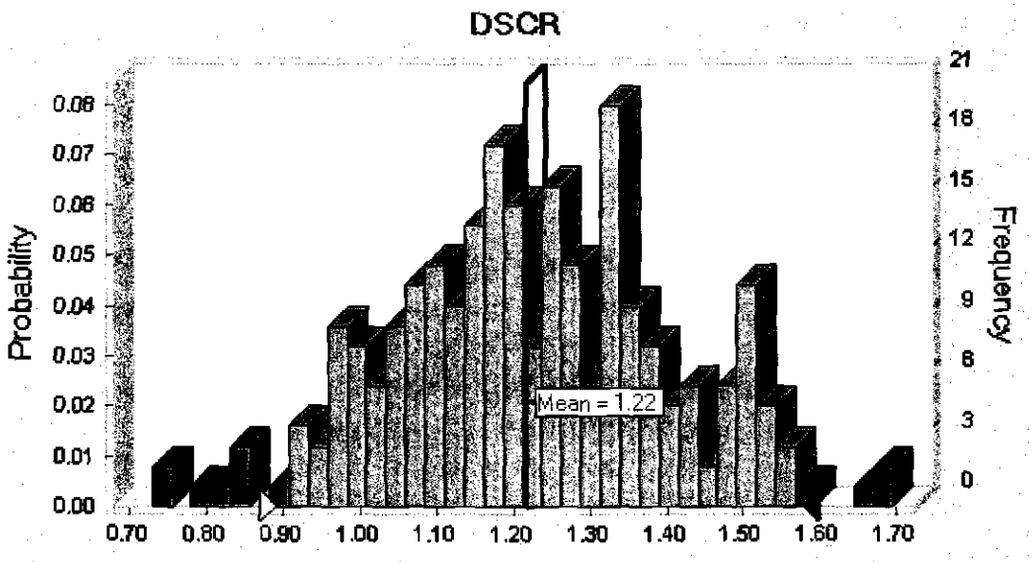
To ensure the plant is working at the optimal capacity of 95 percent, the Grantee should select an EPC contractor with experience in planning and constructing of such a plant. Additionally, the Grantee should purchase equipment that can run at 95 percent capacity without any complications. Lastly, the equipment will have to be maintained regularly and technicians/engineers should be trained accordingly.

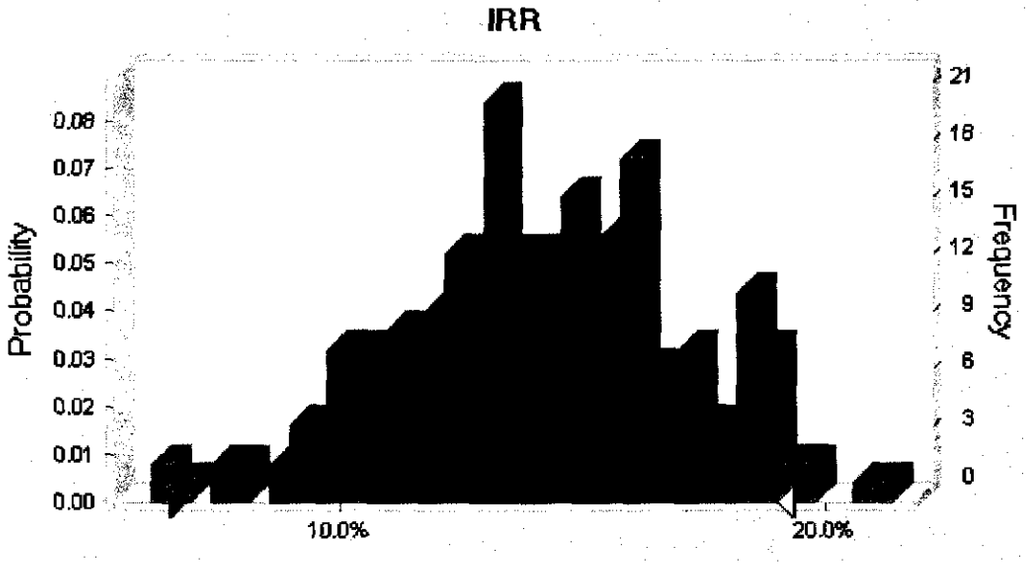
## F.4 RISK ANALYSIS IN ECONOMIC TERMS

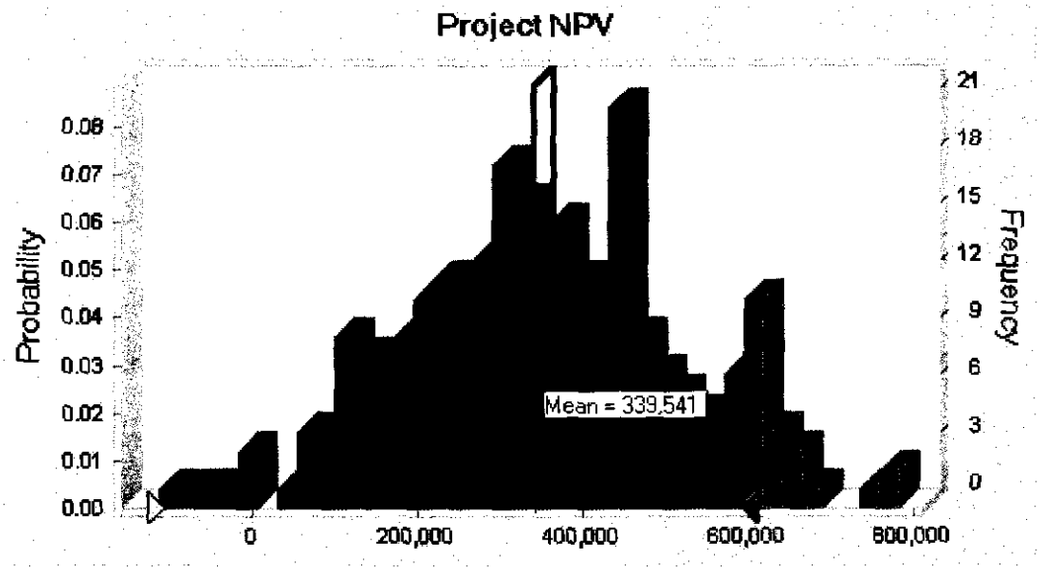
As discussed in Section E.3, some assumptions have a greater impact on profitability measures than other assumptions. In the base case of the financial model, the DSCR and IRR are 1.34 and 12 percent, respectively. The NPV in the base case is just under $254 million, using a discount rate of 8.8 percent. In this section, the analysis will focus on each key assumption individually, in order to analyze its effect on DSCR, IRR, and NPV. Simulations in Crystal Ball will analyze each assumption at a 95 percent confidence interval and the key assumptions will have the same ranges of values as in Section E.3. A 95 percent confidence indicates that during the life of project, the DSCR, IRR, and NPV will fall between a specific range 95 percent of the time.

**Sales Price:** When the sales price moves ±25 percent across the normal distribution, there is a possibility that the project may be unable to cover its debt payments during some years because it is not sufficiently profitable. As seen in the charts for each profitability measure, we

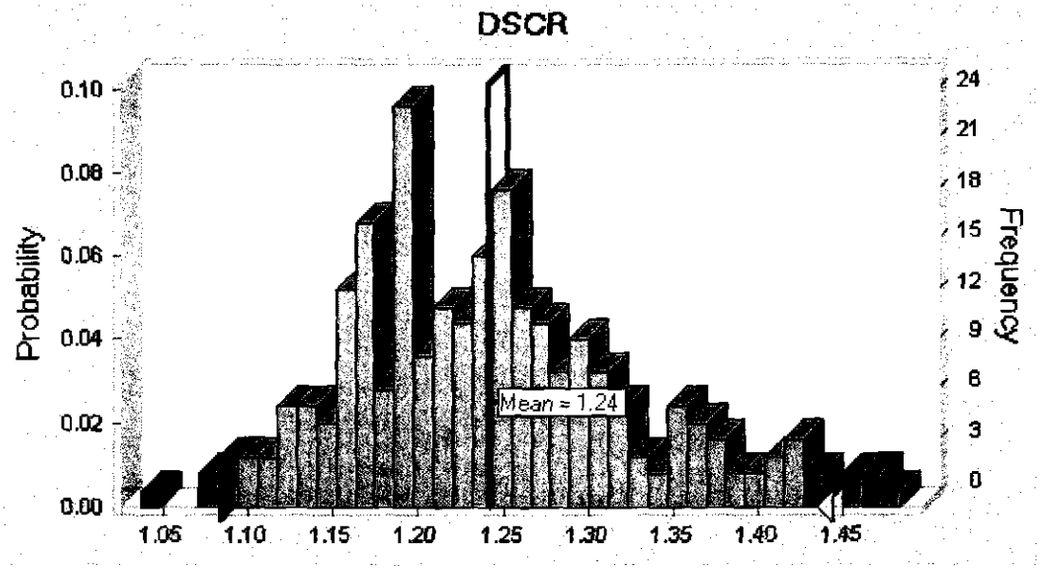
can predict with 95 percent confidence that the DSCR will range from 0.9 to 1.6, with a mean of 1.2 and the IRR will range from 7.0 to 19.0 percent. The NPV will fall between negative $100 million and $600 million, with a mean of $340 million. Therefore, in a worst-case scenario where the sales price is reduced by ±25 percent for an extended period of time, the DSCR could fall below 1, and a cash flow shortage to cover debt service may arise. Since part of the range of the IRR falls below the cost of capital, the project NPV could also be negative. It must be noted, however, that the probability that the sales price will fall by 25% during all years is extremely low. More likely, sales price will be higher in some years and lower in others, and the probability distribution would cluster around the mean.

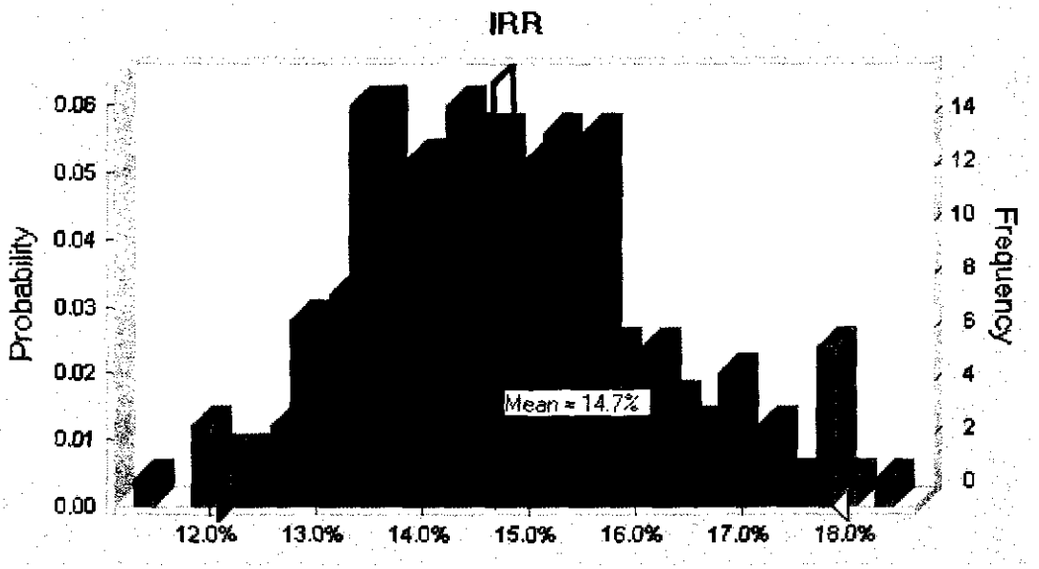


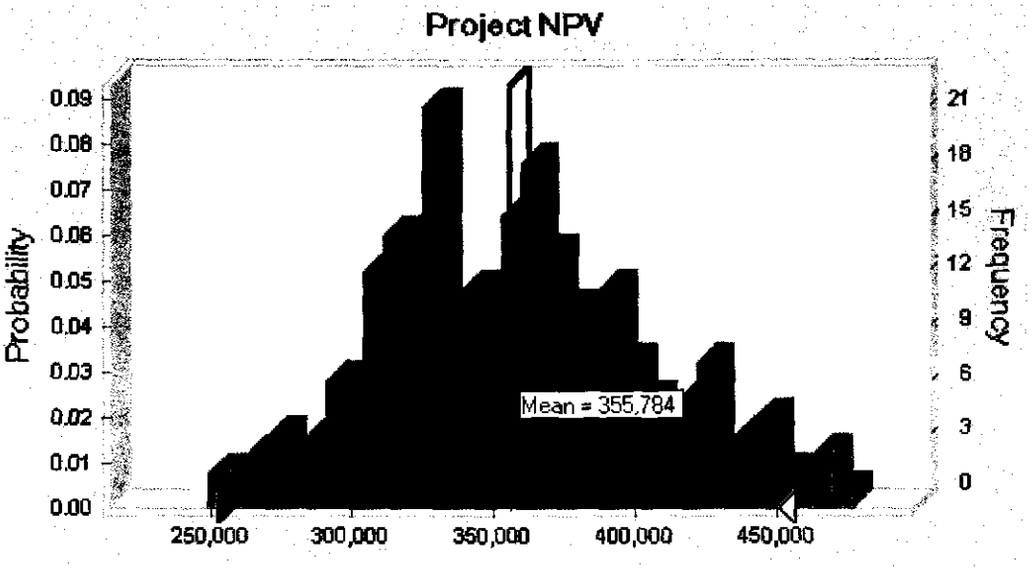






**Construction Cost:** The DSCR, IRR and NPV perform satisfactorily even when the cost over/underrun moves by ±25 percent across the normal distribution. As seen in the charts for each profitability measure, the DSCR ranges from 1.1 to 1.4 with a mean of 1.24 and the IRR ranges from 12 percent to 18 percent with a mean of 15 percent. The NPV also remains satisfactory, ranging between $260 million and $450 million, with a mean of $356 million. As seen in each graph, the DSCR, IRR and NPV results are strong enough for the project to be deemed profitable even under a worst-case scenario.

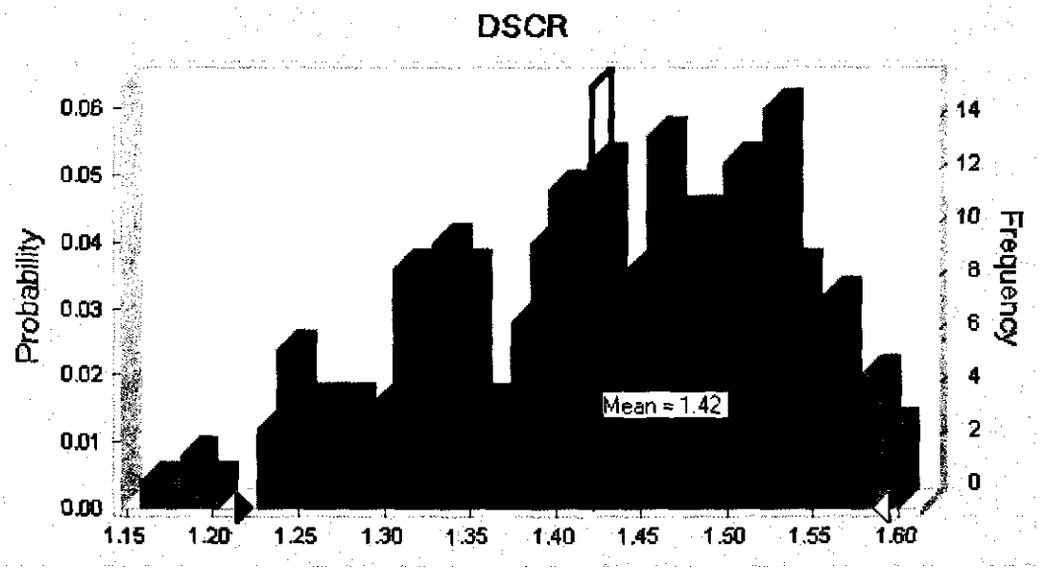


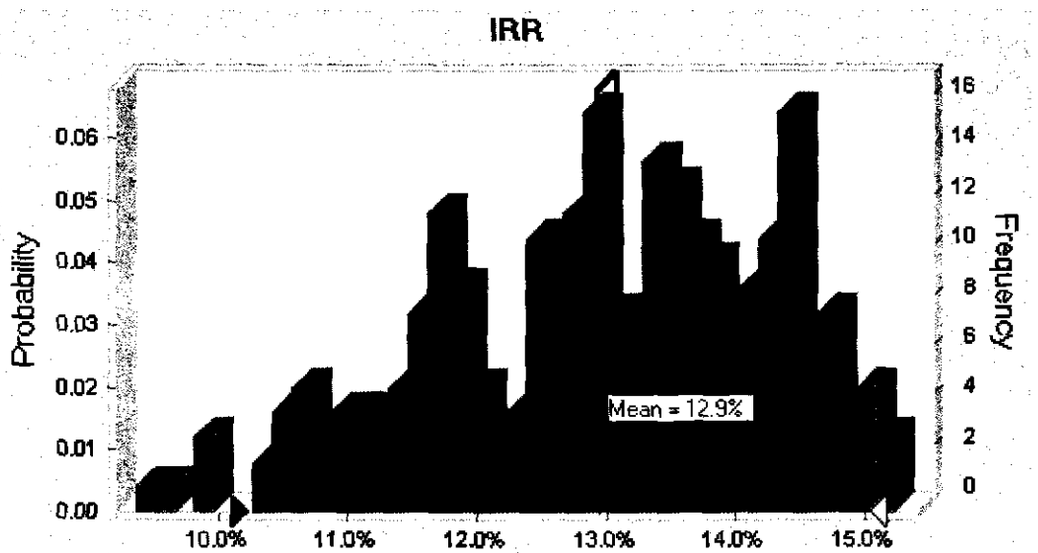


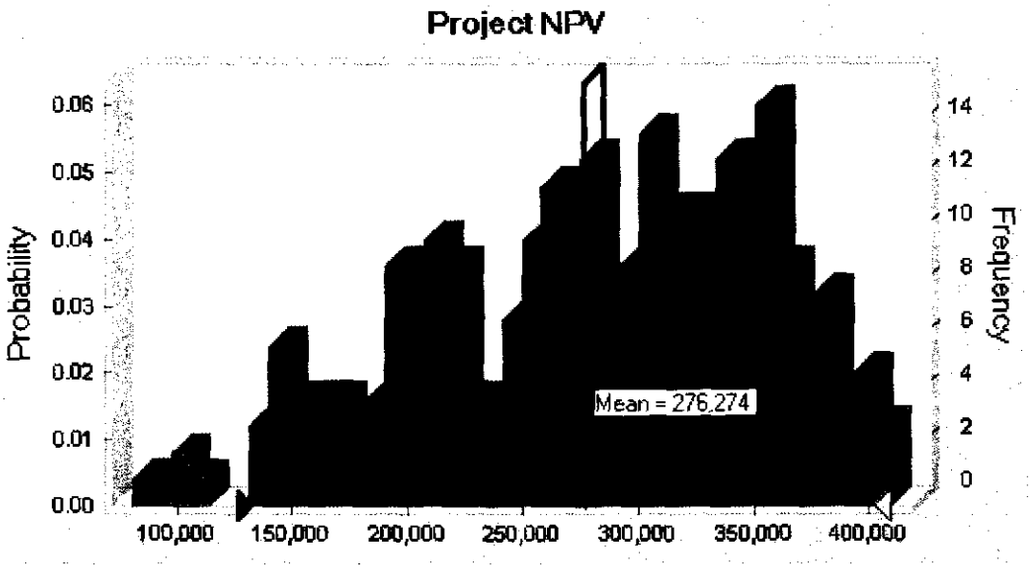




**Capacity Factor After Year 1:** The DSCR, IRR and NPV also perform satisfactorily when the capacity factor ranges from 75 percent to 100 percent. As seen in the charts for each profitability measure, the DSCR falls in between 1.2 and 1.8, with a mean of 1.4, whereas the Project IRR falls between 10.0 and 15.6 percent, with a mean of 12.9 percent. The NPV also remains within an acceptable ban, ranging from $130 million to $400 million, with a mean of $276 million. Similar to the Construction costs, even at a very low production capacity, the

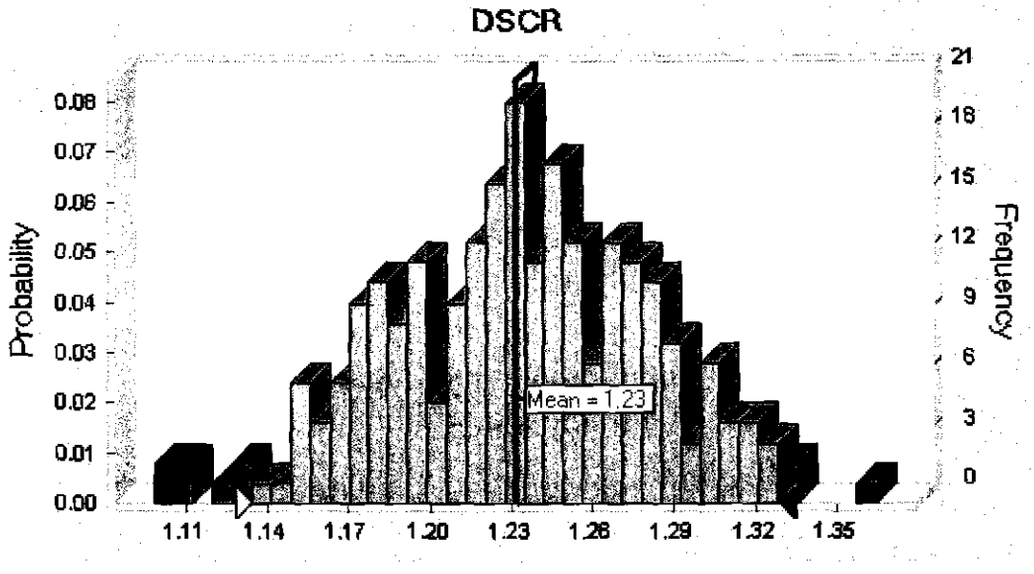
results of all three metrics show that the project will still be profitable, holding all other assumptions constant.

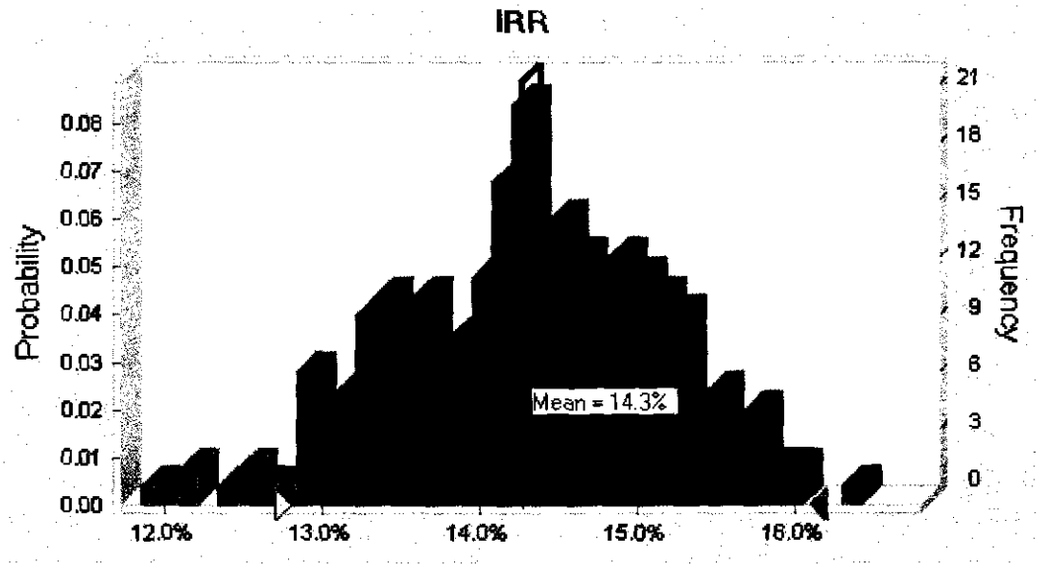


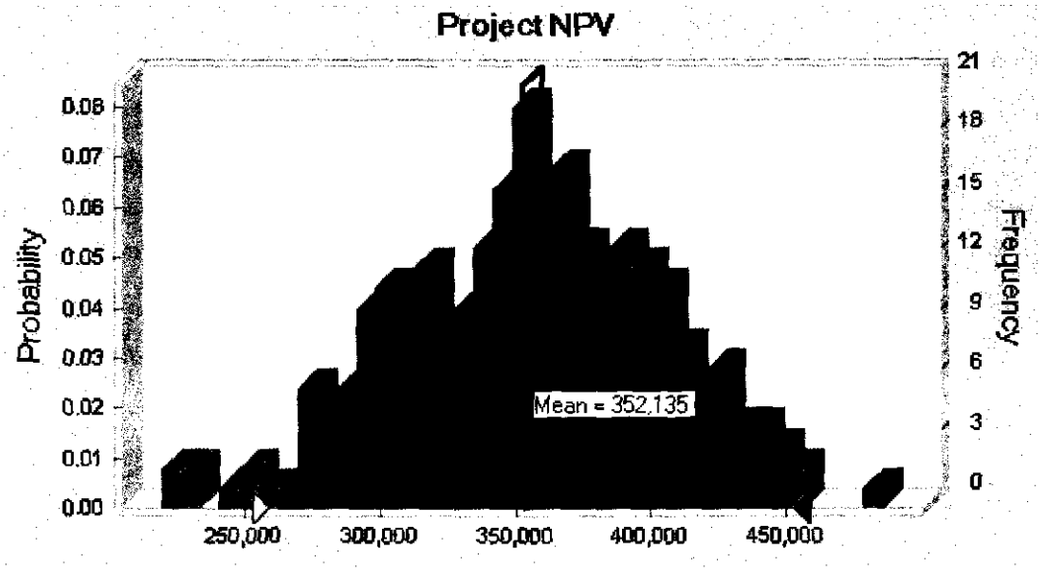






**Feed & Utility Costs:** Using a 95 percent confidence interval, the project will maintain profitability even if feed and utility costs fluctuate by +/-25 percent across the normal distribution. As seen in the charts below, the DSCR ranges from 1.14 to 1.32, with a mean of 1.23. The IRR ranges from 12.9 percent to 16.0 percent, with a mean of 14.3 percent. Similarly, the NPV remains positive across the spectrum, ranging from $250 million to $450 million with a mean of $352 million.




IRR
Probability
Frequency
Mean = 14.3%
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
21
18
15
12
9
6
3
0
12.0%
13.0%
14.0%
15.0%
16.0%


Project NPV
Probability
Frequency
Mean = 352,135
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
21
18
15
12
9
6
3
0
250,000
300,000
350,000
400,000
450,000

# TASK G FINANCING AND IMPLEMENTATION PLAN

This Project Implementation Strategy is based on Granherne's experience in undertaking other successful complex projects in similar overseas locations. It takes into account the requirements of potential lenders to the project, the complexities of dealing with three process licensors and the logistical problems in moving large pieces of process equipment into Egypt.

## G.1 PROJECT IMPLEMENTATION

Successful Project Implementation will depend upon an effective Project Execution Strategy and a carefully prepared Financing Strategy, both of which are structured to meet the requirements and expectations of the principal project stakeholders.

It is suggested that the Grantee will form an association with foreign partners who will contribute both technical expertise and provide a percentage of the required project equity. The scenario considered is that one partner will provide methanol production and international market access while a second partner would provide fertilizer production expertise and access to international fertilizer markets. Such a structure will require that an EPC contracts be awarded for the methanol production facilities and a second EPC contract for the ammonia production facilities. A third contract would be awarded for the design and construction of the dedicated marine loading terminal and sea water intake structure, the costs being equally apportioned between the methanol and ammonia partners.

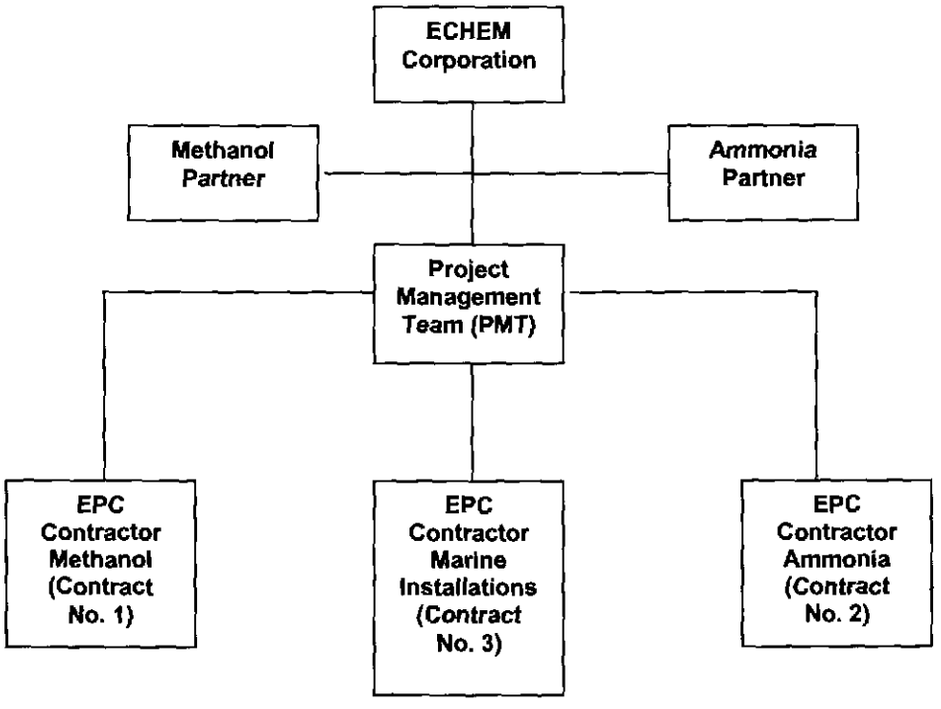
To provide overall construction and start-up management to the project, it is suggested that the partners award a Project Management Team (PMT) contract to an experienced contractor. The PMT would include team members from all of the principal stake holders who would be integrated into the Managing Contractor's team.

The three principal EPC contracts awarded at initiation of the project will cover the design, procurement and construction of the Phase I installations. The EPC Contractor will optimize the plant layout such that the additional process and utility units can be added without interfering with the Phase I installations. CAPEX expenditures to develop the Phase I installations should be minimized while building in provision for planned expansion. The marine terminal should be prepared for two berths but only one berth needs to be completed that will cover both Phase 1 and Phase II of the Project.

Separate EPC contracts will be negotiated and awarded for Phases II and III of the Project.

The suggested overall contracting structure is shown in Figure 1.

**FIGURE 1 – OVERALL CONSTRUCTION MANAGEMENT STRUCTURE**




## G.2 FINANCING PLAN

### G.2.1 Basic Strategy and Approach

High demand for petrochemical products has led to an increase in investments in this market by a variety of investors. Combined with strong project finance activity in Egypt, several viable debt and equity financing options will enable the Grantee to successfully implement the project. Because each financing source has different investment parameters, policies, and risk tolerances, selection should be based on the Grantee's specific priorities for project financing and implementation:

***Priorities for Project Financing and Implementation***

- To obtain financing at the lowest possible combined cost on an all-in cost basis;
- To reduce the amount of capital required from Echem and/or the level of contingent risk to be assumed by Echem; and
- To obtain financing as quickly as possible and under a structure that will facilitate rapid implementation of the project.

## G.2.2 Financing Options - Senior Debt

Limited recourse financing and full recourse financing are the major types of senior debt available. The following section outlines the different characteristics of each financing option to provide the Grantee with an alternative that maximizes flexibility and minimizes costs.

1. Limited recourse financing with commercial bank lead arranger
2. Limited recourse financing with developmental finance institution (DFI) lead arranger
3. Full recourse loan backed by the Government of Egypt (sovereign debt)

Limited recourse senior debt for petrochemical projects can typically provide for up to 70 percent of a project's total cost, including capitalized soft costs such as transaction fees and interest during construction. A limited recourse approach would entail the creation of a special purpose vehicle (SPV) to own and operate the project assets. Under such a structure, the SPV would serve as the borrower for long-term debt financing, and lenders would rely primarily on the project's assets and cash flows for repayment and collateral. During the start-up phase, some supplemental credit support would typically be required from the project's key stakeholders, including the owner(s) of the SPV and the EPC contractor.

Loan tenors for limited recourse senior debt loans are typically long-term and tied to a combination of risk factors, including (i) the duration and sensitivity of project's offtake and supply contracts, (ii) the general appetite of the capital markets for country-specific risk, and (iii) other risk factors as discussed in Task F. In addition, the project will have to pledge its liquid assets and cash flow from operations against the loan to back the creditor's investment in case of default.

If timing for implementation is the only criterion for choosing a financing strategy, a securitized financing full recourse loan backed by a sovereign guarantee from the Government of Egypt may be the best financing approach. However, if the Government of Egypt would prefer to preserve its sovereign credit capacity and the Grantee would like to implement the project using a tailored and efficient financing strategy, this option may not be the best alternative.

Based on the "base case" economics of the Integrated Methanol/Ammonia project, the following indicative key terms and conditions for limited recourse senior debt can be expected:

| | |
|---|---|
| *Amount*: | 60-70 percent of total project costs, or approximately USD 550-642 million for each phase |
| *Currency*: | USD or EUR |
| *Tenor*: | 10-12.5 years, including a 2.5-year grace period on principal for construction |

| | |
|---|---|
| *Amortization*: | 40 equal quarterly payments of principal |
| *Interest Rate*: | LIBOR + 100-150 basis points per annum |
| *Covenants*: | - Minimum debt service coverage ratio of 1.0x -1.5x |
| | - Maximum debt to equity ratio of 1.7:1 - 2:1 |
| | - No payment of dividends until certain financial tests are met |
| *Contingent support*: | Contingent guarantees from the Grantee, the EPC contractor and others until physical, operational, legal, and financial tests are met |

It is anticipated that limited contingent support might also be required from the Egyptian General Petroleum Corporation (EGPC).

Such a financing effort would likely be a syndicated loan effort led by a major commercial bank or DFI (the "Lead Arranger") with experience in underwriting and arranging project finance loans to the petrochemical industry. Given the size of the financing, one or more other commercial banks may be involved as "Co-Arrangers" on the deal as well. It is important that the underwriting commitments from the Lead Arranger(s) be detailed and strong to ensure rapid and successful placement of the debt and facilitate a timely start of construction. The Grantee might consider enlisting the services of a financial advisor in this regard to help optimize the terms and conditions of such underwriting commitments and the speed up the financing process.

If a DFI acts as the lead arranger for the limited recourse senior debt, commercial banks will more than likely participate in the syndication. Increased competition among banks will likely reduce borrowing costs even further. However, time to disbursement of funds will probably be longer because commercial banks and DFIs have slightly different lending procedures. Loan tenors from DFI financing typically carry a repayment period that is up to 2 years longer than that offered by commercial banks. On the flipside, financing from commercial banks results in the fastest time to disbursement, because the process to meet social and environmental requirements is generally shorter.

Export credit agencies (ECAs) such as the Unites States Ex-Im Bank also have the capability to provide limited recourse financing to projects similar to this one to facilitate the purchase of equipment and services from their respective country. More than one ECA can provide financing to the project, and ECA support often complements or enhances financing that is being offered by commercial banks. The benefit of such support is that it may lower the all-in cost of senior debt and/or extend the effective loan tenor beyond what the commercial banks may be willing to do on a stand-alone basis. However, a drawback to this is that ECA involvement often complicates the financing process and increases the amount of time required to obtain financing and begin construction.

## G.2.3 Financing Options - Equity and Quasi-Equity

Based upon a total Phase I project cost of approximately USD 916.9 million, the estimated Phase I requirement for equity and/or equity-like capital (such as subordinated debt) is in the range of USD 366.77 million. Some of this requirement is expected to be met by equity contributions from the Grantee, while the remainder is being sought from third parties. Equity requirements for Phases II and III should be less of an issue as they could potentially be funded from cash from earnings retained within the SPV, though there should be nothing to prevent the SPV from raising additional outside equity if this approach is preferred. The following section describes the three main equity and quasi-equity financing options available to the Grantee.

### Quasi-Equity (Subordinated Debt)

Development finance institutions and some institutional investors are the most likely targets for quasi-equity financing. While subordinated debt is priced higher than senior debt (typically a few percentage points higher on the interest rate, plus some form of profit-sharing as a return enhancement), it can reduce the required level of "pure" equity contributions and, thus, reduce the amount of ownership dilution that the Grantee would suffer as a result of bringing in outside investors.

Quasi- equity financing of this type could be structured as an unsecured loan that would involve no principal repayment until the end of a stated term (probably in the range of 7-10 years), at which time 100 percent of the principal would be repaid. Another possible structure could entail the same term structure with principal payments that are amortized over the life of the loan. In either case, capital from subordinated debt will be junior to senior debt in terms of rights to both cash flow and collateral, and interest on the loan would be paid quarterly or semiannually at an annual coupon rate to be negotiated. Interest payments would be subject to the availability of cash flow after senior debt service. In addition, the subordinated lender would also seek some equity-like "upside" in the form of a share of EBITDA, or stock options that could be exercised during or at the end of the loan term. The availability and terms of subordinated debt would ultimately depend upon project economics, but based on the current base case analysis, the project should be able to support a meaningful amount of this type of capital. Based on our experience, the pricing for such debt might be in the 3-5 percent higher than limited recourse senior debt.

### Preferred Equity

Likely preferred equity investors include institutional investors and in some cases DFIs. Legally, the investment is in the form of shares of stock in the company, though the investor may receive a "preferred dividend" that would be computed as an annual percentage of total investment, payable subject to available cash flow and compounding if sufficient cash flow is not available. A preferred equity investor would stand in line behind a sub debt lender in terms of cash flow

priority, thereby making it possible for both a sub debt lender and preferred equity investor to participate simultaneously in the Project.

The preferred dividend may be fixed at a certain percentage, thus making it behave more like quasi-equity debt (though this fixed rate would probably be priced higher than the sub debt). More typically, the preferred equity will act like common equity in terms of receiving a pro-rata share of free cash flow with the common equity investors, except that the preferred shareholders would first be entitled to a priority cash flow of a certain "hurdle rate" equating to a certain return on investment (perhaps in the range of 8 percent).

**Common Equity**

Common shareholders would probably include the Grantee and potential strategic investors. This type of equity stands in line behind all types of equity financing in terms of cash flow priority and liquidation. To compensate for these risks, return expectations for common shareholders are generally greater. For example, while subordinated debt and preferred equity generally have caps that limit the amount of dividends disbursed, common equity generally does not. Thus, common equity holders are likely to receive a large proportion of dividends after creditors and preferred equity investors have been satisfied.

It is important to keep in mind that the Grantee's in-kind equity contributions that are legitimate project costs, such as land and the cost of project development, can be counted as equity contributions on the basis of fair market value or actual cost (typically whichever is lower), and can thus be used to reduce the amount of cash equity required from the Grantee under a 60/40 debt to equity split of project costs with lenders.

## G.2.4 Potential Financing Sources

**Commercial Banks**

Local and international commercial lenders (e.g., National Bank of Egypt, Commercial International Bank, Citibank, HVB) should be the primary targets for senior debt financing. Based upon their financial resources and experience in underwriting major syndicated project finance loans, the Lead Arranger will most likely be an international commercial bank based outside of Egypt. Local commercial lenders could also play an important role as they could assist the Lead Arranger in assessing country risk and related tax and regulatory issues, and could potentially provide an EGP-denominated working capital loan to the SPV if necessary and appropriate. The Grantee should begin the selection of a Lead Arranger by issuing a Request for Proposals once the scope and cost of the project has been finalized (or nearly finalized).

Financing from this source results in the fastest time to disbursement as compared to the other sources mentioned earlier. This is partially due to the state of project finance activity in the oil

and gas sector in Northern Africa and the Middle East, which is extremely active at this point. With strong competition among commercial banks, borrowing costs are hovering at attractive levels.

**Development Finance Institutions**

Development finance institutions such as the International Finance Corporation (IFC), a member of the World Bank Group, Deutsche Investitions und Entwicklungsgesellschaft (DEG) of Germany, and the Development Netherlands Finance Corporation (FMO) offer financing in the form of senior debt, quasi equity (or subordinated) debt, and/or preferred equity, and more than one of these groups can provide loans to finance the project. While loan tenors from DFI financing typically carry a repayment period that is up to 2 years longer than that offered by commercial banks, the terms and conditions are usually less favorable. Additionally, the complex DFI environmental and social approval process slows the time to disbursement.

In terms of equity financing, DFIs typically invest equity or quasi-equity on a passive (i.e., institutional) basis. Each would seek to invest no more than 10-15 percent of the total equity capital required. Such financing is typically offered on commercially-attractive terms; however, it is important to note that DFIs require borrowers or investee companies to meet detailed social and environmental requirements that may add some additional cost and/or time to the financing process.

**Export Credit Agencies**

ECAs have developed a capability to provide limited recourse financing to projects such as Echem to facilitate the purchase of equipment and services from their respective country. For example, the U.S. Export-Import Bank of the United States ("U.S. Ex-Im Bank") provides short-, medium- and long-term export/import trade loans and credit insurance to support sales of U.S. goods and services. ECA term financing can be arranged for up to 100 percent of the contract value over a term of 2 to 10 years. ECAs typically charge up-front exposure fees, which are dependent on the country and the loan term and can be financed as part of the loan. For example, U.S. Ex-Im Bank's exposure fee for Egypt would equate to a risk premium of approximately 2-3 percent per annum.

More than one ECA can provide financing to the project, and ECA support often complements or enhances financing that is being offered by commercial banks. The benefit of such support is that it may lower the all-in cost of senior debt and/or extend the effective loan tenor beyond what the commercial banks may be willing to do on a stand-alone basis. Additionally, there is increased potential of securing U.S. Ex-Im Bank financing for possible U.S. export-related activities as a result of the funding for the feasibility study being provided by another U.S. government agency (i.e., USTDA). It must be noted, however, that the ECA financing process is a little more complex, and time to disbursement is generally longer. However, this shortfall is

mitigated by the lower cost of senior debt, especially if Echem purchased capital-intensive equipment primarily from manufactures in one or two specific countries. Thus, it may be beneficial for Echem to look closely at possible U.S. suppliers for equipment and services.

**Private Equity Investors**

Institutional investors manage pools of capital for purposes of generating a return. Potential financial investors would include equity investment funds interested in Africa or the petrochemical industry. Most of these private equity funds invest on a portfolio basis and do not participate in the day-to-day management of companies. Quasi-equity and preferred equity are the most common investment options because these "passive" investors are willing to accept a lower return for a lower degree of risk. To further limit their exposure, it is likely that institutional investors require an exit mechanism that allows the sale of their shares to common equity investors after a pre-determined time frame. Based on the current market, they would typically seek returns in the range of 10-15 percent per year for a project of this nature.

Strategic investors invest in projects as part of an overall corporate strategy. Strategic investors, which could include the project's suppliers and offtakers, would play a more active role in the company, and financial returns on investment may be more variable, as these investors may look at economic benefit in a broader context. Thus, strategic investors are likely to purchase common equity in hopes of generating high returns to compensate for the added risk.

**Splitting the Project into Two Separate Projects**

As may currently be under consideration by the Grantee, splitting the project may facilitate raising equity as it would allow potential investors to invest in a single plant with a particular product output. This would be especially attractive to "strategic" corporate investors interested in building productive capacity in the region.

## G.2.5 Possible Financing Scenarios

Based upon the analysis above, the scenarios on the following page illustrate the possible options that the Grantee might pursue in financing each phase of the project. These are based on a conceptual cost estimate of USD 1.048 billion for Phase I.

***ILLUSTRATIVE FINANCING ALTERNATIVES (USD millions)****

| Financing Type | DFI-Led Financing | Commercial Bank-Led Financing |
|---|---|---|
| Senior Debt - [1] | $550.15 | $550.15 |
| Quasi-Equity [2] | $122.4 | $0.0 |
| Preferred Equity [3] | $81.37 | $0.0 |
| Common Equity [4,5] | $162.7 | $366.77 |
| TOTAL | $916.92 | $916.92 |

***The DFI-led*** financing alternative offers the Grantee greater ownership because quasi-equity and preferred equity usually do not provide any voting rights. This also reduces the dilution effects that arise when the number of additional common equity investors is reduced. In return for greater ownership, the Grantee will have to increase any required contingent support or guarantees, as lenders would rely primarily upon the strategic investors. Additionally, DFIs have an environmental and regulatory approval process that is more complex, and thus, time to disbursement is generally longer than under DFI-led financing. Furthermore, the interest rate is likely to be higher but the loan terms are generally more favorable. Because the DFI-led financing alternative includes more participants in both debt and equity categories, the financing process is likely to be more complicated.

***The commercial bank-led*** financing alternative offers the benefit of a reduced equity contribution, and thus, would also probably reduce any contingent support or guarantees required from the Grantee. Moreover, this approach would also probably streamline the financing process, as it would exclude DFI participation and entail a smaller overall number of participants. Even though the tenor is likely to be lower, the terms and conditions are likely to be less favorable. However, this is offset by a faster time to disbursement and lower interest rate.

**Recommendation**

Based upon the Grantee's specific objectives regarding financing and implementation, a limited recourse project financing approach with a commercial bank will be most appropriate for the

* Based on approximate project costs
[1] Syndicated commercial bank loan with possible ECA support
[2] Primarily from DFIs and possibly institutional investors
[3] Primarily from institutional investors and possibly DFIs
[4] Primarily from Grantee and strategic investors
[5] Includes in-kind contributions from the Grantee

project. Appetite for petrochemical project finance is currently very strong and the lead arranger will be able to find a syndicate of banks at beneficial interest rates. Furthermore, commercial bank financing is more flexible and timely than DFI financing. This will enable the Grantee to take advantage of the current low interest rate environment and provide financing to initialize construction as soon as possible.

## G.2.6 Financing Sources References

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## G.2.7 Financial Implementation Strategy

As discussed above, it is recommended that a SPV be established to own the project assets and facilitate a limited recourse project financing. Given the high degree of analysis required to

complete such a financing, it is important that the Grantee be prepared to provide drafts of key contracts (e.g., offtake, gas supply, EPC) to potential lenders. On a separate but related note, the structure and negotiation of these contracts in a way that supports risk-sharing is crucial. Please refer to the recommended risk mitigation strategies in Task F for more detail. Implementing these strategies can facilitate and accelerate the financing process. An illustrative timetable for securing limited recourse project financing, and the major prerequisites for each step, are outlined below.

**Echem Methanol/Ammonia Project**
**Timeline for Project Financing**

| # | Task/Event | Estimated Completion | Prerequisites to Completion |
|---|---|---|---|
| 1 | Finalize information memorandum and financial model | Week 4 | Feasibility study |
| 2 | Make presentations to potential loan arrangers and equity investors | Week 8 | |
| 3 | Appoint lead arranger for debt financing and finalize equity participation | Week 12 | Letters of intent from potential lenders and investors |
| 4 | Conduct due diligence and receive draft term sheet | Week 22 | Finalize agreements for EPC, fuel supply, and offtake |
| 5 | Obtain binding commitments from lenders and investors | Week 26 | Negotiated and agreed term sheet |
| 6 | Finalize financing documents ("Financial Closing") | Week 34 | |
| 7 | First disbursement | Week 36 | Satisfaction of conditions precedent to disbursement |

## G.3 EPC SCHEDULE

A summary schedule is shown in Figure 2. The EPC schedule shown in Figure 3 in this section has been prepared to include the project activities by the Owner(s) and the selected PMT Contractor that would be required to "kick-start" the project. The EPC contract award will be in two steps:

- Step I – Selection and award of contract to the PMT contractor to participate in the permitting process and EPC Contractor selection.
- Step II – Award of the three EPC Contracts and full release of contract work following the availability of financing.

This "pre-release" phase is shown in the schedule.

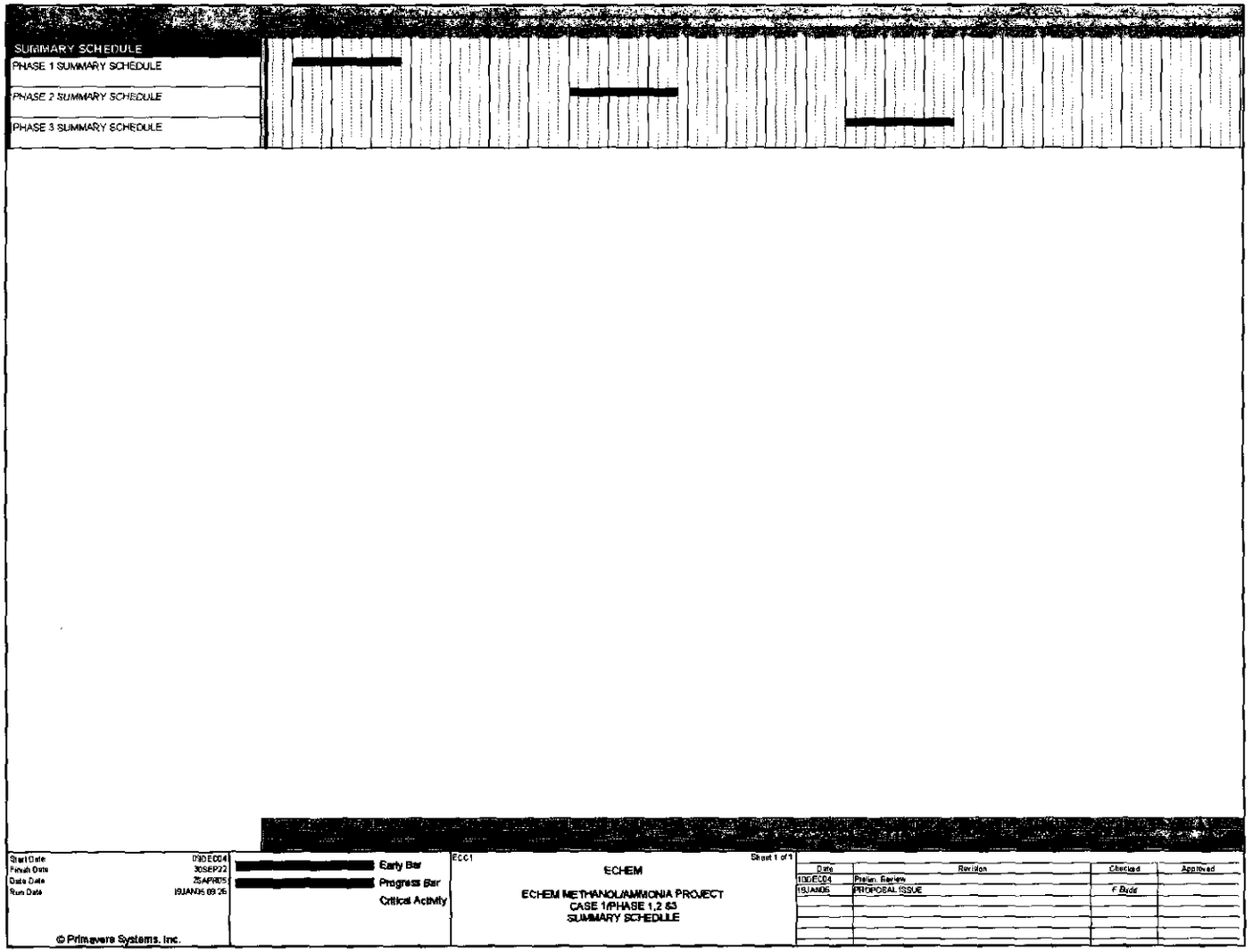
The EPC section of the schedule shows the principal work activities for each of the two process units (Methanol and Ammonia), the utilities and offsite installations including ammonia and methanol storage, equipment and buildings.

The schedule includes time for process licensors to prepare the Process Release Technology Package to enable the selected EPC Contractor to commence the detailed engineering. The schedule assumes that the construction work productivity will be similar to work performed in other construction sites managed by KBR in Egypt.

The duration for the EPC work associated with the Methanol process unit, which is the larger and more complex process unit, controls the schedule, being 33 months from EPC Contract award. It is anticipated that during the first six (6) months of the EPC schedule, the Process Licensors for the methanol and ammonia production units will concurrently develop their Process Release Packages. The Process Licensor contract award would be managed by the respective EPC Contractor. Commencement of process release and detailed engineering work on the other units should be phased to avoid unnecessary front end cash flow and associated costs.

Larger versions of these diagrams are contained in Appendix 3 of this Study.

## FIGURE 2 - PRELIMINARY PROJECT PHASING SCHEDULE



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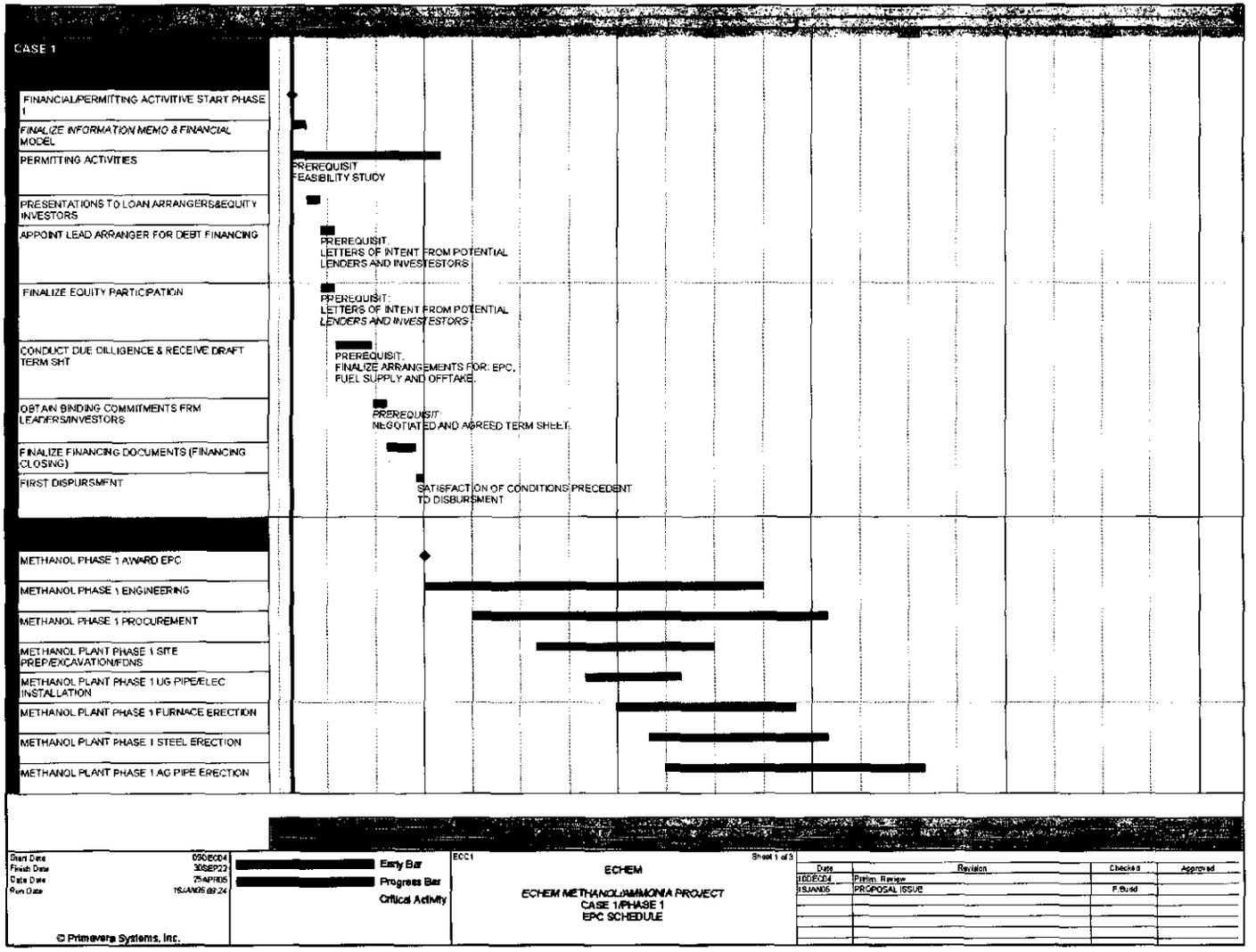

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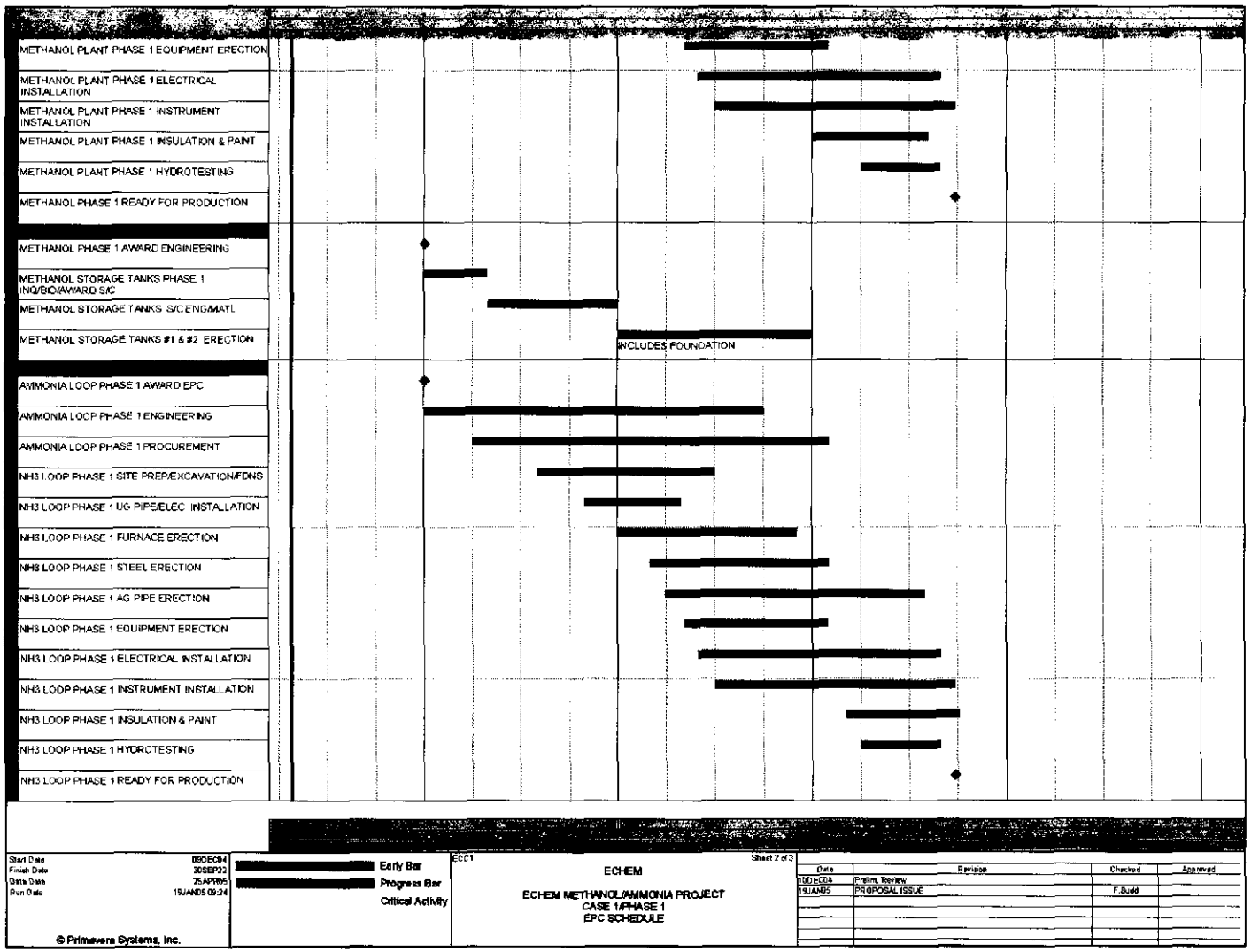

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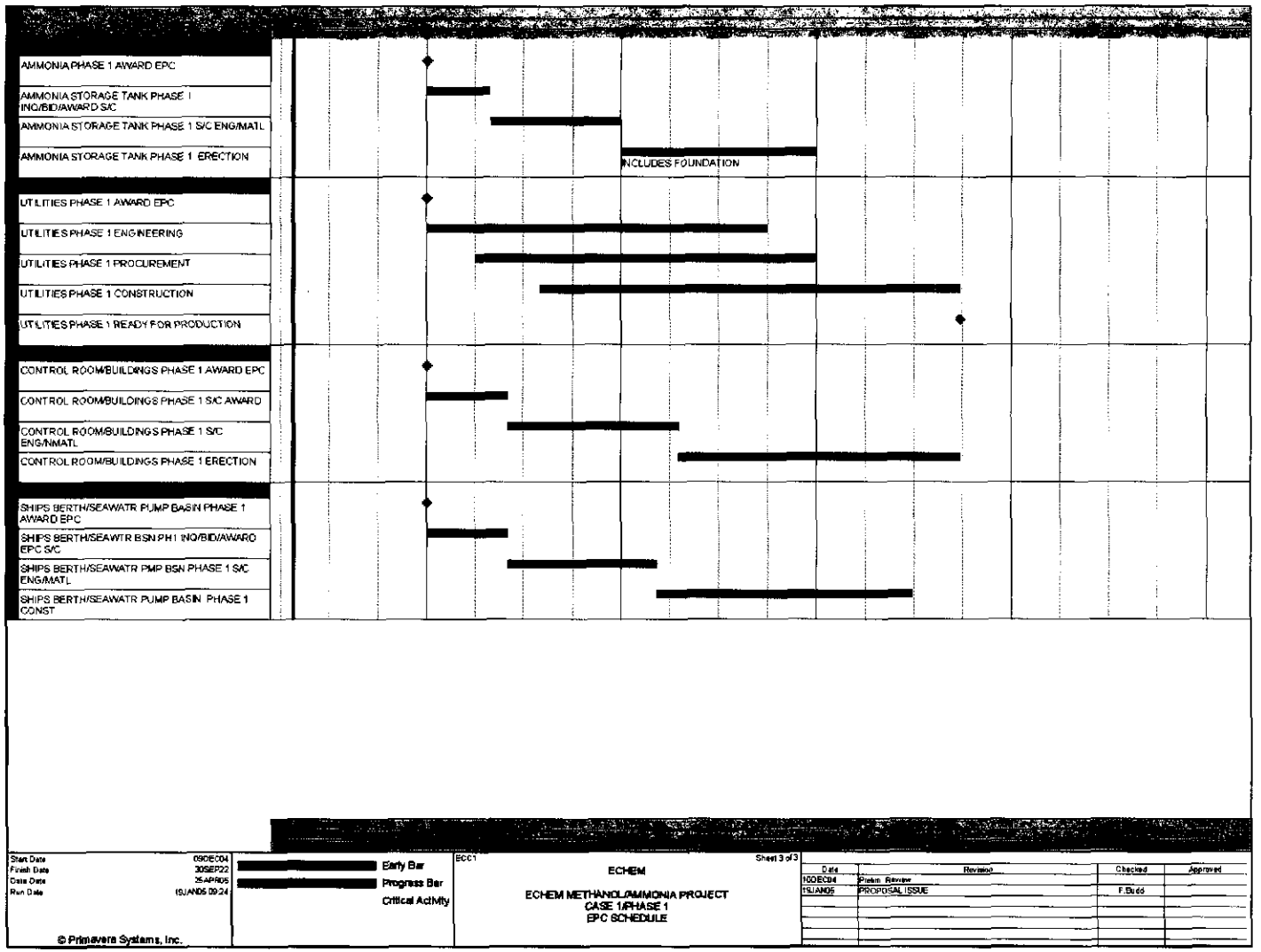

# APPENDIX 1

## Preliminary Environmental Assessment

The document in this Appendix is the Preliminary Environmental Assessment report (PEA) prepared by the Cairo office of KOMEX, an internationally recognized environmental consulting company. KOMEX was subcontracted by KBR to undertake this study.

The following is the report prepared by KOMEX. A summary of the PEA is included in Task C.5 of this Report, along with the mitigation and protective measures identified.

# PRELIMINARY ENVIRONMENTAL ASSESSMENT

## FOR

## PROPOSED INTEGRATED METHANOL/AMMONIA PRODUCTION COMPLEX

## DAMIETTA PORT, EGYPT

**PREPARED FOR:**

**GRANHERNE**

**PREPARED BY:**

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**KE 60024** **JANUARY, 2005**

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# EXECUTIVE SUMMARY

This report presents the results of a Preliminary Environmental Assessment (PEA) for a proposed Methanol and Ammonia production complex at Damietta Port industrial area. The PEA is completed for the purpose of highlighting the potential impacts for the proposed new Integrated Complex at the feasibility/early stage of the project. The PEA reviews potential effects on the environment which could be caused by the construction and operation of the facility at Damietta. The PEA was undertaken by Komex Egypt on behalf of KBR.

The proposed facility will produce approximately 3,000 metric tonnes/day of Methanol and 1,200 metric tonnes/day of Ammonia, principally for export. Appendix II shows the proposed location for the facility.

The process produces various forms of waste, some of which have the potential to cause adverse environmental effects if compliance is not assured or if accidents occur. Effects of emissions and operating activities on the quality of soil, water and air were considered. The area proposed for development was surveyed to check for the presence of any important (National and International) wildlife species, and to evaluate the likely effects of the proposed activities on them. Effects on local employment, the local economy and cultural aspects were also taken into account.

Preparation of the PEA involved the following tasks:

- Detailed literature survey/review on the project area, including reviewing reports, maps, textbooks, atmospheric and climatic conditions, geological settings, and groundwater, etc.
- Several site visits.
- Public consultation with relevant stakeholders and interested parties.
- Assessment of the project - environment interactions using matrix tables and source-pathway-receptor risk assessment concepts.
- Production of a PEA report.

Information about the proposed process and designs were reviewed to identify the potential for pollution, or other effects on the environment. This was assessed based on the nature and state of released compounds, their location and mode of release, the likely mass and rate of released compounds, and the likely nature of effect. Once the locations were identified where impacts were likely to occur, the nature of the interaction with the environment, and the likely significance of impacts on the environment were evaluated using a matrix approach. The matrices are provided in Appendix VI.

In terms of positive economic impact and employment, the project will enable Egypt to annually export approximately 3,000 metric tonnes of Methanol and 1,200 metric tonnes of Ammonia and generate foreign income while providing a great number of jobs both during the construction and operation phases. The socio-economic benefits of the project are thus largely positive. The PEA identifies other possible impacts on local biology, soil, air and water quality.

The PEA provides the basis for a detailed/full EIA in a later stage should the feasibility of the project be proven. In the detailed EIA a detailed site specific baseline assessment should be conducted, where suitable mitigation measures are recommended to reduce the potential adverse environmental impacts to acceptable levels, and recommendations made concerning ongoing environmental management of the project to ensure that environmental quality is sustained throughout its lifetime.

Based on this PEA, the assessment team concludes that the proposed Methanol/Ammonia integrated complex is environmentally feasible, and a full EIA should be conducted at the FEED[1] stage with a comprehensive baseline assessment and detailed environmental management plan (EMP).

[1] Front End Engineering Design

# 1 INTRODUCTION

## 1.1 Background

The Egyptian Petrochemical Holding Company. (ECHEM) has proposed the construction and operation of an Integrated Complex for the production of Methanol and Ammonia in Damietta Port in the Arab Republic of Egypt.

Komex was retained by Granherne to prepare a Preliminary Environmental Assessment (PEA) addressing the environmental implications of the proposed project.

## 1.2 Purpose of the Preliminary Environmental Impact Assessment

This document covers the PEA for construction and operation of the planned plant in Damietta, Egypt.

The overall purposes/objectives of the PEA are:

- To assist with project planning, including identification of key issues and opportunities;
- To assist in ensuring environmentally sound and sustainable development by providing all the environmental information necessary to determine the environmental acceptability and feasibility of the project;
- To present the regulatory requirements;
- To provide investors with an understanding of the resource values, their constraints and other resource users in the area;
- To provide a forum for other local industry and local residents to become knowledgeable about this project; and
- To provide a baseline of management information essential to the long-term viability of the project.

The terms of reference for the environmental assessment were developed during discussions between Granherne and Komex.

# 2 LEGISLATIVE AND REGULATORY FRAMEWORK

## 2.1 Relevant Laws and Regulations

Law No. 4 is the main Environmental Law in Egypt concerning the environment and was passed in 1994. The Executive Statutes of this law were set out in 1995. This law established an Egyptian Environmental Affairs Agency (EEAA). The EEAA has the power to set criteria and conditions, monitor compliance and to take procedures against violators of these criteria and conditions. Various decrees have also been passed dealing with drainage of liquid wastes, and protection of the River Nile and other waterways from pollution.

The law dictates that the licensing authority must assess the environmental impacts of proposed facilities, Article 10, Decree 338 (A10/D338). The license application must include data to be entered in Form A12/D338, which shall be maintained as a register of the facility's impact on the environment during operation (A17/D338).

Form A12/D338 is to contain the following information:

- Emissions emanating or draining from the facility;
- The efficiency of treatment processes and specification of any residual material from the treatment process;
- Details of environmental safety procedures applied in the facility;
- The results of periodic tests and measurements necessary to demonstrate compliance with emission, discharge and health and safety requirements; and,
- The name of the officer in charge of maintaining the register.

The EEAA can visit the facility and take samples to ensure conformity. The EEAA must be notified of any deviation from the criteria by registered letter. The letter must also outline the procedures taken to correct the problem. If a violation occurs and the establishment fails to comply within 60 days the facility could be closed, the violating activity suspended and/or court action could be taken (A18/D338).

Any expansions or renewals to the existing facility or any work, which might result in an adverse impact on the environment or workers, are subject to the preceding articles (A19/D338).

### 2.1.1 Conditions in the Workplace

The facility must operate such that leakage or emission of air pollutants inside the workplace will not affect worker's health and safety (A45/D338). The facility must operate such that humidity and temperature will be maintained within the set limits for workers (A46/D338) and suitable Personal Protective Equipment (PPE) are to be provided as required for workers in the facility.

### 2.1.2 Use of Hazardous Materials and Wastes

The production of dangerous materials and wastes is prohibited without a licence. The license is issued for a fixed time interval. The required information to be submitted when applying for a

licence is summarised in A26/D338. Management of Hazardous wastes is subject to rules and procedures, which are set out in A28/D338.

### 2.1.3 Air/odour Emissions

The facility must demonstrate that it will meet air/odour emission standards, taking into account not only the facility's emissions, but also those of existing industries in the same area (A34 - 36/D338).

The location of the facility must take into account suitability with respect to distance from urban areas and wind direction (A34/D338).

The release of noxious and harmful smoke, gases and fumes resulting from burning fuel at a facility is regulated by A42/D338. This article covers precautions and permissible limits as well as specifications of chimneys in burning any kind of fuel.

### 2.1.4 Noise Emissions

The facility must meet noise regulations for within the workplace, outside the facility and for the area as a whole (A44/D338).

### 2.1.5 Disposal of Liquid Wastes

A license is required to discharge industrial liquid wastes into the public sewer system (A7/Law 93 update and Decree 44/2000). There are existing discharge criteria (A11/D649) to which the liquid wastes must adhere (A8/Law 93). Routine analyses of the liquid wastes should be carried out periodically to ensure compliance with Law 4/94. The Authority in charge of sewerage has the right to obligate the owner to undertake treatment or purification (A4/D649).

Surface drainage of liquid wastes is not allowed except with a license. The criteria for drainage will be set by the Minister of Housing and Utilities (A14/Law 94).

Oily discharges are required to pass through an oil/water separator prior to being discharged (A3/D649).

## 2.2 Additional Relevant Egyptian Laws/Regulations

Additional relevant laws and regulations include:

- Egyptian Decree: Prime Minister's Decree No. 338 of the year 1995 (Executive Regulations of the Law Number 4, 1994).
- Minister of Housing and Infrastructure: Decree No. 44 for 2000 (Modifying the Executive Regulations of Law No. 93 for 1962) – maximum limits for reusing treated sewage for irrigation.
- EEAA: Guidelines for development of Ports, Harbors and Marinas. Environmental Impact Assessment (1999).
- EEAA. Guidelines for Egyptian Environmental Impact Assessment. Environmental Management Sector (1996).

- Egyptian Standard ES1109 (1971). Aggregates from Natural Sources.

## 2.3 Environmental Register Requirements

According to the Law of the Environment, all facilities must keep an environmental register.

## 2.4 Relevant Conventions, Standards and International Regulations

The design of the plant shall be in accordance to good engineering practice and shall be based on the latest issue of the following standards and/or codes.

### 2.4.1 International Conventions

- MARPOL (1978).
- UN Convention on the Law of the Sea 1982.
- Barcelona Convention.
- Basel Convention on Transboundary Movements of Waste.

### 2.4.2 Standards/Regulations

- General Guidelines for Full Environmental Impact Assessment, EGPC[2] EH&S General Division, January 1997.
- Standard Methods for examination of Water and Wastewater - Amer. Public Health Assoc.
- Handbook for Sampling and Sample Preservation of Water & Wastewater - US EPA.
- Handbook for Analytical Quality Control in Water and Wastewater Laboratories - US EPA.
- International Maritime Organization Dangerous Goods Code.

[2] Egyptian General Petroleum Corporation

# 3 DESCRIPTION OF THE ENVIRONMENT

## 3.1 Project Location

The proposed Methanol/Ammonia complex will be located with in the Damietta Port premises (Figure ). The Damietta port is situated on the Mediterranean coast (Longitude 31° 45' E; and, Latitude 31 ° 28' N), approximately 8.5 Km west of the Nile's Eastern branch and about 70 Km west of the Port-Said port. The port covers a total area of approximately 9.3 $Km^2$, of which 6.2 $Km^2$ is land area and 3.1 $Km^2$ is water area. It includes an 11.3 Km long, 300 m wide approach area dredged to 15 m, with two sheltering breakwaters: one to the west at a length of 1.640 Km (140 m in land and 1,500 m in water) and the other to the east, 738 m long (238 m in land and 500 m in water). The approach area provides access to a barge channel consisting of two ports, one (1.35 Km long) links the barges dock to the sea and the other (3.75 Km long) links the Dock to the Nile Branch. The barge dock occupies an area of 62,500 $m^2$ and is equipped with a 250 m long berth with a water depth of 5 m. The rotation dock is 500 m in diameter and varies in depth from 14.5 m in front of the containers broth to 12 m in front of the general cargo berths.

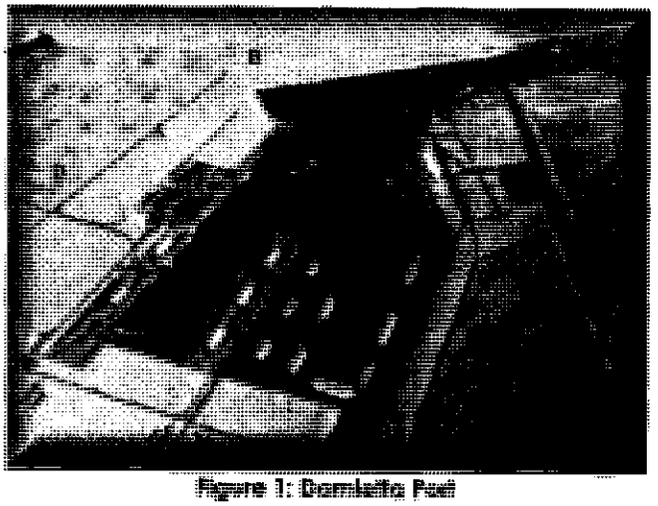


Figure 1: Damietta Port

As presented in Figure 1**Error! Reference source not found.**, the site (A) is bounded by SEGAS LNG facility (B) from the north western boundary, port container yard expansion area (C) from the eastern boundary and administration buildings area (D) from the southern boundary. Appendix II, shows the site layout indicating the location of the production plants and the distribution of its utilities within Damietta Port.

## 3.2 Field Programmes

Komex had previously conducted several EIA studies over the past few years for a neighboring facility within the Damietta Port premises. Relevant baseline information collected during these studies was updated and incorporated into the current PEA. Four site surveys were conducted on 7, 13 September, 17 November and 30 December 2004 to collect site specific information.

## 3.3 Physical/Chemical Environment

### 3.3.1 Terrestrial Physical/ Chemical Environment

#### 3.3.1.1 *Surrounding Geology and Soils*[3]

Information regarding the surrounding geology and soils was determined from borehole samples collected from 4 boreholes drilled (Samsung-Arab contractors) at the Damietta Port east dock area. A description of the soil lithology is summarized in
Table Table 1.

**Table 1: Local Soil Lithology**

| | Description | Thickness |
|---|---|---|
| Fine to Medium Sand | The upper layer of the profile consists of fine, silty sands with traces of broken shells | 10.7 – 12.0 m |
| Soft Clay | Soft, darkish grey silty clay, locally medium darkish grey silty clay with lenses of sand | 19.5 m |
| Fine Greyish Sand | Silty medium to fine sands, with traces of broken shells and lenses of darkish grey silty clay | 4.5 - 4.7 m |
| Silty Clay | Very stiff, locally hard brown silty clay, silty clay with traces of gypsum | Bottom encountered at levels from 37.05 LLWL to 38.95 LLWL (Lowest Low Water Level) |
| Medium Sand | Calcareous medium to fine sand with traces of calcareous hard cemented sand | |

#### 3.3.1.2 *Groundwater*

At the proposed site area, groundwater is mainly contained in the coastal sand aquifer where the soft clay layer, underlying the silty sand layer, acts as an aquiclude. Groundwater levels in the project area are shallow and range between 0.4 to 1.85 mbgl (metres below ground level).

The response of groundwater levels to tidal fluctuations suggests the presence of hydraulic connection with the Sea. In-addition, preliminary chemical analyses (Geogroup Corp. 2001) reveal high concentrations of sulphate and chloride, which ascertains the former.

Groundwater in the area was also found to be characterised by high values of TDS.

#### 3.3.1.3 *Climate and Meteorology*

The proposed site area is characterized with prolonged hot dry summers, with very little cloud cover, and short, mildly rainy, winters.

[3] From M W Kellogg EIA conducted for Damietta LNG Project.

*Temperature*

The Damietta Governorate, proposed site area, exhibits typical Mediterranean region temperatures where the average annual minimum air temperature is 17.5°C and the average maximum air temperature is 22.5 °C.

Table 2 and Table 3, respectively, show the number of days with maximum or minimum (other than average) temperatures in an average climatic year in Damietta. Table 4 provides details of the meteorological parameters for Damietta and Appendix III provides 30 years of meteorological data for Damietta.

**Table 2: Minimum Temperatures in Damietta Port**

| Minimum Temperature | No. of Days |
|---|---|
| 0°C | 0 – 5 Days |
| 5°C | 0 - 5 Days |
| 10°C | 60-90 Days |

**Table 3: Maximum Temperatures in Damietta Port**

| Maximum Temperature | No. of Days |
|---|---|
| 35°C | 0 –5 Days |
| 40°C | 0 –5 Days |
| 45°C | 0 –5 Days |

*Winds*

During summer season moderate NW or N winds are most prevalent, however occasional increases to fresh or strong may be exhibited.

During the winter season, no wind direction predominates, however N and W winds are often more frequent. During spring (April and May) sea breeze predominates, and winds from between NW and NE exceed all others. It is during this season that the Khamasin winds, a variety of the Scirocco, are most prevalent. Although Khamasin winds are usually moderate to strong they occasionally reach gale force.

Land and sea breezes are less marked in the winter months but may occur in places during settled weather. Near the Egyptian coast, gales are mainly confined to the period of October to May, and are most frequent from December to February.

**Table 4: Regional Meteorological Parameters, Mean Values**

| Month<br>Meteorological Element | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Maximum Air Temperature (°C)* | 18.2 | 18.5 | 20.3 | 23.1 | 26.4 | 29.2 | 30.6 | 30.9 | 29.3 | 27.3 | 23.6 | 19.7 |
| *Highest maximum air temperature (°C)* | 26.5 | 31.9 | 35.8 | 38.8 | 45.6 | 40.8 | 39.5 | 38.6 | 37.9 | 36.1 | 35.4 | 28.5 |
| *Date (yy/dd)* | 87/18 | 52/28 | 31/16 | 93/17 | 41/10 | 33/30 | 34/16 | 36/15 | 39/29 | 51/6 | 41/7 | 62/3 |
| *Lowest Maximum air temperature (°C)* | 10.6 | 8.8 | 10.3 | 15.3 | 19.5 | 23.8 | 26.0 | 27.0 | 23.5 | 20.3 | 15.1 | 11.9 |
| *Date (yy/dd)* | 74/23 | 92/24 | 83/6 | 94/3 | 87/1 | 90/4 | 69/15 | 68/24 | 70/30 | 65/30 | 94/29 | 71/22 |
| *Minimum air temperature (°C)* | 8.6 | 9.0 | 11.0 | 13.6 | 16.8 | 20.0 | 21.4 | 21.6 | 20.2 | 18.4 | 15.1 | 10.7 |
| *Highest minimum air temperature (°C)* | 17.0 | 15.6 | 17.6 | 21.7 | 23.4 | 24.8 | 25.8 | 26.4 | 25.0 | 24.4 | 23.2 | 17.7 |
| *Date (yy/dd)* | 85/14 | 68/29 | 61/17 | 94/20 | 64/30 | 65/13 | 89/16 | 78/3 | 86/24 | 63/18 | 66/4 | 71/2 |
| *Lowest minimum air temperature (°C)* | 1.5 | 0.7 | 3.8 | 4.6 | 9.5 | 7.0 | 16.9 | 16.3 | 14.7 | 11.4 | 6.8 | 3.7 |
| *Date (yy/dd)* | 53/14 | 34/17 | 49/5 | 49/19 | 65/5 | 93/3 | 49/26 | 49/22 | 49/30 | 59/21 | 48/28 | 31/31 |
| *Relative humidity (%)* | 76 | 75 | 73 | 71 | 71 | 71 | 72 | 76 | 75 | 75 | 76 | 76 |
| *Highest relative humidity (%)* | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| *Date (yy/dd)* | s.d | s.d | s.d | s.d | s.d | s.d | s.d | s.d | s.d | s.d | s.d | s.d |
| *Lowest relative humidity (%)* | 26 | 24 | 20 | 16 | 13 | 21 | 24 | 25 | 31 | 29 | 25 | 31 |
| *Date (yy/dd)* | 85/1 | 71/28 | 75/22 | 66/14 | 65/26 | 95/7 | 94/3 | 63/18 | 66/22 | 77/10 | 95/5 | 80/4 |
| *Amount of Rainfall (mm/month)* | 26 | 19.7 | 13.0 | 4.6 | 1.5 | 0.2 | Trace | Trace | 0.4 | 7.1 | 15.7 | 24.0 |
| *Highest amount of Rainfall (mm/month)* | 37.0 | 29.0 | 44.3 | 31.8 | 15.8 | 8.5 | Trace | Trace | 18.0 | 35.0 | 55.0 | 40.1 |
| *Date (yy/dd)* | 32/28 | 93/13 | 91/22 | 86/1 | 61/6 | 79/4 | 34/21 | 42819 | 57/30 | 37/27 | 53/5 | 93/22 |
| *Dry temperature (°C)* | 12.9 | 13.4 | 15.3 | 18.1 | 21.0 | 24.5 | 25.8 | 26.0 | 24.5 | 22.4 | 18.4 | 14.6 |
| *Highest dry temperature (°C)* | 17.1 | 17.5 | 19.4 | 22.0 | 25.1 | 28.2 | 29.2 | 29.9 | 28.4 | 26.2 | 22.6 | 18.8 |
| *Lowest dry temperature (°C)* | 9.8 | 9.9 | 11.3 | 14.0 | 16.5 | 19.9 | 21.3 | 21.4 | 20.2 | 18.4 | 15.3 | 11.5 |
| *Pressure on mean level sea* | 1018.5 | 1017.0 | 1015.3 | 1013.6 | 1021.6 | 1011.2 | 1008.4 | 1008.5 | 1012.5 | 1015.6 | 1015.4 | 1018.2 |
| *Highest pressure on mean sea level* | 1032.5 | 1029.9 | 1028.8 | 1026.3 | 1024.4 | 1019.4 | 1016.4 | 1016.3 | 1028.3 | 1024.8 | 1028.4 | 1028.8 |
| *Date (yy/dd)* | 92/4 | 89/3 | 923 | 83/20 | 95/8 | 90/5 | 79/11 | 72/24 | 92/28 | 91/27 | 88/14 | 63/26 |
| *Lowest pressure on mean sea level* | 929.9 | 997.9 | 1000.8 | 993.6 | 999.4 | 1000.1 | 999.7 | 1001.8 | 1003.6 | 1001.5 | 1000.5 | 999.3 |
| *Date (yy/dd)* | 69/21 | 86/5 | 93/6 | 71/11 | 92/7 | 88/11 | 95/2 | 77/7 | 67/8 | 69/9 | 76/24 | 62/18 |
| *Number of days fog* | 0.2 | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 | 0.03 | 0.0 | 0.1 | 0.03 | 0.2 | 0.1 |

***Source: The Egyptian Meteorological Authority – Climate Directory (2001)***

Remarks: -The data cover an area of 50 km $^2$

Trace = amount of rainfall < 0.1 mm.

*Rainfall*

The area exhibits seasonal rainfall where nearly all rainfall occurs during winter. Similar to North African coast areas, most rain falls with W or NW winds. After heavy thunderstorms local flooding near the coast may occur, but serious situations are rare.

In the dry season, from June to September inclusive, there is often no rain in any part of the region. The average annual rainfall in Damietta is approximately 115 mm. The number of days in the climatic year in which rainfall exceeds the average is shown in Table 5.

**Table 5: Number of Days with above average Rainfall**

| Rainfall | No. of Days |
|---|---|
| 0.1 mm | 40 Days |
| 1 mm | 20-25 Days |
| 5 mm | 5-10 Days |

#### 3.3.1.4 *Site description*

The proposed project would be located to the south of SEGAS on an area of 1 $Km^2$ (as proposed by Damietta Port Authority). The port has dedicated a main entrance for access to both the proposed site and the SEGAS site (Plate 1). The site is characterised as coastal sand plains, with almost no vegetation, and no dominant dune system.

Currently, the site is heavily impacted by large quantities of accumulated construction/demolition and dredged sediment wastes (Plate 2A and 2B). Upper soil layer, of un-impacted areas, consisted of fine, silty sands with traces of broken shells. Ongoing construction activities were observed to the south east of the proposed site (Plate 3), however, no activities were observed on site during site visits.

The proposed outfall will use the same corridor/route as the existing SEGAS outfall, where the outfall site falls within a restricted area where fishing is prohibited, thus meeting the EEAA criteria for discharge conditions. The major features in the study area are the breakwaters to the east and west of the Port entrance (Plate 4) and the dredged channel (approximately 15 m) approach, which cuts through the shallow, near-shore, waters (Plate 5). Routine maintenance dredging (annual) is conducted within the channel. A ship wreck is identified (Admiralty Chart No. 2578 amendment, 2000) on the eastern approach to the main shipping channel entrance to Damietta Port in the vicinity of navigational buoy Fl. R.2.5s No 12.

The western breakwater is in the vicinity of an existing outfall. The western breakwater is 1300 m long at an angle of 10° (from N) and is constructed of large concrete rip-rap. A walkway exists along the entire breakwater.

### 3.3.2 Natural Hazards

#### 3.3.2.1 *Surface Water*

The nearest sources of surface water to the site are the branch of the Nile channelled into Damietta Port and the Mediterranean Sea.

#### 3.3.2.2 *Flash Flood Hazards*

Three approaches have been taken to study the possibility of flash-flood hazards on the proposed project location. The first approach was to search for previous flash flood incidents. This approach revealed no such incidents.

The second approach was to study the possibility of flash-flood occurrence through detecting the elements which impose a flash-flood hazard. The first element was rainfall - rainfall data for the past thirty years was studied, suggesting that the location has never been subject to severe rainfall. The second element was gradient - flash-floods usually occur in areas of steep gradients, trapped between sharp mountainous areas and the sea. There are no steep gradients in the area.

A third approach was also covered, where recent satellite images for the location were examined, the images indicated no flash-flood routes. The project site and surrounding areas are thus not expected to be subject to any flash-flood hazards. This analysis is provided strictly for the purposes of environmental impact considerations, and not for engineering design or planning purposes. Should flood return and flood protection information be required for design purposes, a detailed hydrological study of the site should be completed.

## 3.4 Terrestrial Biological Environment

### 3.4.1 Sensitive Habitats

The proposed site is not a nationally or internationally recognised area for nature or conservation. The site is a designated industrial area. However, the Mediterranean Sea in its entirety is protected by international legislation such as the Barcelona Convention.

The nearest Site of Scientific Importance (International Bird Area) is Lake Manzala, which is the largest of Egypt's wetlands covering an area of 770 $km^2$ (location 31°03'-31°31' N; 32°49'-32°18'E). Lake Manzala is Egypt's most important wetland for wintering water birds, home to an estimated total of 233,900 birds in winter (1989/1990)[5]. Lake Manzala is approximately 25 km south-east from the proposed site.

The Mediterranean shore of Lake Manzala is a potential site for breeding of endangered marine turtles (e.g. Loggerhead, *Caretta caretta*).

The Swamp Cat (*Felis chaus*) is still known to occur in good numbers in this region.

### 3.4.2 Vegetation

As previously mentioned the site was found to be impacted by large quantities of accumulated construction/demolition and dredging wastes. The vegetative cover was found to be very low, consisting mainly of sparse vegetation patches (Plates 6A and 6B) and one dense vegetative patch was recorded towards the south eastern boundary of the site (Plate 7).

The site is fenced and on the outer side of the fence (beyond port premises) large areas of agricultural lands exist.

### 3.4.3 Birds

Although over 470 bird species have been recorded in Egypt, only approximately 150 of these are considered resident breeders[4]. The remaining majority of species pass through Egypt during their migration from Scandinavia, Eastern Europe, Balkans, Siberia and Central Asia to eastern and southern Africa each autumn and during their way back each spring[5]. The existing Northern Delta lakes form an important stopover area for most migrating birds. With respect to the study area, the most significant of these lakes is Lake Manzala which passes through the Damietta Governorate. This lake (770 $Km^2$) is considered an important wintering area for Shelducks, Shovellers, and Coots, in-addition to many shorebirds especially Avocets[3]. A list of bird species sighted in Damietta is presented in Table 6.

**Table 6 Birds Reported in Damietta**

| Species[6] | Occurrence[7] |
|---|---|
| Crex crex | Passing Visitor[8] |
| Circus macrourus | Passage Migrant (Small numbers) |
| Phalacrorax carbo | Passage Migrant |
| Egretta alba | Passage Migrant |
| Egretta garzetta | Winter Migrant – breeder |
| Ardeola ralloides | Passage Migrant – rare breeder |
| Anas clypeata | Winter Migrant |
| Porphyrio porphyrio | Passage Migrant – common breeder |
| Recurvirostra avosetta | Sighted during winter, spring and autumn – casual breeder |
| Charadrius hiaticula | Passage Migrant |
| Charadrius alexandrinus | Breeding Resident/Partial Migrant |
| Charadrius percuarius | Breeding Resident |
| Hoplopterus spinosus | Breeding Resident |
| Tringa tetanus | Passage Migrant/Winter Visitor |
| Larus minutus | Uncommon Winter Migrants |
| Larus ridibundus | Wide Spread Migrant/Winter Visitors |
| Larus genei | Winter Migrants - common breeder |
| Sterna albifrons | Passing Migrant – breeder |
| Chlidonia hybridus | Spring and Autumn Passing Migrant |

The proposed site may used as an occasional feeding area for some of these birds, but is not thought to be a breeding area.

### 3.4.4 Mammals

The proposed site is currently surrounded by ongoing development and industrial activity (public road, LNG facility, Port activities), thus reducing the numbers of wild animals in the area. A mammalian foot prints were recorded (Plate 8) during recent site surveys and a few incidental sightings of mammals were noted in the area, including a weasel, rats (reported as being prevalent across the site) and domestic farm animals, during previous field/site surveys.

[4] Directory of important bird areas in Egypt (1999)

[5] Common birds of Egypt (2002)

[6] Center for Documentation of Cultural and Natural Heritage (CULTNAT)

[7] Birds of Egypt and the Middle East (2001)

[8] Recorded in the IUCN 2002 Red List, Red data list of Egypt (threatened species)

Table 7 provides a listing of mammals recorded in Damietta. None of the recorded species were found listed in the Red Data List of Egypt[8].

**Table 7: Mammals Reported In Damietta**

| Species[6] | Common Name |
|---|---|
| Hemiechinus auritus | Long-eared Hedgehog |
| Crocidura olivieri | African Giant Shrew |
| Rattus rattus | Black Rat |
| Gerbillus andersoni | Andersons Gerbil |
| Canis aureus | Golden/Asiatic Jackal |

None of the recorded/sighted mammalian species were found listed in the IUCN red list.

### 3.4.5 Insects and Reptiles

Many species of insects live in Egypt: beetles, mosquitoes, flies, and fleas are especially numerous. Scorpions (nocturnal) may be found in desert areas.

During the previous survey[3] the following faunal species were either observed or recorded as being present:

- Spiders (Clubionidae) and pseudoscorpions (Halominniza aegyptiaca litoralis);
- Beetles such as Ochthebius auratus and Anacaena sp;
- Mosquitoes (Bezzia sp.);
- Snakes; and,
- Lizards.

Table 8 provides a listing of reptiles recorded in Damietta.

**Table 8: Reptiles Reported In Damietta**

| Species[6] | Common Name |
|---|---|
| Hemidactylus turcicus | Turkish Gecko |
| Tropiocolotes nattereri | Natterer's Gecko |
| Mesalina brevirostris | Short-nosed Desert lizard |
| Chelonis mydas | Green Turtle[8] |
| Eretmochelys imbricata | Hawks-bill Turtle[8] |
| Lepidochelys kempi | Kemp's Ridley Turtle |
| Dermochelys coriacea | Leather Back turtle |

### 3.4.6 Subtidal

Other important species that may be found along the inshore coastline of the site include:

- *Portunus pelagicus* (crab);
- *Metapenaeus monoceros* (shrimp). Adults found offshore, juveniles inshore, but mainly brackish;; and,
- *Callinectes sapidus* (English/American Blue crab).

### 3.4.7 Species of Commercial Importance

There are no reported species of commercial importance on the proposed site. Commercial fishing occurs beyond the area of influence. The Port and shallow inshore waters of the Mediterranean are no fishing zones.

Within the region, there is a fishing industry that depends upon sardines (20%), mullet (9%), and shrimp and crabs (11%).

## 3.5 Existing Landscape & Visibility

A panorama of the site provided in Plate 9 shows the existing view from inside the site location (NE) looking towards the turning basin (on the right), going through the SEGAS LNG jetty/facility, old port wall, and on the left the new Port wall separating the site and the new coastal international road. The proposed site area is currently relatively undeveloped, but has been impacted by previous construction and dredging activities associated with the construction of the neighborhood facilities over the past few years.

The proposed site is located within an industrial zone, where many industrial facilities are under construction or in operation. The existing landscape units at the proposed site location consists of the SEGAS LNG plant, flare and other components, the UGD plant with its components, a container storage area, and the new Port perimeter wall. Across the Port the predominant vertical focal points are the storage "hangers" within the eastern section and the loading/unloading cranes to the south of the Port (Plate 10).

Beyond the port premises, to the east of the public road, some small shelters exist, were residents use the growing vegetation for livestock grazing (Plates 11 and 12). Beyond the shelters areas of trees (date palm) and scrub vegetation are clearly visible. There is a small irrigation channel along the inner eastern edge of the public road. General garbage (plastic, paper) is visible across the site and surrounding area.

The region to the west of the public road is a large, crop land, irrigated area, where a permanent village – Ezzbat Khamsa- exists (Plate 13). The area is densely vegetated with many established trees.

## 3.6 Existing Site Use

The site used to be an ex-military site till the year 2000, when it was given to the Port and became an industrial area. Potential sources of contamination, due to military activities, may include the following:

- Underground fuel storage tanks;
- Car batteries, fuel drums, paints, oils;
- Ammunition waste; and,
- Live ordinance.

Since year 2001, there has been heavy construction and dredging activities taking place inside the Port. Construction and dredging wastes have been dumped into the site, which might be sources of contamination.

No activities were observed on the proposed site.

## 3.7 Socio-Cultural Environment

The surrounding area beyond the perimeter wall of Damietta Port is currently cultivated land. The land is used by local farmers who are settled outside the Port premises and also graze their animals (cattle) on the local irrigated land, beyond the main road to the west of the site and north west of the site. There is a neighboring permanent village to the west of the public road.

During the site survey conducted 30 December 2004, an incident was recorded where a tractor driver was dumping wastewater (source not known) on farm/live stock grazing land in the presence of area residents (Plate 14). The incident may indicate the level of indifference that the surrounding community suffers. .

### 3.7.1 Demography

The proposed site lies within the Damietta Governorate which is divided into four major centres, namely; Al Zarka, Damietta, Fariskur and Kafr Sa'ad. The Governorate occupies approximately 910 $Km^2$ (0.1 % of Egypt) with a population density of approximately 1161 persons/$km^2$. Damietta's population attributes to approximately 1.54% of Egypt's overall population, with a relatively equal gender based distribution. Damietta suffers from a relatively high illiteracy rate and the greater portion of its population resides in rural areas where they (approximately 39 %) work in the agricultural field (including hunting/fishing). Table 9 presents a summary of the population distribution in the Damietta Governorate.

**Table 9: Population of Damietta Governorate. Egyptian Statistical Year Book – June 2004. Central Agency for Public Mobilisation & Statistics (CAPMAS).**

| | |
|---|---|
| Population | 1,056,324 |
| Rural | 73 % (1996) |
| Urban | 27 % (1996) |
| Females | 516,798 |
| Males | 539,526 |
| Total Employed population | 293,300 |
| Illiteracy (%) | 47 |
| population in public institutions | 1902 (1996) |
| number of public institutions | 63 (1996) |

### 3.7.2 Total Units, Roads, and Vehicles

Table 10 illustrates the distribution of units (buildings) amongst the rural and urban areas of Damietta Governorate. Table 11 illustrates the length and status of roads in Damietta, and Table 12 presents a break down of vehicles in Damietta.

Damietta is characterized with a relatively high number of vehicles with a predominance of larger vehicles used for distribution (trucks). Motorcycles are the most used form of transport for many of the residents of Damietta.

**Table 10: Total Units. Egyptian Statistical Year Book – June 2004. Central Agency for Public Mobilisation & Statistics (CAPMAS).**

| | Total units in urban areas (1996) | Total units in rural areas (1996) |
|---|---|---|
| Habitation | 69,958 | 153,334 |
| Work | 2766 | 3290 |
| Habitation & work | 710 | 1438 |
| Public institution | 127 | 80 |
| Others | 28,823 | 42,728 |
| Total | 102,384 | 200,870 |

**Table 11 Statistical Breakdown of the Length of Roads (Km) Used in Damietta – June 2004. Central Agency for Public Mobilisation & Statistics (CAPMAS).**

| From 7.5 – 12m wide | More than 12m wide | Regional Roads | Total Paved (Asphalted) | Unpaved Roads |
|---|---|---|---|---|
| 70 | 40 | 528 | 638 | 3 |

**Table 12: In-movement Licensed Vehicle. Egyptian Statistical Year Book – June 2003. Central Agency for Public Mobilisation & Statistics (CAPMAS.**

| In-movement licensed vehicle (2003) | |
|---|---|
| Lorry and truck | 12,222 |
| School Bus | 19 |
| Travel Bus | 26 |
| Tourism Bus | 0 |
| Private Bus | 91 |
| Public Bus | 73 |
| Taxi | 4,999 |
| Private cars | 17,750 |
| Tractors | 43 |
| Motorcycles | 20710 |
| Commercial & temporary | 204 |
| Public sector | 1081 |
| Government | 345 |
| Governorate | 1419 |
| Total | 47579 |

### 3.7.3 Economic Activities: Egypt

Table 13 describes the income and employment statistics for Egypt. The population is currently rising at a level of 1.72% per year, with a net annual migration rate of – 0.35 migrants/1000 population.

**Table 13: Egyptian Income and Employment**

| | |
|---|---|
| Population: | 68,359,979 |
| Age Structure: (15-64): | 61% of total (approx. 50:50, M:F) |
| Inflation rate (consumer prices): | 3.7% |
| Labour force by occupation: | 40% Agriculture |

| | |
|---|---|
| | 38% Services<br>22% Industry |
| Unemployment Rate: | 11.8% (1999 estimate) |
| Exports: | USD 4.6 billion |
| Imports: | USD 15.8 billion |

Increased sustainable industrial development and product exports are a major factor for future growth of the Egyptian Economy.

### 3.7.4 Damietta Port Capacity

Damietta port capacity information covering the period between 1993 to 2002 is presented in Table 14. This information shows that the port reached its maximum capacity during 1995-1996. Since then, the Port has reduced to half of the 1996 capacity, back to a level approaching that of 1993.

**Table 14: Damietta Port Capacity (million ton). Egyptian Statistical Year Book – June 2004. Central Agency for Public Mobilisation & Statistics (CAPMAS).**

| Year | Damietta Port Capacity (million ton) |
|---|---|
| 93/94 | 2.7 |
| 94/95 | 3.5 |
| 95/96 | 6.0 |
| 96/97 | 5.8 |
| 97/98 | 4.9 |
| 98/99 | 2.2 |
| 99/00 | 1.7 |
| 00/01 | 2.9 |
| 01/02 | 2.8 |

### 3.7.5 Land Use

Damietta is mostly known for its agricultural activity, including dairy production and rice mills. It is also a fishing industry town, with one of the largest fleets on the Mediterranean, accounting for half of the fishing boats of Egypt. Moreover, it is well known for its localized industries including furniture, leathers, textile and sweet industries, and for some of its tourist resorts (mainly Ras El-Bar).

The Damietta port area has been designated as an economic industrial zone where several industrial facilities have already commenced operation. The area outside the entrance of the port is predominantly used for agricultural purposes. Table 15 illustrates the distribution of agricultural land in the Damietta Governorate.

**Table 15: Distribution of Agricultural Land Owners and Area. Egyptian Statistical Year Book – June 2000. Central Agency for Public Mobilisation & Statistics.**

| Distribution of agricultural land owners and area (1995) (Feddan) | | |
|---|---|---|
| | Area | Owners |
| Less than -one Feddan (0.42 ha) | 7930 | 17165 |
| 1- | 8960 | 6732 |
| 2- | 11310 | 4877 |
| 3- | 10304 | 3066 |

| | | |
|---|---|---|
| 4- | 9548 | 2209 |
| 5- | 13401 | 2149 |
| 10- | 16197 | 1247 |
| 20- | 14167 | 524 |
| 50 - | 7205 | 104 |
| Over 99- | 5785 | 38 |
| **Total area** | **104,807** | **38111** |

## 3.8 Damietta, the City and the Port

### 3.8.1 General

Similar to other Delta cities, much of Damietta's long history has gone to the Nile's destructive forces, Mediterranean rains and the continuous ploughing of the land[9]. Substantial changes in the ports formation at the Damietta branch of the Nile have occurred over the past 2000 years[10]. The importance of the port has also suffered greatly over the past 200 years[10]. Recently, port facilities have been updated to relieve traffic at the Alexandria port. It started operation in July 1987, mainly to handle grain, flour and other bulk goods. The Port lies on the West Side of the Damietta branch of the River Nile 210 km northeast of Cairo and 15 km from the Mediterranean.

Currently, Damietta resides on a narrow strip of land in the Northern Delta of Egypt. The Nile divides the city into two parts bounded by the Mediterranean to the north, Lake Manzala to the east and the Daqahlia Governorate to south and west.

### 3.8.2 History

The city of Damietta has a long recorded history which goes back to the Hebrew era where it was mentioned in Torah as *kaftoud*. During the Pharoanic era it was known as *Tim Any* or *Tamit* which stands for "a body of water" and during the Roman and Coptic era's it was known as *Tamyatish* and, respectively. The current name "Damietta" is considered a corruption of the Coptic name '*Tamiati*".

The port of Damietta dates back to the Greek-Roman era where it was considered a key harbour for Roman trade and military ships. Its somewhat inland position provided considerable shelter and protection to ships against the sea. Nevertheless, accumulation of sandbars in the Nile Branch mouths often cut Damietta off from sea, causing larger ships to anchor offshore.

The presence of the port continued to bring prosperity to the city through the Middle Ages. During the Arab stage Damietta was made a commercial centre famous for textiles (AD 638), until Crusader attacks led Mamluk Sultan Baybers I (1260 – 77) to raise Damietta, its fortifications, block the Damietta Nile branch and re-establish a new Damietta at its current location, 6.4 km inland. The following Mamluk continued to use the port mainly for export of goods within the Ottoman Empire, as trade with European countries through Damietta port was banned during that period (1250 – 1517).

[9] The Nile Delta – The Past. Website: http://interoz.com/egypt/delta2.htm

[10] http://www.hut.fi/~fahim/damietta/pages/port.html

In the 1770s Aly Bey al-Kabir and Mohammed Bey Abu-al-Dahab, in their attempt to conquer Palestine and Syria, supplied the needs of their troops through the Damietta port. Together with their successors, they encouraged trade with European countries, and by 1776 fully 25 % of the ships utilizing the Damietta port were European. The city and port flourished as a centre for trade with European countries until the last few decades of the eighteenth century, as European wars significantly impacted these activities.

The significance of the city and the port as a trade centre was further degraded as much of the Nile's trade was diverted to Alexandria through the construction of Mahmudiyah canal in 1819. However, the city retained some trade, mainly with Istanbul and Syria.

### 3.8.3 Archaeology

The city was destroyed during the Mamluk stage and was later rebuilt in the Ottoman stage. Some buildings related to this stage (Ottoman) still exist, and are often in good condition. In general, the city has a number of fine mosques. An ancient mosque from the Fatimid period still exists, in a bad condition, in the old Damietta town. The mosque (Abu El-Maati mosque) is surrounded by a cemetery, which occupies an enormous area.

Data concerning archaeological areas of interest within Damietta was collected from the Centre for documentation of Cultural and Natural Heritage and is presented in Table 16. The geographical mapping of archaeological areas in Damietta is presented in Appendix IV.

**Table 16 Archaeological Areas of Damietta**

| Markaz (Center) | Archaeological Areas | Status of the Supreme Council of Antiquities |
|---|---|---|
| Al-Zarka | None | |
| Damietta | Manzalah Lake – Tell El Gosseh | Under supervision |
| | Tell Shata | Owner |
| Fariskur | Tell El Barashyeh | Owner |
| | Tell El Arab, Tell El 'arab | Owner |
| | Tell El Gaz | Owner |
| | Telal Abu Geriedah | Under protection of the Law |
| Kafr Sa'd | El Kom El Ahmar (Vi) | Owner |
| | Tell El Dier | Owner |
| | Tell El Mahgareh | Owner |

### 3.8.4 The Project Site

The project site is of no major archaeological importance. Based on observations and literature searches for the region (see Reference section), there are no historical sites within or in close connection to the proposed production plants or utility areas.

# 4 DESCRIPTION OF THE PROPOSED PROJECT

Kellogg Brown & Root (KBR) has retained Komex to conduct a preliminary environmental assessment (PEA) for the construction and operation of the integrated Methanol/Ammonia complex.

## 4.1 Integrated Methanol and Ammonia Complex

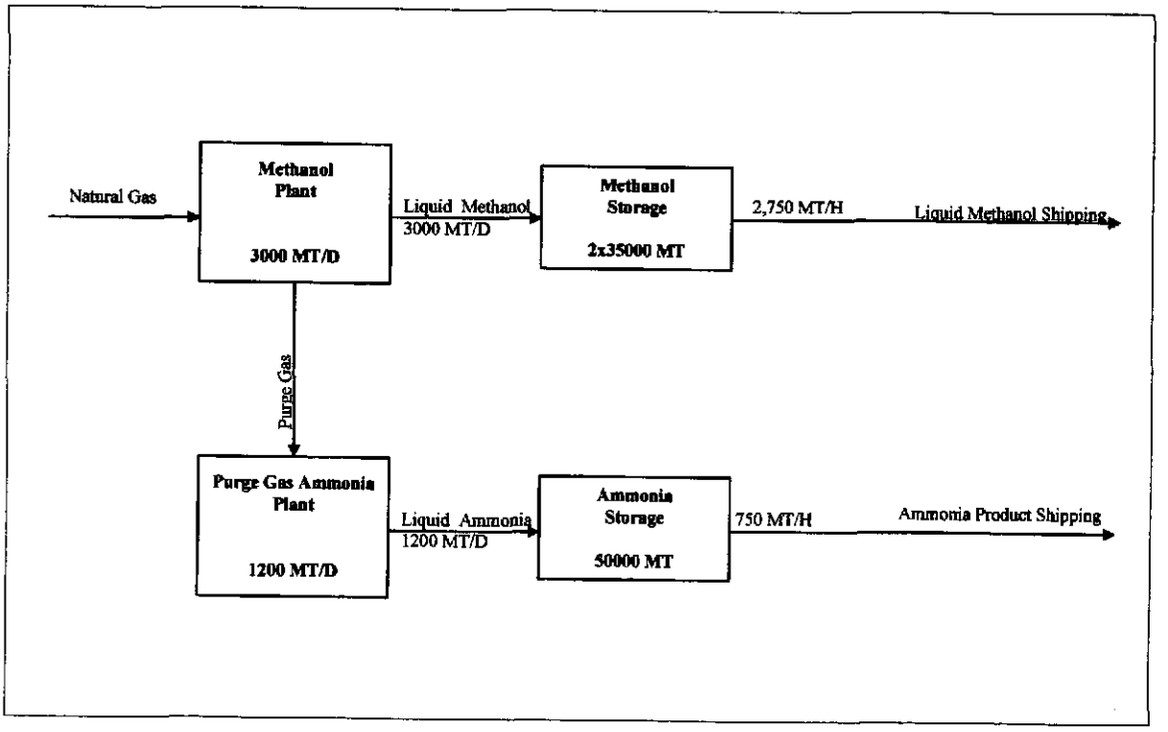
The proposed project involves the construction and operation of an integrated complex for the production of Methanol (primary product) and Ammonia (secondary product). A three phase production expansion plan has been developed for the construction and operation of the complex. It is planned that Phase I, Phase II and Phase III will commence production in mid 2008, 2011 and 2015, respectively. Each phase will operate with a production capacity of 3,000 MTPD Methanol and 1,200 MTPD Ammonia.

Appendix II illustrates the overall site plan of the complex indicating the location of the production complex and the distribution of its utilities within Damietta Port.

### 4.1.1 Process Description

The process comprises an integrated methanol production process unit producing methanol and hydrogen rich gas. The hydrogen rich gas is used as feed to the ammonia synthesis process unit.

**Figure 1 – Schematic – Integrated Methanol/Ammonia Production Unit**

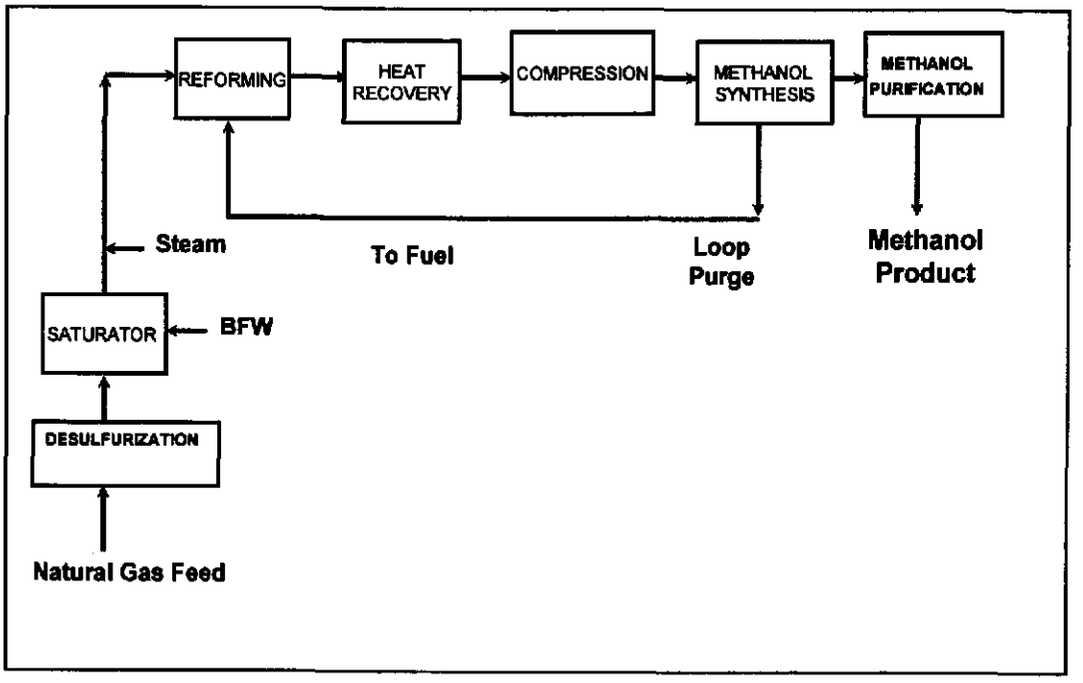


### 4.1.1.1 Methanol Production

The selection of the Methanol Process was undertaken by Granherne which included a preliminary technology screening analysis conducted between three major process technology licensors The process selected by Granherne is One Synergy incorporating a Johnson Matthey Low Pressure Methanol (LPM) process, improved by Davey Process Technology using Johnson Matthey Catalyst and known as Improved Low Pressure Methanol. Although process information was not made available by the Process Licensor, effluent and emission information for the aforementioned process was made available, as was data to design the utility units.

Figure 2 is a schematic of the One Synergy Conventional Methanol Process.

**Figure 2 – One Synergy Conventional Methanol Process**



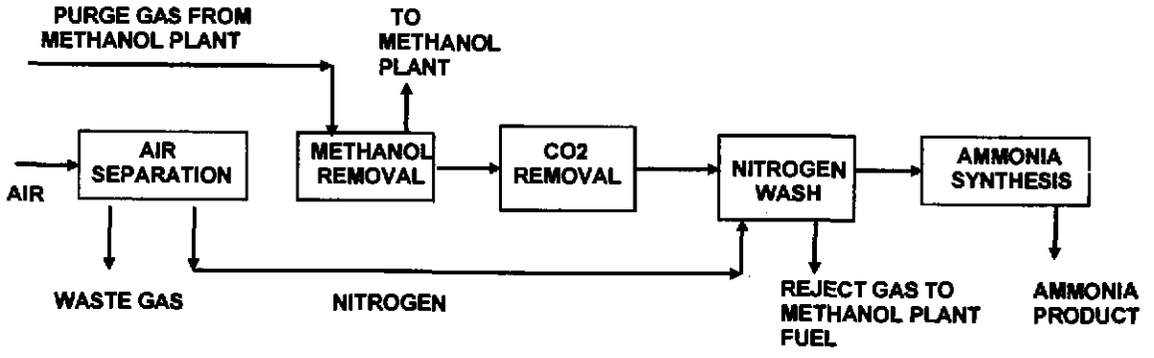

### 4.1.1.2 Ammonia Production

Prior to selection of the Ammonia production technology a preliminary technology screening analysis was conducted between three major process technology licensors. The analysis was performed based on various significant factors including environmental considerations, plant safety, plant efficiency, investment cost, on stream time, simplicity in operation and maintenance and reliability. The findings of the analysis favored the selection of the KBR Ammonia production technology.

Figure 2 highlights the major KBR ammonia process steps and the key features of KBR process are listed below;

A purge gas ammonia plant is much simpler and cheaper than a conventional ammonia plant because the purge gas from the methanol plant consists mainly of hydrogen. Therefore, the reforming and shift sections normally used in an ammonia plant to produce hydrogen are not needed. In addition, the purge gas from the methanol plant is available at a higher pressure than is normally used for ammonia plant synthesis loop makeup gas, which saves compression in a purge gas ammonia plant.

**Figure 3 – Purge Gas Ammonia Plant Schematic**




Purge gas (85% pure hydrogen) from the methanol plant will be fed into the ammonia loop at a rate of 122,300 $Nm^3/hr$. The purge gas, together with nitrogen, form the feed to the ammonia synthesis loop.

The purge gas from the methanol plant requires purification before being charged to the synthesis loop. This purification:

- Removes oxygen compounds such as moisture, carbon monoxide and carbon dioxide, which would poison the ammonia synthesis catalyst, and
- Purifies the purge gas, removing impurities such as methane, which would build up in the synthesis loop in the ammonia plant.

Purification is accomplished using liquid nitrogen wash. The nitrogen wash results in a hydrogen loss of two to three percent.. At end-of-run in the methanol plant, slightly more purge gas will be available, with the excess directed to plant fuel.
The air separation technology is well demonstrated and competitive, with units available from many vendors:
The purified makeup syngas is compressed and mixed with recycled gas. This combined gas is preheated and then fed directly to the intercooled horizontal synthesis converter. Ammonia is produced in either two or three catalyst beds in series with feed effluent exchangers between the beds.

Ammonia produced in the converter is recovered by an ammonia refrigeration system consisting of an ammonia compressor and the unitized chiller. The total inert in the fresh syngas entering the syngas compressor is about 0.3 mole percent and is all argon. Some of the argon in the

syngas entering the Synloop dissolves in the ammonia leaving the high pressure separator. Most of the dissolved gas is flashed off in the letdown drum. The rest is removed from the loop in a small purge stream representing about five percent of the syngas feed. The purge stream is fed to the ammonia recovery system.

### 4.1.2 Process Utility Summary

The utilities, for the purpose of the project, utilizes two 19 MW gas turbines for generation of plant power requirements. A process utility summary is presented in Table 18.

## 4.2 Waste Streams

### 4.2.1 Liquid Waste Streams: Operational Phase

Liquid waste would be produced at several stages of the operational phase. Table 17 presents a description of the key sources, quantity and composition of waste streams associated with the proposed facility as well as the mitigation strategy. Streams that exceed the EEAA guidelines will be diluted prior to discharge and will satisfy these EEAA rules.

**Table 17 Operational Phase Liquid Wastes**

| Methanol Process | | | |
|---|---|---|---|
| Source | Flow Rate | Components and Temperature | Environmental Mitigation Strategy |
| Saturator Blow Down | 3.5 (kg/MT MeOH) | Water<br>pH: 10 – 12<br>BOD (mg/l): <210<br>COD (mg/l): < 375<br>Methanol (mg/l): <250<br>Carbon dioxide (mg/l): <150<br>Methane (mg/l): <10<br>TSS (mg/l): <30 | Meets Egyptian regulations covered by Law 4. Discharge to Outfall Sewer where diluted by Seawater |
| Steam System Blow Down | 44 (kg/MT MeOH) | Water<br>pH: 9 – 10<br>BOD (mg/l): <10<br>COD (mg/l): <10<br>TSS (mg/l): <10 | Meets Egyptian regulations covered by Law 4. Discharge to Cooling Tower |

| Ammonia Process | | | |
|---|---|---|---|
| Steam System Blow Down | 400 kg/hr | Water<br>COD (mg/l): < 10 | Meets Egyptian regulations covered by Law 4. Discharged to Cooling Tower |
| Process Air Compressor Condensate | 4100 kg/hr | Clean Water | Meets Egyptian regulations covered by Law 4. Discharged to Cooling Tower |
| Utilities and Offsites | | | |

| | | | |
|---|---|---|---|
| Sanitary System | 48700 kg/day (Approx 48.7 $m^3$/day) | Temperature (°C): Ambient | Sanitary Treatment System (settling of suspended solids, biological treatment, and chlorination) and discharged to Outfall Sewer |
| Cooling Tower Blowdown | 2360 t/hr | Water (2 cycles of concentration) | Low Cycle of Concentration. Discharge to Outfall Sewer |
| Desalination Unit Reject | 1271 t/hr | Water | Low Cycle of Concentration. Discharge to Outfall Sewer |
| Boiler Blowdown | 0.6 t/h | Water | Meets Egyptian regulations covered by Law 4. Discharged to Cooling Tower |
| Demineralized Water Plant Effluent | 225 (kg/MT MeOH) | Water Temperature: 45°F | Neutralized in Neutralization Tank and discharged to Outfall Sewer where diluted by Seawater |
| | | | |

A preliminary review of Table 17 reveals that some streams would be discharged at elevated temperatures while other streams contain hazardous substances (methanol), the impacts of which are addressed in Chapter 5.

**Table 18: Utility Summary**

| ECHEM<br>Damietta, Egypt | METHANOL AND AMMONIA PROJECT<br>UTILITY SUMMARY | | | | | | | | | | | 31-Dec-04 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Natural gas | Sea water makeup | Desali-nated water | Boiler feed water from polisher | 40 bar steam | 3.5 bar steam | Conden-sate to polisher | Cooling water | Drinking/ service water | Waste water | Instrument Air | Electrical Power |
| | $Nm^3/hr$ | $m^3/hr$ | t/hr | t/hr | t/hr | t/hr | t/hr | $m^3/hr$ | t/hr | t/hr | Nm3/h | kW |
| Methanol plant | 149,500 | | | 422 | 28 | | -356 | 18,000 | 5 | -6 | 350 | 5,000 |
| Ammonia plant | -13,500 | | 60 | 43 | -7 | 0.4 | -36 | 6,498 | 5 | -0.4 | -550 | 23,348 |
| Utilities | | | | | | | | | | | 150 | |
| Sea water desalination | | 1,453 | -172 | | 2 | 23 | -23 | | -10 | -1,271 | | 908 |
| Drinking, fire, service water | | | 10 | | | | | | | | | 17 |
| Condensate Polisher | | | 100 | -590 | | | 490 | | | | | 189 |
| Deaerator and inlet HE | | | | | | 39 | -39 | | | | | |
| Package boiler | 2,993 | | | 31 | 0 | -30 | | | | -1 | | 438 |
| Power generation | 12,022 | | | 94 | -23 | -32 | -37 | 2,020 | | -2 | | -45,350 |
| Cooling water system | | 2,864 | 2.0 | | | | | -26,518 | | -2,360 | | 13,593 |
| Plant & instrument air | | | | | | | | | | | | 0 |
| Offsites | | | | | | | | | | | 50 | |
| Methanol storage | | | | | | | | | | | | 40 |
| Methanol loading | | | | | | | | | | | | 0 |
| Ammonia storage | | | | | | | | | | | | 125 |
| Ammonia loading | | | | | | | | | | | | 0 |
| Waste water treatment | | | | | | | | | | | | 693 |
| Flare | 455 | | | | | | | | | | | |
| Light/AC & Misc. | | | | | | | | | | | | 1,000 |
| Total | 151,471 | 4,317 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -3,640 | 0 | 0 |

NOTES:
1. Power generation by two 19 MW gas turbine-generator sets with heat recovery steam generator and two steam turbines.
2. A negative number indicates export.
3. "Natural gas" from ammonia plant is vent gas as equivalent natural gas

## 4.2.2 Solid wastes

### 4.2.2.1 Construction Phase

Construction wastes will include the following:

- Domestic waste from camps, kitchens and canteens (food, medical, sewage, etc);
- Packaging waste;
- Unused construction materials, off-cuts from piping and cabling bulks;
- Testing materials and fluids;
- Civil wastes (soils and gravels);
- Road manufacture wastes;
- Waste paints and solvent based products;
- Containers with residues; and,
- Vehicle wastes (tires, oils, batteries, etc).

These wastes will be segregated on site in accordance with their toxicity and will be transported to appropriate toxic or non-toxic waste handling centres, recycling centres, or reuse sites in Egypt.

### 4.2.2.2 Operational Phase

During the operational phase, it is expected that the number of employees, at all staffing levels, would be approximately 150 personnel for Phase I, increasing by 30 for each subsequent phase. This number of workers will generate a large quantity of domestic or "housekeeping" waste. This includes plastics, clean cardboard boxes, food scraps, and sanitary sewage treatment sludge, in addition to process-related solid wastes.

*Process related solid wastes:*

Process related solid wastes will mainly comprise of spent catalysts. A list of catalysts required for processing is presented in Table 19. Table 19also provides information regarding catalyst point of use and expected life time prior to disposal.

**Table 19: Integrated Process Catalyst Summary**

| Point of Use | Catalyst Type | Expected Life Years |
|---|---|---|
| | **Methanol Plant** | |
| Steam Reformer | Nickel Reforming | 3 |
| Methanol Synthesis Converter | Cu on Al2O3/CaO with promoter | 3 |
| Hydrotreater | Co-Mo | 5 |
| Desulfurizers | Zinc Oxide | 1 |
| | **Ammonia Plant** | |
| Ammonia Synthesis Converter | Iron/Pre-reduced | 8 -10 |
| Molecular Sieve Dryer | Zeolite | 3 – 5 |

During the operational phase, spent catalysts would either be returned to catalyst manufacturers or properly disposed of in toxic land fill sites.. However, as described in Appendix V, most of the above listed catalysts are recorded as hazardous materials, and require meeting specific criteria's for handling, storage and disposal.

No hazardous material landfills are currently available in Egypt; however one landfill is under construction in Alexandria.

### 4.2.3 Air emissions

#### 4.2.3.1 *Construction Phase*

The main dust emissions that may be produced during construction activities are those related to excavation works both on and offshore.

Heavy equipment and vehicle movements also give rise to dust emissions. Other emissions may include exhaust from vehicles and generators.

#### 4.2.3.2 *Operational Phase*

Air emissions would be produced at several stages of the operational phase. Table 20 presents a description of the key sources, quantity and composition of emissions associated with the proposed facility.

**Table 20 Operational Phase Emissions**

| Methanol Process | | | |
|---|---|---|---|
| Source | Flow rate | Components | Environmental Mitigation Strategy |
| Reformer Flue Gas | 4,465 $Nm^3$/MT MeOH | Temperature (°C): 180<br>$O_2$: 1.7 mol%<br>$N_2$: 70.1 mol%<br>$CO_2$: 8.5 mol%<br>$H_2O$: 19.7 mol%<br>[b] $SO_2$: 0.45 ppmw<br>[a] NOx: See Note | Sulfur level of natural gas to be less than 8 ppmv, resulting in $SO_2$ emissions of 0.5 ppmv, below the Egyptian limit of 1100 ppmv.<br><br>Conventional burners are capable of controlling $NO_x$ to 150 ppmv, below Egyptian limit of 155 ppmv. |
| Boiler Flue Gas | 390 $Nm^3$/MT MeOH | $O_2$: 1.7 mol%<br>$N_2$: 70.1 mol%<br>$CO_2$: 8.5 mol%<br>$H_2O$: 19.7 mol%<br>[b] $SO_2$: 0.45 ppmw<br>[a] NOx: See Note | Sulfur level of natural gas to be less than 8 ppmv, resulting in $SO_2$ emissions of 0.5 ppmv, below the Egyptian limit of 1100 ppmv.<br><br>Conventional burners are capable of controlling $NO_x$ to 150 ppmv, below Egyptian limit of 155 ppmv. |
| Deaerator Vent | 10 $Nm^3$/MT MeOH | Temperature (°C): 109°C Steam | None Required |
| Converter Catalyst Oxidation Vent | Occurs for a period of 24 – 36 hours at catalyst change | Temperature (°C): 50<br>$O_2$: 2.0 mol%<br>$N_2$: 98.0 mol% | No Pollutants |

| | | | |
|---|---|---|---|
| Tanks:<br>- Crude Methanol Tank<br>- Refined Methanol Shift Tank Vent<br>- Methanol Product Storage Vent | Subject to equipment size | $N_2$ with low methanol | Floating roof type product tanks to minimize vapor emissions. |
| Miscellaneous Emissions:<br>- Flare Gases<br>- Firewater Pump Diesel Driver<br>- Sample Point Vents<br>- Atmospheric Vents | Subject to equipment size | Combustion products of natural gas / diesel<br><br>Small intermittent flows of process gas<br><br>Releases due to upset | Emission levels low and / or intermittent. |
| **Ammonia Process** | | | |
| $CO_2$ | 4,100 $Nm^3/hr$ | No Sulfur Compounds | High vent to disperse flow.<br><br>No Egyptian regulations which limit $CO_2$ emissions. |
| Oxygen Vent | 25,000 $Nm^3/hr$ | $O_2$: 59 vol%<br>$N_2$ + Ar: 41 vol% | No Pollutants |
| Dryer Vent | 9,600 $Nm^3/hr$ | No Pollutants | No Pollutants |
| **Utilities and Offsites** | | | |
| Gas Turbine Generator Exhaust | 326,349 $Nm^3/hr$ | Temperature (°C): 230<br>$O_2$: 12.3 mol%<br>$N_2$: 76.1 mol%<br>$CO_2$: 4.0 mol%<br>$H_2O$: 7.7 mol%<br>[a] NOx: See Note | Sulfur level of natural gas to be less than 8 ppmv, resulting in $SO_2$ emissions of ~0.5 ppmv, below the Egyptian limit of 1100 ppmv.<br><br>Conventional burners are capable of controlling $NO_x$ to 150 ppmv, below Egyptian limit of 155 ppmv. Provisions for water / steam injection. |
| Package Boiler | 37,806 $Nm^3/hr$ | Temperature (°C): 315<br>$O_2$: 2.5 mol%<br>$N_2$: 72.6 mol%<br>$CO_2$: 8.5 mol%<br>$H_2O$: 16.3 mol%<br>[b] $SO_2$: 0.45 ppmw<br>[a] NOx: See Note | Sulfur level of natural gas to be less than 8 ppmv, resulting in $SO_2$ emissions of 0.5 ppmv, below the Egyptian limit of 1100 ppmv.<br><br>Conventional burners are capable of controlling $NO_x$ to 150 ppmv, below Egyptian limit of 155 ppmv. Provisions for water / steam injection |
| | | | |

[a] Meets World bank standards for NOx emissions averages
[b] based on a maximum natural gas Sulphur content of 5ppm (vol)

A preliminary review of the composition of emissions reveals the presence of hazardous substances, green house gases and photo oxidants, the impacts of which are addressed in Chapter 5.

*Other Sources*
Other sources, not considered above, are expected to provide only minor contributions to the total quantity and environmental impact of gaseous emissions from the proposed facility.

### **4.2.4** Noise

#### *4.2.4.1 Construction noise*

Sources of construction noise include:
- Construction vehicles and plant;
- Construction camp noise;
- Pile driving; and,
- Other special localized activities.

#### *4.2.4.2 Operational Noise*

The plant has a significant number of major noise sources, including:
- Gas Turbines;
- Compressors;
- Flares;
- Skid units; and,
- Heat exchangers and/or cooling towers.

The Egyptian Environmental Law (Law 4/1994) sets the criteria for noise levels in industrial areas as illustrated in Table 21.

**Table 21: Law 4 Allowable Noise Limits**

| Type of Area | Permissible Limit For Noise Intensity Decibal (a) | | | | | |
|---|---|---|---|---|---|---|
| | Day | | Evening | | Night | |
| | From | To | From | To | From | To |
| Industrial Area (Heavy Industries) | 60 | **70** | 55 | **65** | 50 | **60** |

The law is found to set different noise level criteria during the day/night, the reason for which is that many of the industrial areas in Egypt include residential areas, thus requiring a more stringent criterion. However, during a meeting with an EEAA official it was indicated that in cases where proper noise modeling provides evidence that no significant impacts would arise from higher noise levels, the facility would be granted an approval for operation.

## 4.3 Pre-construction, Construction, Operation and Maintenance Activities, Staffing and Support Facilities and Services

Certain materials used for pre-construction, construction and operation as well as for maintenance activities will be brought from local sources in Egypt, larger prefabricated components will be imported. Many materials will be transported via the sea.

It is estimated that the maximum number of trucks, vans and cars on the site will be in the order of approximately 60 to 90 plus 10 - 20 cranes[11]. Less than half of this volume is anticipated to be active at any one time. Vehicle/other movements will be in accordance with specific Egyptian traffic regulations to satisfy safety requirements, where certain sizes or types of vehicles will be restricted from certain areas within the plant. There will also be controlled designated parking areas.

The estimated number of barges including crane barges and jack-up platform is 2 to 5[11].

Personnel during both the construction and operation phases will mainly be from Egypt where skilled labor is available. Otherwise, specific tasks may require skilled labour from outside Egypt. It is estimated that each construction phase may involve the presence of around 800 persons on site during peak time, and 600 personnel on average. During operation, the project will provide direct job opportunities for approximately 150 employees with a 20 % increase upon operation of each phase.

### 4.3.1 Required Off-site Investment

Where facilities do not exist for the reuse, recycling or disposal of waste material from the site, this material will be required to be exported to an appropriate handling facility outside of the country. Arrangements will be made with other industries within Egypt where appropriate.

### 4.3.2 Longevity of Major Components

The plant design life for all major components will be twenty years.

[11] Numbers are estimated based on team past experience

### 4.3.3 Workers Facilities

A number of facilities have been designed for use by the staff and workers on site during the construction and operation phase. These will include:

- Canteen;
- Administrative area;
- Medical Clinic; and,
- Car Parks.

# 5 SIGNIFICANT ENVIRONMENTAL IMPACTS

## 5.1 Procedures

The description of the existing conditions in section 3 provides a multidisciplinary analysis of the ecosystem of Mediterranean Sea and the onshore location of the proposed development. This baseline knowledge permits the identification of the main concerns and issues pertaining to the development of the onshore facilities and the offshore outfall in the Mediterranean, and forms the basis of this Preliminary Environmental Impact Assessment (PEA).

To aid in the PEA, the concept of Valued Environmental Components (VECs) has been used as a tool to highlight important individuals or groups, which could suffer adverse impacts. The VECs have been selected following identification of the pathways linking environmental components of concern with project activities, and are fundamental to the process of the PEA.

## 5.2 Environmental Components

The purpose of a Preliminary Environmental Assessment (PEA) is to examine, analyse and assess the planned project activities at an early stage. The PEA should assist in ensuring environmentally sound and sustainable development by providing all the environmental information necessary to determine the environmental acceptability and feasibility of a proposal. This PEA was commissioned to assess the effects on the terrestrial, marine and atmospheric environment, due to the development of:

- A Methanol/Ammonia integrated complex in the Port of Damietta; and,
- Associated facilities of the proposed plant.

The PEA forecasts changes (positive and negative) that may occur to the environment, and demands a baseline understanding of the natural driving forces at the proposed project location. The early identification of impacts that may occur in the area reduces the risk of future adverse environmental effects, and permits the proposal of mitigation guidelines to avoid, reduce or remedy significant adverse effects.

The PEA also acknowledges potential socio-economic impacts, which predicts the effect on people and communities occurring as a result of the onshore/offshore development.

This report identifies potential impacts in relation to construction and operational phases of the project (also operational maintenance and process impacts). These include potential impacts on VECs associated with:

- Wastewater effluents;
- Air emissions;
- Solid wastes;
- Land use;

- Infrastructure;
- Noise;
- Traffic (land); and,
- Employment.

### 5.2.1 Marine Components

Marine invertebrates are one of the important groups of organisms associated with the port and the coastal Mediterranean Sea. This ecosystem also supports a large diversity of fish species ranging from benthic dwellers to large pelagic species. Marine mammals (such as Dolphins) are also common. The coastal area of the Mediterranean adjacent to the northern site boundary is prohibited for fishing.

Along the shoreline a number of crab burrows were noted (mainly *Ocypode sp*). Macroalgae were present along the rocky areas of the riprap and along the breakwater (predominantly *Enteromorpha sp* and *Ulva sp*).

### 5.2.2 Marine Pathways

#### *5.2.2.1 Physical Impacts*

Marine organisms may be damaged or killed by direct physical impact. Some of this damage occurs naturally, especially during storms, but if rates of damage due to human activity become significant, the total rate may exceed the rates of colonization and growth by new organisms.

Damage may occur during construction through:

- construction of structures directly on the shoreline and on the sediment;
- building materials being accidentally dumped in the coastal waters or blown into the water;
- dredging in the Port; and,
- dredging and construction for the marine outfall.

#### *5.2.2.2 Loss of Habitat*

Any infilling over the sea bed, for the creation of additional land, or for the construction of roadways or solid jetties in the Port, or the dredging or excavation of areas of seabed, will destroy the marine life on the underlying area. In addition, unless exceptional care is taken during the construction phase, further damage can extend 20 m or more to either side.

#### *5.2.2.3 Sedimentation and Turbidity*

Increased suspended sediments can lead to an overall reduction in the quality of the water column. Increases in turbidity can be a result of:

- coastal construction;
- dredging; and,

- increased marine traffic.

Increased turbidity may be detrimental to benthic species – particularly sedentary species such as tube worms. Prolonged reduced clarity may also lead to a reduction in the photosynthetic productivity of the water column.

### 5.2.2.4 Eutrophication

A wide variety of chemically active components released into the sea may damage marine life, leading to the degradation of the marine environment and loss of marine resources.

The most important example is nutrients, nitrates and phosphates, which are critical to the rates of plant growth both on land and in the sea. As nutrient levels increase, so plant growth increases up to a certain point. At the same time, one or a few marine plant species, such as *Enteromorpha* sp. and *Ulva* sp., increasingly dominate, thus excluding other forms of marine life. At higher nutrient levels, accumulation of decomposing plant material typically leads to reduced oxygen conditions in which only bacteria thrive.

Nutrients may also reach the sea as a result of:

- run-off or leaching from agricultural or landscape schemes;
- leaking underground/aboveground pipes (sewer); and,
- the accidental disposal of liquid waste from land or from ships.

Another impact of an enhanced nutrient load is that phytoplankton growth rates increase and can form nuisance blooms. Generally these blooms are not harmful, but do reduce the aesthetic value of the area and increase the BOD of the water column. However, in some cases the blooms can be formed by toxic algae that can be potentially dangerous for humans. The toxins pass through the food chain from micro algae to fish and finally to humans.

### 5.2.2.5 Temperature Variation

Many marine species have an optimum temperature range between which growth and survival occurs. For many Mediterranean species this is between 17-27°C. Discharge of liquid wastes to the marine environment at elevated temperatures would at least affect marine biota surviving within the discharge zone of influence.

### 5.2.2.6 Salinity Variation

Many species that inhabit the coastal waters of the Mediterranean are euryhaline (can tolerate a wide range in salinities). The maximum salinities reported in the area of influence of the proposed project are up to 39-40. Salinities greater than 45 are likely to cause local community changes. The Port of Damietta is influenced by the waters of the Nile, therefore salinity range may be between 30-40 in the Port.

#### 5.2.2.7 Anti-Fouling Paints

Since the 1960's, butyltin compounds (organotins) have been used world-wide for various purposes. Tributyl Tin (TBT) has been implemented extensively as anti-fouling agents in paints used for boats and aquaculture nets. Organotins are also used as stabilisers in plastics and wood preservatives.

Earlier studies on TBT effects focused mainly on lower trophic organisms in the food chain. These studies reported physiological abnormalities such as growth reduction in marine microalgae, shell thickening and spat failure in oysters and imposex in gastropods and whelks (imposex is a malformation of the genitals). Other impacts include endocrine disruption in shellfish, algae mortality, and bioaccumulation in coastal ecosystems. Further investigation in marine vertebrate predators such as marine turtles, tuna and shark suggest that greater accumulation of butyltins can occur at higher food chain levels.

The International Maritime Organisation (IMO; London) has voted to ban Tributyl Tin (TBT) biocides in antifouling paints for ships. A ban on painting ships with TBT antifouling paints will come into effect January 1, 2003; a ban on the presence of TBT on all ships' hulls will begin January 1, 2008.

IMO banned TBT for use on vessels shorter than 25 metres in 1990.

#### 5.2.2.8 Hydrocarbon Fuel spills

Floating oil contaminants will directly affect mammals and birds that swim or dive through the surface of the water. For chemicals such as benzene, this has further implications for pelagic species and human health. Hydrocarbons could also be released from the shore operations.

The magnitude and persistence of contamination in the inter-tidal zone is greatly dependent on the geomorphology and the sediment characteristics of the coast. On beaches of fine sand, the contaminants are likely to remain on the surface where it can readily be removed. On beaches of coarser sands, the contaminants may penetrate with the tidal water table down to hard substrata.

### 5.2.3 Terrestrial Components and Pathways

The area of the proposed development can be described as the coastal zone and consists of sandy shorelines (Plate 15), with undulating sand drifts across the main sections of the site. It is a harsh environment with dry, sandy soils, little rainfall, high salinity and exposure to wind. There is little vegetative cover and the flora and fauna are relatively impoverished.

Incidental sittings of rats and a weasel were noted across the site. Numerous rat burrows are present along the sandy berm adjacent to the Port.

#### 5.2.3.1 Loss of Habitat

For terrestrial ecological components there is scope for physical destruction of habitat during construction-work. This loss of habitat will most affect insects, beetles, spiders and pseudo scorpions across the site. Birds are not known to nest at the development site and therefore will be affected most by a potential loss of feeding grounds. Migration routes may be disrupted.

Many mobile animal species may be able to exploit the areas beyond the site perimeter.

Some areas across the site will be landscaped. This will result in the loss of the current sparse native vegetation and its replacement by 'cultivated forms'. Introduction of non-native species creates the potential for release of such organisms into the surrounding landscape. There is, however, scope for diversification of the existing local flora and fauna through sympathetic management.

#### 5.2.3.2 General Disturbance

Construction of workers housing and onsite facilities will increase the noise levels across the site and in the area. Noise during construction and operation, together with disturbance caused simply by the presence of people, may disrupt the behaviour of some bird species within the area. Frequent disturbances can mean that some birds are unable to feed for adequate periods and will fail to breed successfully. The increased noise on the site may also adversely affect the neighboring village.

### 5.2.4 Socio-Economic Components and Pathways

In addition to the terrestrial elements of the ecosystem there are other valued components that should also be evaluated in the context of this impact assessment. These include the neighboring residents and local farmers.

Disturbances to the local residents and farmers may include elevated noise, light levels, increased vehicle movements and the risk of explosion from the proposed facility.

Positive impacts will be achieved from the project in terms of the potential employment from the site. Employment opportunities will be available for skilled and unskilled workers. Indirectly, the local economy will be enhanced due to the increase in personnel in the area (and direct spending potential) and the associated opportunities for businesses and industries in the area (e.g. recycling industries, accommodation).

National unemployment levels are 11.8% (1999 estimate), with an employment breakdown of 40% Agriculture; 38% Services; 22% Industry. During each construction phase the project will directly offer approximately 600 job opportunities. During operation, the project will provide direct job opportunities for approximately 150 employees with a 20 % increase upon operation of each phase. Other indirect job opportunities would be provided by other servicing industries, related to the project, thus offering many thousands of skilled and unskilled workers employment. Training will also be necessary for many of the new staff, and new skills and techniques will be transferred to the local market.

## 5.3 Valued Environmental Components

To aid in the PEA, the concept of Valued Environmental Components (VECs) has been used as a tool to highlight important individuals or groups, which could suffer adverse impacts. The VECs have been selected following the identification of the pathways linking environmental components of concern with project activities, and are fundamental to the process of the PEA. The VEC's have been selected following consultation with the EEAA and other relevant statutory authorities in the area, and also based on the expertise of the project team.

In order to establish a framework for analysis of impacts that may arise from this coastal development, the project team formulated a list based on literature searches, site assessment, Egyptian regulations/guidelines (Law 4) and valued environmental components (VECs) that could be affected.

Three main components are assessed:

- Biotic (biological);
- Abiotic (physical); and,
- Social.

These three components are further sub-divided into specific categories, which are the valued environmental components for this sensitive ecosystem. Table 22 lists these VECs.

**Table 22: Valued Environmental Components.**

| Component | VEC |
|---|---|
| Biotic | Plankton |
| | Pelagic Fish |
| | Demersal Fish |
| | Crustaceans |
| | Mollusks |
| | Birds |
| | Marine Mammals |
| | Onshore vegetation |
| | Onshore Mammals |
| | Reptiles |
| | |
| Abiotic | Coastal Morphology |
| | Sediment Dynamics |
| | Soil and groundwater |
| | |
| Social | Local Fishing |
| | Local Farmers |
| | Existing Site-users |
| | Nearby Village |

A total of 17 Valued Environmental Components were identified, 10 of which are classed in the biotic component. These VECs are considered under the main proposals of the Project development.

## 5.4 Impact Evaluation

The evaluation of environmental and social impacts that could arise from development activities associated with the proposed project involved the following steps:

1. All phases and activities associated with the project were listed.
2. For each activity, the potential environmental effects were determined.
3. The significance of each environmental effect on the Valued Environmental Components listed in Table 21 was assigned one of five significance classes:
   - Class 1 – Significant, major impact.
   - Class 2 – Significant, moderate impact.
   - Class 3 – Insignificant, minor impact.
   - Class 4 – No impact predicted.
   - Class 5 – Unknown.

The determination of the significance of each impact followed a procedure outlined in Table 23. Impacts were evaluated using three criteria of magnitude, scale and duration of impact. The difference between a local scale and regional scale was determined in terms of magnitude and duration of the impact. Based on this interaction, a scaling from 1-3 was assigned resulting in a classification as a major impact (Class 1), a moderate impact (Class 2) or a minor impact (Class 3). Two other classes were also assigned if applicable: No impact predicted (Class 4) or Impact Unknown due to insufficient information (Class 5).

**Table 23: Assessment of Impact Significance**

| |
|---|
| ***Duration*** **– what is the length of the negative impact?** |
| None-no effect. |
| Short – less than one year. |
| Moderate – one to ten years. |
| Long – greater than ten years. |
| Permanent (irreversible) |
| |
| ***Magnitude*** **– what is the effect on the resource within the study area?** |
| None-no effect. |
| Small – affecting less than 1% of the resource. |
| Moderate – affecting 1-10% of the resource. |
| Great – affecting greater than 10% of the resource. |
| |
| ***Spatial Extent*** **– what is the scale of the impact in terms of area, considering cumulative impacts and international importance?** |
| Local – in the immediate area of the impact. |
| Regional – having large scale impacts. |

Impacts are classified on a regional or local scale and assigned a class.

*Regional Scale*

| | Duration | | | |
|---|---|---|---|---|
| **Magnitude** | **Permanent** | **Long** | **Moderate** | **Short** |
| Great | 1 | 1 | 1 | 2 |
| Moderate | 1 | 1 | 2 | 2 |
| Small | 1 | 2 | 2 | 3 |

*Local Scale*

| | Duration | | | |
|---|---|---|---|---|
| **Magnitude** | **Permanent** | **Long** | **Moderate** | **Short** |
| Great | 1 | 1 | 2 | 3 |
| Moderate | 1 | 2 | 2 | 3 |
| Small | 2 | 2 | 3 | 3 |

Finally, a significance class is established:

| CLASS | SIGNIFICANCE | DESCRIPTION/COMMENTS |
|---|---|---|
| Class 1 | Significant, Major impact | Impacts are expected to be permanent and non reversible, and/or has international significance. |
| Class 2 | Significant, Moderate impact | Impacts are considered to be long term (>10 years), reversible and/or regional in extent. |
| Class 3 | Insignificant, Minor impact | Impacts are considered to be short term (<10 years), reversible or localised in extent. |
| Class 4 | Insignificant | No impact is expected. |
| Class 5 | Unknown | There is insufficient data on which to assess significance. |

## 5.5 Environmental Pathways

The environmental pathways link the stresses generated by project activities with the Valued Environmental Components that form the focus of the study. The proposed development is likely to have its most significant negative impacts on the marine, terrestrial and atmospheric environment, but in most cases these are anticipated as temporary and insignificant. Positive impacts will occur for some of the socio-economic VECs. A summary of the potential pathways and impacts are listed in Table 24.

**Table 24: Summary of Potential Pathways and Impacts**

| PHASE | PATHWAY | TYPE OF IMPACT |
|---|---|---|
| **Construction** | -dredging | -habitat destruction (terrestrial) |
| | -increased sediment load | -habitat destruction (marine) |
| | -increased noise | -behavioral change of mammals/ birds/ local residents |
| | | -behavioral effects on birds, mammals |
| | -increased waste water | -increased macro/micro algal growth (marine) |
| | -increased solid wastes | -loss of habitat; physical destruction |
| | -coastal construction including intake & outfall | -loss of habitat along shoreline |
| | -increased vehicles | -loss of natural habitat across site |
| | -extension beyond the existing Port perimeter | -social impacts to local farmers and residents who may have to relocate |
| | - Need for local personnel | -Positive impact for employment prospects in the area |

| PHASE | PATHWAY | TYPE OF IMPACT |
|---|---|---|
| **Operation** | -Marine effluent | -increased macro/micro algal growth (marine) |
| | | -change in the local benthic community |
| | -dredging damage | -physical destruction of coastal community |
| | -leaching of brine/freshwater | -salinity fluctuations causing community changes to marine ecology |
| | | -physical destruction of habitat (terrestrial) |
| | - Emissions, noise and disturbance | -behavioral effects (possible displacement of reptiles and birds) |
| | | -alteration of terrestrial communities and habitats |
| | | -introduction of alien species (ballast water) |
| | | -nuisance to local villagers |
| | | -Positive impact for employment prospects in the area |
| | - Need for local personnel | |

| PHASE | PATHWAY | TYPE OF IMPACT |
|---|---|---|
| **Accidental Events** | -collision of product transport vessels | -ecotoxicity, fish kills, mortality |
| | -surface oil slicks/releases | -marine mammals/ birds mortality |
| | -surface spillage of brine | |
| | -surface spillage of waste water | -salinity fluctuations causing community destruction |
| | | -increased BOD, faecal coliforms |
| | -explosion | -loss of life (including human) in the vicinity of the blast zone |

### 5.5.1 Seawater Intake

A list of ranked identified impacts of the seawater intake is provided in Table 1, Appendix VI

*Construction*

A sea water intake basin will be constructed on the beach that will accommodate the sea water intake pumps and filtration grid equipment. Sea water will be pumped from this basin in GRP pipelines. The pipelines will follow the DPA 50 meter wide utilities corridor to the proposed site.

This would be a small structure, which would not result in significant loss of habitat. Construction activities would result in impacts such as increased air emissions due to a minor increase in marine and onshore traffic, general litter and wastes from human activities and increased noise due to increased machinery usage.

Construction of the seawater intake may have negative impacts to a number of VECs, including plankton, crustaceans, mollusks, pelagic and demersal fish.

| Biotic | Abiotic | Social |
|---|---|---|
| Impact Significance without application of mitigation measures: | | |
| 3 | 3 | 3 |

*Operation*

Each operational phase would require, at normal operating conditions, intake from the sea of 4,487 $m^3/h$ to cover the requirements of the desalination plant and the cooling water system.

Appropriate pipe design/maintenance should reduce associated impacts, especially those related to fish intake and marine bio fouling.

Operation of the seawater intake may negatively impact a number of VECs, including plankton, crustaceans, mollusks, pelagic and demersal fish, and potentially the local fishing industry.

| Biotic | Abiotic | Social |
|---|---|---|
| Impact Significance without application of mitigation measures: | | |
| 3 | 3 | 4 |

*Accidental Events*

Accidental events related to the marine intake may result from leaks and ruptures of the pipe and/or screen. This may negatively impact a number of VECs, including plankton, crustaceans, mollusks, pelagic and demersal fish, and potentially the local fishing industry if screens are ruptures or if intake increases significantly.

| Biotic | Abiotic | Social |
|---|---|---|
| Impact Significance without application of mitigation measures: | | |
| 3 | 4 | 3 |

### 5.5.2 Marine Outfall

Egyptian regulations require that the marine outfall be located greater than 500 m from the existing shoreline. A list of ranked identified impacts of the marine outfall is provided in Table 2, Appendix VI.

*Construction*

The marine outfall will be at the 3m contour line. It will not be close enough to interfere with the sea water intake. A GRP sea water effluent pipe line from the plant will extend down the 50 m utilities corridor on the west side of the ports land, over the beach area and out to sea. In the sea, it will be weighted to avoid drift.

The major identified impacts during the construction of the marine outfall are due to increase in seawater turbidity. Increased turbidity results in a reduction in the depth of penetration of incident irradiance, which may have negative impacts on the micro and macro algal community if the events are long-lived. High sedimentation rates may also directly impact the benthic community by smothering filter feeders and stationary organisms.

The construction of the outfall may require some dredging of the benthos, and will destroy the existing benthic community along the outfall route. This loss would be temporary until the re-colonization of the outfall corridor and surrounding area.

Other impacts related to the construction of the outfall include air emissions, noise and general litter related to construction activities.

The main VECs negatively impacted through the construction of the outfall include crustaceans, mollusks, demersal fish and marine mammals, and potentially the soil and groundwater in the coastal fringe.

During the construction phase, there will be positive benefits for the local community in terms of employment and the need for specialist local experience.

| Biotic | Abiotic | Social |
|---|---|---|
| Impact Significance without application of mitigation measures: | | |
| 3 | 3 | 3 |

*Operation*

The existence of an outfall structure may result in a change in the biological community along the corridor of the structure. Biofouling may also occur on the ports and pipeline.

Discharges to the sea could also result from natural drainage such as surface water runoff and water tank overflows. This water is thought to be uncontaminated and should not cause any significant impacts. The marine outfall is designed to discharge a number of wastewater drains. The expected, per operational phase, rates and types of discharges, under normal conditions, through the marine outfall are shown in Table 25.

**Table 25: Routine Discharges to the Sea**

| Routine Discharge via outfall | Quantity | Quality |
|---|---|---|
| Methanol plant water reject | 630 $m^3$/hour | Should abide with Annex I of Law 4 of 1994 |
| Ammonia plant water reject | 1120 $m^3$/hour | Should abide with Annex I of Law 4 of 1994 |
| Desalination unit reject (OSBL) | 1.3 $m^3$/hour | Should abide with Annex I of Law 4 |

| | | |
|---|---|---|
| | | of 1994 |
| Treated Effluent from Sanitary Water Treatment | 2 m³/hour | Should abide with Annex I of Law 4 of 1994 |

Water reject from methanol plant are expected to contain trace amounts of methane (< 10mg/l) and methanol (< 250 mg/l). According to the USEPA (1994)[12], Methanol is a toxic substance; however in the aquatic environment it is usually removed by biodegradation and has low acute toxicity to aquatic organisms, lethal concentrations being much greater than 100 mg/L.

Water reject from the ammonia plant is expected to contain trace amounts of ammonia (1 ppm) and trace methanol (discussed above). Ammonia appears on the U.S. EPA[13] list of extremely hazardous substances and is considered very toxic to aquatic organisms[14]. The EEAA environmental regulations set the criteria for ammonia (nitrogen) discharge to the marine environment at 3 mg/l, which greatly exceeds the expected discharge composition.

Based on the above presented discussion, at the expected discharge composition no significant impacts are expected to occur, however, monitoring for any biotic/abiotic impacts should be conducted periodically and in the case of impact detection contingency plans should be applied immediately.

Additionally, discharged wastewater quality should be monitored for all parameters to assure compliance with the standards set for discharge to the marine environment, specified in Law No. 4 of 1994.

In cases where discharge fails to meet the required specifications, off-spec effluent from the treatment units will be recycled for re-treatment.

The main VECs potentially negatively impacted through operation include plankton, Crustaceans, Mollusks and demersal and pelagic fish, and marine mammals.

| Biotic | Abiotic | Social |
|---|---|---|
| Impact Significance without application of mitigation measures: | | |
| 3 | 4 | 4 |

*Accidental Events*

Accidental events related to the marine outfall include fuel spills, which could occur during construction. Other events may be related to discharge of off spec effluent through accidental discharges and/or leaks.

Accidental releases of chemicals (e.g. methanol and/or ammonia) will have severe negative impacts to a number of VECs, including plankton, crustaceans, mollusks, pelagic and demersal

[12] Source: http://www.epa.gov/chemfact/s_methan.txt

[13] As required by the Superfund Ammendments and the Reauthorization Act of 1986.

[14] http://www.ilo.org/public/english/protection/safework/cis/products/icsc/dtasht/_icsc04/icsc0414.htm

fish, marine mammals, birds, onshore vegetation, soil and groundwater quality and potentially the local fishing industry

Accidentally exceeding certain parameter concentrations in sanitation water may lead to release of nutrients. This may cause excessive growth of algae, known as Eutrophication. The quantities of certain marine species such as *Enteromorpha* sp. and *Ulva* sp, may increase. As these species are opportunistic (r strategists), their exceedance may exclude other forms of marine life. At high nutrient levels, accumulation of decomposing plant material typically leads to reduced oxygen conditions in which only bacteria thrive. Another impact of the enhanced nutrient load is that phytoplankton growth rates increase and can form nuisance blooms. Generally, these blooms are not harmful but do reduce the aesthetic value of the area and increase the BOD of the water column. However, in some cases the blooms can be formed by toxic algae, which can be potentially dangerous for humans. The toxins can pass through the food chain from microalgae to fish, and finally to humans.

| Biotic | Abiotic | Social |
|---|---|---|
| Impact Significance without application of mitigation measures: | | |
| 2 | 3 | 3 |

### 5.5.3 Dredging "Berths and Revetments"

A list of ranked identified impacts for dredging is provided in Table 3, Appendix VI.

*Construction*

Piles driven through the benthos within the port will have localized effects on the ecosystem. Piled jetties, although causing loss of habitat and physical destruction in the immediate vicinity of the piles, will prevent widespread impacts along the Port compared with other construction methods. The physical presence of the pier may cause changes to sediment transport and current patterns within the port.

Pile driving and other construction activities may also lead to increased noise levels. Construction activities require increased lighting during night-time.

Existence of a new structure may result in loss of habitat at all dredged locations. Dredging activities may also increase the turbidity level and result in a temporary decrease in water quality.

Construction of Berths and Revetments may negatively impact a number of VECs, including plankton, crustaceans, mollusks, pelagic and demersal fish, and potentially the local fishing industry. Sediment dynamics and coastal morphology may also be influenced.

During the construction phase there will be positive benefits for the local community in terms of employment and added income for local industries.

| Biotic | Abiotic | Social |
|---|---|---|
| Impact Significance without application of mitigation measures: | | |
| 3 | 3 | 3 |

*Operation*
Maintenance dredging will present adverse impacts to the benthic community within the Port and may also cause increased turbidity and a decrease in water quality. Impacts are considered to be minor as there was very low biomass observed from the sediment samples collected in the vicinity of the site. Routine dredging currently takes place to maintain the main shipping channel.

Increased marine traffic may also result in increased noise levels.

The operation of the loading facility may negatively impact a number of VECs, including plankton, crustaceans, mollusks, pelagic and demersal fish, and potentially the local fishing industry.

| Biotic | Abiotic | Social |
|---|---|---|
| Impact Significance without application of mitigation measures: | | |
| 3 | 3 | 3 |

*Accidental Events*
Accidental fuel spills may occur and impact a great number of VECs, other impacts may be related to collisions, general litter and wastes from human activities and boats during all phases of the development as well as spill of ballast water from dredgers.

Accidental events may negatively impact a number of VECs, including plankton, crustaceans, mollusks, pelagic and demersal fish, birds, and potentially the local fishing industry.

| Biotic | Abiotic | Social |
|---|---|---|
| Impact Significance without application of mitigation measures: | | |
| 2 | 3 | 3 |

### 5.5.4 Excavation works and Roads

The proposed site has been used, by neighboring facilities, as a dredged sediment disposal area, accordingly pre-construction activities would require excavation and transport of dredge remains prior to excavation for construction. The impacts of these activities are only addressed under the construction phase.

In-addition, the construction of roads, especially within the facility boundaries, may be deemed necessary.

A list of ranked identified impacts of the roads is provided in Table 4, Appendix VI.

*Construction*
In general, during the construction phase, the main impact to the VECs will be from the air borne transport of particulates (increased dust). This increased particulate load can be prevented, and should be short-lived providing that sound mitigation measures are applied.

Construction waste disposal, increased traffic, vehicle emissions and noise together with loss of habitat during construction may also have significant impacts on VECs including vegetation, birds, reptiles and existing site users.

During the construction phase, there will be positive benefits for the local community in terms of employment.

| Biotic | Abiotic | Social |
|---|---|---|
| Impact Significance without application of mitigation measures: | | |
| 3 | 3 | 3 |

*Operation*
Road operation may cause increased traffic, noise, dust as well as light during night-time operations.

During the operational phases on the site, little impact to the VECs is predicted.

| Biotic | Abiotic | Social |
|---|---|---|
| Impact Significance without application of mitigation measures: | | |
| 3 | 4 | 3 |

*Accidental Events*
Road accidental events are related to collisions, fuel spillage, fire, fatalities and spills and leaks from sanitation and wastewater container vehicles.
Accidental events may negatively impact a number of VECs, including soil and groundwater, vegetation, reptiles and the social components.

| Biotic | Abiotic | Social |
|---|---|---|
| Impact Significance without application of mitigation measures: | | |
| 3 | 3 | 3 |

### 5.5.5 Stacks, Vents and Flare Emissions

It is important to note that in the context of the PEA no emission/air dispersion modeling has been conducted, however a detailed air dispersion modeling will be conducted for the full EIA in the FEED stage to assure compliance with environmental legislations.

A list of ranked identified impacts for stacks is provided in Table 5, Appendix VI.

*Construction*
Activities with potential to cause environmental impacts during construction include import of raw materials via sea; increased light during the night; increased noise; increased traffic as well as loss of habitat for certain species.

During the construction phase there will be positive benefits for the local community in terms of employment.

| Biotic | Abiotic | Social |
|---|---|---|
| Impact Significance without application of mitigation measures: | | |
| 3 | 3 | 3 |

*Operation*
The operation of vents and flare will cause increased air emissions, increased light from flares and increased noise during normal operations.

Under normal operating conditions, it is expected that the air emissions will include Nitrogen oxides, sulphur dioxide, methane, methanol and ammonia.
As previously stated, methanol and ammonia are considered toxic hazardous chemicals and their impact would range from mere irritation to fatal (depending on exposure concentrations and periods). These chemicals could affect biota through ingestion, inhalation and through dermal contact.

However, impact would not be considered significant if proper dispersion modeling and contingency plans are applied to assure compliance with environmental standards. Never the less, minor impacts may affect social receptors (neighboring village and personnel) for short periods during equipment start up and abnormal operation conditions.

| Biotic | Abiotic | Social |
|---|---|---|
| Impact Significance without application of mitigation measures: | | |
| 3 | 4 | 3 |

*Accidental Events*
Accidental release of fugitive air emissions may have severe adverse environmental affects on the surrounding community and all the biotic and social VECs.

Non compliance events may cause reduction in air quality impacting biological receptors including humans. Leaks, fire and explosions may also cause significant impacts to the local community, including human fatality. HSE program/ environmental policy, emergency response measures, and contingency plan should be in place to mitigate such accidental events.

| Biotic | Abiotic | Social |
|---|---|---|
| Impact Significance without application of mitigation measures: | | |
| 2 | 3 | 2 |

### 5.5.5.1 Sanitation Water

A list of ranked identified impacts for sanitation water is provided in Table 6, Appendix VI.

*Construction*
The assessed impacts are related to loss of habitat due to trenching of pipelines and outfall construction, increased solid wastes, traffic, garbage from personnel and noise.

Construction may negatively impact a number of VECs, including plankton, crustaceans, mollusks, pelagic and demersal fish, birds, mammals, vegetation and potentially the local fishing industry.

During the construction phase, there will be positive benefits for the local community in terms of employment.

| Biotic | Abiotic | Social |
|---|---|---|
| Impact Significance without application of mitigation measures: | | |
| 3 | 3 | 3 |

*Operation*
Disposal/reuse of off-spec treated sanitation water may impact the receiving water quality. Appropriate monitoring of treated sanitation wastes should eliminate/minimise such impact. Wastewater disposal (tertiary treated) as irrigation water will not cause any significant impacts to the VECs provided that it meets the required irrigation water criteria[15].

Normal operation may negatively impact a number of VECs, including plankton, crustaceans, mollusks, pelagic and demersal fish.

| Biotic | Abiotic | Social |
|---|---|---|
| Impact Significance without application of mitigation measures: | | |
| 3 | 4 | 4 |

*Accidental Events*
Spillage of hazardous treatment chemicals may impact the biotic, abiotic as well as the social VECs. Rupture/leakage of underground system and accidental disposal of off spec treated wastewater may result in release of nutrients to the Environment. Excessive release of nutrients to the marine environment may lead to eutrophication and/or increase in phytoplankton growth. Hazardous chemical spills may directly cause fish kills and impact the local fishing community if the spill is extensive.

| Biotic | Abiotic | Social |
|---|---|---|
| Impact Significance without application of mitigation measures: | | |
| 2 | 3 | 2 |

### 5.5.6 Solid Waste

A list of ranked identified impacts for solid wastes is provided in Table 7, Appendix VI.

*Construction*
During the construction phase, construction activities would give rise to demolition and construction wastes. The large number of construction personnel will also give rise to significant quantities of garbage.

[15] Decree No. 44 for year 2000 - Modifying the executive regulations of Law 93 for 1962.

Construction activities may negatively impact a number of VECs, including mammals, vegetation, sediment dynamics and the neighboring village.

During the construction phase there will be positive benefits for the local community in terms of employment.

| Biotic | Abiotic | Social |
|---|---|---|
| Impact Significance without application of mitigation measures: | | |
| 3 | 3 | 3 |

*Operation*

The main source of solid wastes during the operation phase would comprise of spent catalysts, these wastes will either be land filled (if found inert) or sent back to catalyst manufacturers for regeneration. Accordingly no significant impacts are expected to be exhibited under normal operational conditions.

Plant activities will lead to an increase in garbage, solid wastes and wastewater treatment sludge. Increased traffic and noise levels due to routine collection operation are also expected.

Solid waste, generated by operation activities may negatively impact a number of VECs, including mammals, vegetation, sediment dynamics and the neighboring village.

| Biotic | Abiotic | Social |
|---|---|---|
| Impact Significance without application of mitigation measures: | | |
| 3 | 4 | 3 |

*Accidental Events*

As most catalysts were found hazardous (Appendix V), leakage from hazardous waste containers and inappropriate handling/disposal are the main concerns. These containers will be labelled and stored in appropriate locations, appropriate waste handling will take place during storage, transportation and disposal. Fire and explosion may occur at solid waste storage areas, and will be detrimental to all biotic and social VECs. Solid wastes (potentially contaminated paper, plastic, cardboard) may also be blown into the Mediterranean Sea and may cause negative impacts to the marine environment in terms of aesthetic impacts and to biotic VECs. Other events, which may cause impacts, include paper and plastic blowing across the site, fires, explosions, odors and attraction of rodents to stockpiles.

| Biotic | Abiotic | Social |
|---|---|---|
| Impact Significance without application of mitigation measures: | | |
| 3 | 3 | 2 |

### 5.5.7 Hazardous Compounds

A list of ranked identified impacts for hazardous compounds is provided in Table 8, Appendix VI.

*Construction*
During the construction phase chemicals and catalysts which are hazardous in nature will be imported to site. Transport of chemicals to site during the construction phase may cause increased marine traffic and noise levels. Waste containers will also cause an increase in hazardous solid wastes. Construction of chemical/waste storage facilities across the site may result in additional construction related impacts.

Construction activities may negatively impact a number of VECs, including mammals, vegetation, sediment dynamics and the neighboring village.

During the construction phase there will be positive benefits for the local community in terms of employment.

| Biotic | Abiotic | Social |
|---|---|---|
| Impact Significance without application of mitigation measures: | | |
| 3 | 3 | 3 |

*Operation*
During the operational phase, the facility's products (methanol, ammonia and urea) and wastes (spent catalysts and chemical containers) resemble the main hazardous materials of concern. Increased traffic (marine and onshore) and associated noise levels due to transportation of chemicals and wastes are expected to occur. Increased solid wastes (spent containers, paper, etc) are also expected.

| Biotic | Abiotic | Social |
|---|---|---|
| Impact Significance without application of mitigation measures: | | |
| 3 | 3 | 3 |

*Accidental Events*
Accidental events due to presence of hazardous compounds are the most significant impacts, which could possibly occur. This may result from onsite spills, container/pipeline leaks and emissions. Spilled compounds may leach to the Mediterranean Sea. Fires and explosions of hazardous compounds may result in significant adverse impacts to all of the identified VECs.

| Biotic | Abiotic | Social |
|---|---|---|
| Impact Significance without application of mitigation measures: | | |
| 2 | 3 | 2 |

## 5.6 Environmental Impact Summary

The former sections cover the identified activities, which may cause environmental impacts and are highlighted in the environmental matrices, Appendix VI. The impacts in the matrices were ranked, and impact significance is established, as described above.

In general, during construction phase, there is scope for physical destruction of marine and terrestrial ecological components habitat. This loss of habitat will affect marine invertebrates, demersal fish, insects, beetles, spiders and pseudo-scorpions across the site. During the operation

phase less significant impacts are anticipated with regards to that aspect, however, significant impacts may be related to waste streams and emissions.

Controlled construction and operation impacts were found to be of less significance, and may mostly be reduced with appropriate mitigation measures. A greater concern should be made to avoid the occurrence of accidental events as they reveal more significant impact as highlighted above.

As part of the detailed EIA which would be completed should the feasibility study show that the project is to proceed, a comprehensive environmental management plan for the site (EMP) would be developed. The EMP's measures would be designed to mitigate against any identified marginal impacts.

## 5.7 Potential Positive Impacts

During both the construction and operation phases of the project, significant positive impacts will be gained by the local community through employment opportunities at the proposed plant. Employment prospects will exist for skilled and unskilled labour, administration staff, caterers and medical staff. Where available, these personnel will be pooled from the local community and within Egypt.

Potential positive effects may also occur through links with existing businesses and industries within Egypt, such as existing waste facilities for the re-use and recycling of many products such as paper, cardboard, glass, mineral oils and lubricants.

# 6 PUBLIC PARTICIPATION

## 6.1 General

Several meetings will take place with relevant government agency representatives, as well as with the public in an early stage of the project. Other public meetings/hearings that were conducted by Komex for other industrial projects in the area revealed the public concern about the financial revenues of any new project, including employment opportunities. This section summarizes the outcomes of previous consultations conducted at Damietta Governorate.

### 6.1.1 Media Perspective

#### *6.1.1.1 Official National Newspapers*

There have been several articles in Egyptian newspapers that announced and supported the Methanol/Ammonia integrated complex. The economic benefits of the project were demonstrated. Several interviews have taken place with the Minister of petroleum and the importance of the project was highlighted. The project was demonstrated as a means to achieve a strategic goal for the Petroleum Sector and to arrive at a balance in the petroleum payment balance.

It was also announced[16] that the Egyptian Petroleum Sector succeeded in joint venturing with two major investors for producing Ammonia/Urea and Methanol. The announcement states an investment capital of approximately US$ 500 million for the Methanol plant with an overall production capacity of 1.3 million tonnes per year. With regards to the ammonia plant, the announcement states an investment capital of approximately US$ 700 million for Urea production with an overall production capacity of 3.5 thousand tonnes per day. Both plants are to commence operation by October 2008.

### 6.1.2 Damietta Port Authority

Meetings were held with the Damietta Port, police officers, and security guards. They were very co-operative and interested to know more about the project. The proposed plant was explained to them and they showed their interest to have it executed.

While conducting the site survey, several meetings were held with SEGAS LNG facility, which shares the northern boundary of the project site. SEGAS management showed a great interest to help, and shared their experience with the project team.

### 6.1.3 Egyptian Survey Authority

A meeting was held with the employees of the Egyptian Survey Authority. The project was demonstrated and discussed as well.

[16] Al-Ahram Newspaper, Issue 43107

# 7 CONCLUSIONS

This document represents the Preliminary Environmental Assessment for the construction and operation of a proposed Methanol and Ammonia production complex in Damietta, Egypt.

During the PEA process, a thorough technical description of the proposed development has been provided, and the key features of the development have been analysed in terms of any potential impact (positive and negative) that the development may present. A group of valued environmental components were identified, based on key regional factors and site inspections, to represent the predominant environmentally important aspects of the area.

### 7.1.1 Potential Negative Impacts

During all phases of the project, adverse impacts may be encountered. These include:

- Loss of habitat where construction works take place. This includes the onshore landmass and the coastal fringes, plus the area lost for the construction of the sea water pump basin and outfall. In most cases this loss of habitat will be temporary, until re-colonization occurs.

- General litter and waste from human activity. General litter and waste could cause a significant impact if efforts are not made to keep the areas clean. The prevailing winds in this area suggest that there is the potential for garbage to be blown along the site. Impacts may not be significant, but will be aesthetically unpleasant.

- Accidental spillage or release of waste streams and emissions of hazardous nature. Whatever the cause, the effect will be highly dependent on the size of spill and the type of compound released. A major release could be significant to all the VECs concerned, with the duration of impact in terms of tens of years.

- Increased turbidity and re-suspension of the bottom sediments will occur during offshore construction. These will be temporary and confined to the period of works. However, routine dredging will occur within the port.

- Airborne transport of particulates will occur during the construction phase.

- Noise during construction and loss of habitat may have significant impacts on the feeding bird population. Shore birds will be the major group affected, but it is likely that many birds will move on to neighboring feeding grounds.

- Accidental release of wastewater may result in contamination of the shallow coastal water. Nutrient increase in the seawater will have a major impact on the marine flora.

- Accidental release of fugitive air emissions may also have adverse environmental affects on the surrounding community and VECs during operation. Emergency response measures should be in place to mitigate such accidental events.

In all cases, these adverse impacts can be mitigated to reduce the negative impact to insignificant. An environmental management plan (EMP) would be developed as a key part of a full EIA, to be prepared at a later stage of the project. This EMP would identify specific mitigation measures, designed to reduce the residual potential impacts to acceptable levels. These measures would be addressed in the context of a full EIA, with aim of achieving or surpassing set guidelines and standards.

Preliminary analysis has not identified any potential impacts which cannot be effectively mitigated against to the degree that they would pose an unacceptable risk to the environment. Based on this PEA, the assessment team concludes that the proposed Methanol/Ammonia integrated complex is environmentally feasible, pending the completion of a full EIA at the FEED[1] stage with a comprehensive baseline assessment and detailed EMP.

### 7.1.2 Potential Positive Impacts

- During both the construction and operation phases of the project, significant positive impacts will be gained by the local community through employment opportunities at the proposed plant.

- Employment prospects will exist for skilled and unskilled labour, administration staff, caterers and medical staff. Where available, these personnel will be pooled from the local community and within Egypt. Up to 600 staff will be required during the construction phases of the project, this will provide a large, positive employment boost for the governorate of Damietta.

- Potential positive effects may also occur through links with existing businesses and industries within Egypt, such as existing waste facilities for the re-use and recycling of many products such as paper, cardboard, glass, mineral oils and lubricants.

# 8 NON TECHNICAL SUMMARY

This report presents the results of a Preliminary Environmental Assessment (PEA) for a proposed Methanol and Ammonia production complex at Damietta Port industrial area. The PEA is completed for the purpose of highlighting the potential impacts for the proposed new Integrated Complex at the feasibility/early stage of the project. The PEA reviews potential effects on the environment caused by the facility at Damietta. The PEA was undertaken by Komex Egypt on behalf of KBR.

The proposed facility will produce approximately 3,000 metric tonnes/day of Methanol, 1,200 metric tonnes/day of Ammonia, principally for export. Appendix I, shows the proposed location for the facility.

The process produces various forms of waste, some of which have the potential to cause adverse environmental effects if compliance is not assured or if accidents occur. Effects of emissions and operating activities on the quality of soil, water and air were considered. The area proposed for development was surveyed on and offshore to check for the presence of any important (National and International) wildlife species and to evaluate the likely effects of the proposed activities on them. Effects on local employment, the local economy and cultural aspects were also taken into account.

Preparation of the PEA involved the following tasks:

- Detailed literature survey/review on the project area, including reviewing reports, maps, textbooks, atmospheric and climatic conditions, geological settings, seawater and groundwater, etc.
- Several site visits.
- Public consultation with relevant stakeholders and interested parties was performed.
- Assessment of the project - environment interactions using matrix tables and source-pathway-receptor risk assessment concepts.
- Production of a PEA report.

Information about the proposed process and designs were reviewed to identify the potential for pollution, or other effects on the environment. This was assessed based on the nature and state of released compounds, their location and mode of release, the likely mass and rate of released compounds, and the likely nature of effect. Once the locations were identified where impacts were likely to occur, the nature of the interaction with the environment, and the likely significance of impacts on the environment were evaluated using a matrix approach. The matrices are provided in Appendix VI.

In terms of positive economic impact and employment, the project will enable Egypt to annually export approximately 3,000 metric tonnes of Methanol and 1,200 metric tonnes of Ammonia, generate foreign income and provide a great number of jobs both during the construction and operation phases. The socio-economic benefits of the project are thus largely positive. The PEA identifies other possible impacts on local biology, soil, air and water quality.

The PEA provides the bases for a detailed EIA in a later stage should the feasibility of the project is proven. In the detailed EIA a detailed site specific baseline assessment should be conducted, where suitable mitigation measures are recommended to reduce the potential adverse environmental impacts to acceptable levels, and recommendations are made concerning ongoing environmental management of the project to ensure that environmental quality is sustained throughout its lifetime.

Based on this PEA, the assessment team concludes that the proposed Methanol/Ammonia integrated complex is environmentally feasible, pending the completion of a full EIA at the FEED[1] stage with a comprehensive baseline assessment and detailed EMP.

# 9 DISCLAIMER

The information presented in this document was compiled and interpreted exclusively for the stated purpose of the document. Komex has provided this document for the sole and exclusive use of Kellogg Brown & Root (KBR). The information presented in this report should not be used as bases for any engineering design and/or modifications for any existing facility.

Any questions concerning the information contained herein, or its interpretation, should be directed to Dr. Paul Hardisty, Managing Director, or Eng. Mohamed A. Hassan, Associate Director, Middle East, Komex.

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# APPENDICES

The following appendices are included in this section:

| | | |
|---|---|---|
| Appendix I | - | Plates |
| Appendix II | - | Site Plot Plan |
| Appendix III | - | Meteorological Data |
| Appendix VI | - | Archeological Areas in Damietta |
| Appendix V | - | List of Hazardous Catalysts |
| Appendix VI | - | Environmental Impact Matrices |

# Appendix I

## PLATES

**Plate 1: ECHEM and SEGAS Site Entrance**

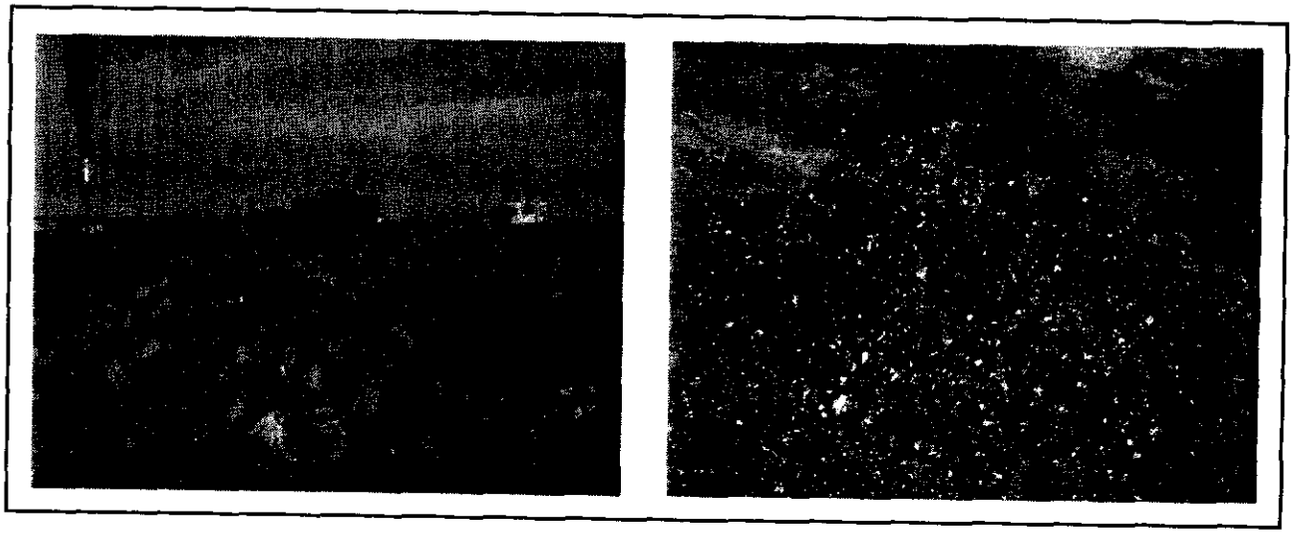


**Plate 2: Accumulated Construction/Demolition Wastes (A) as well as Dredged Sediment Wastes (B)**

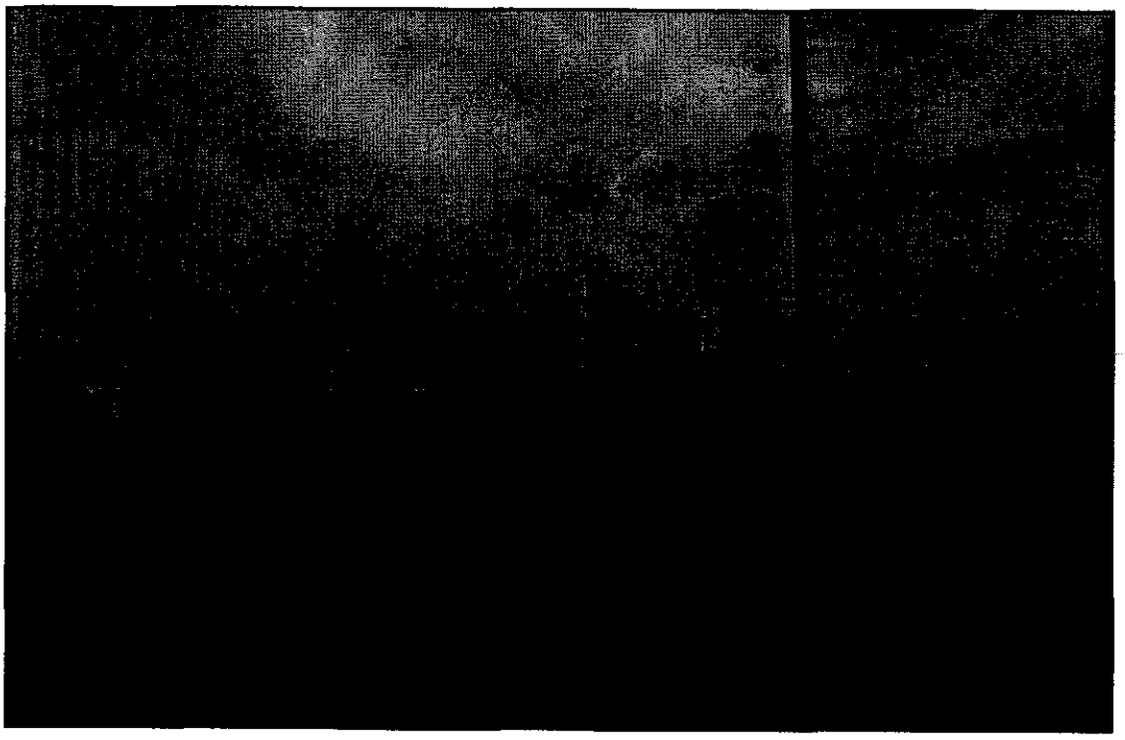


**Plate 3: Ongoing Construction Activities Southeast of the Site**

**Plate 4: Breakwaters Existing to the East and West of the Port Entrance**

**Plate 5: Nearby Dredged Channel**

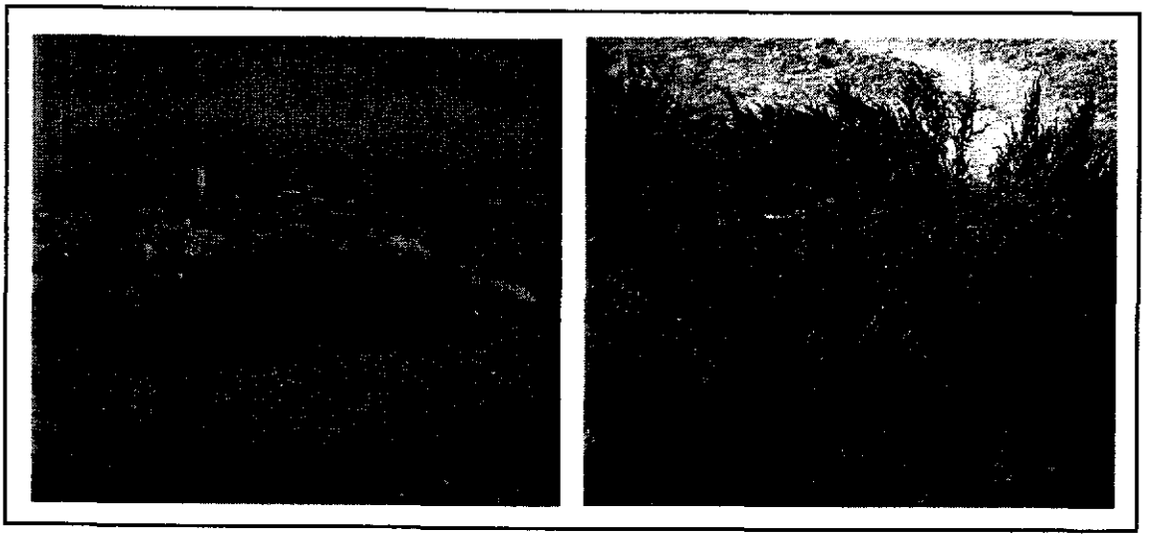


**Plate 6: Sparse Vegetation Patches**

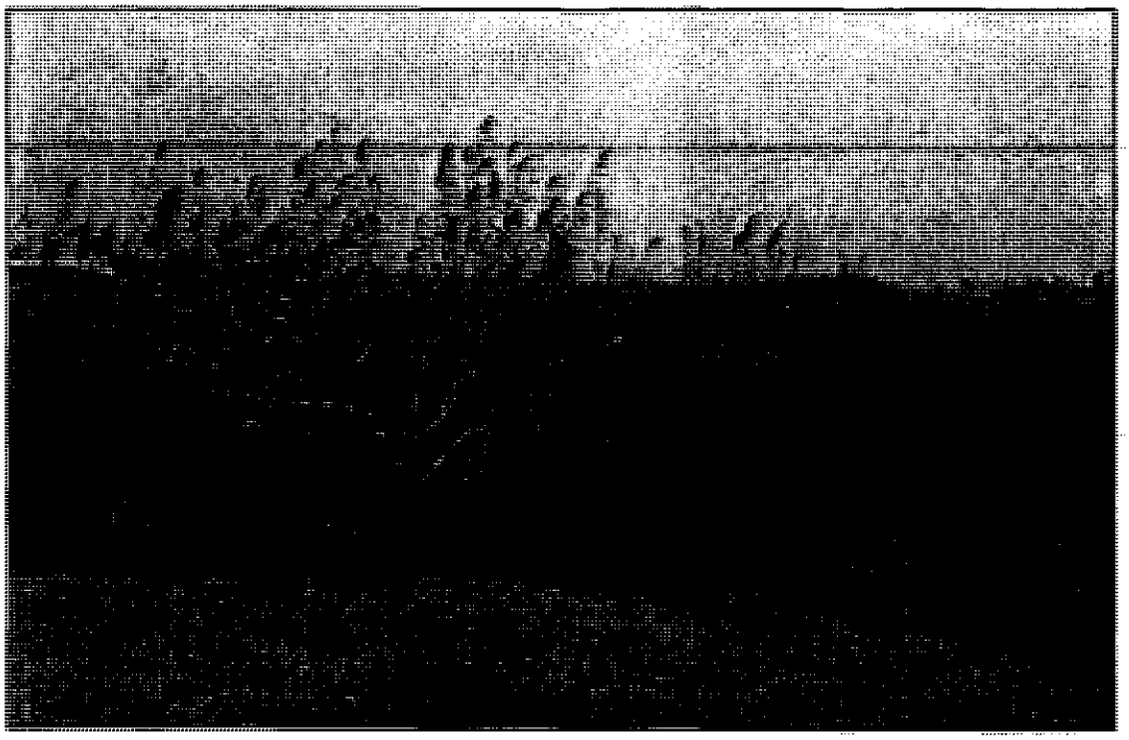


**Plate 7: A Dense Vegetation Patch Recorded Towards the South Eastern Boundary of the Site**

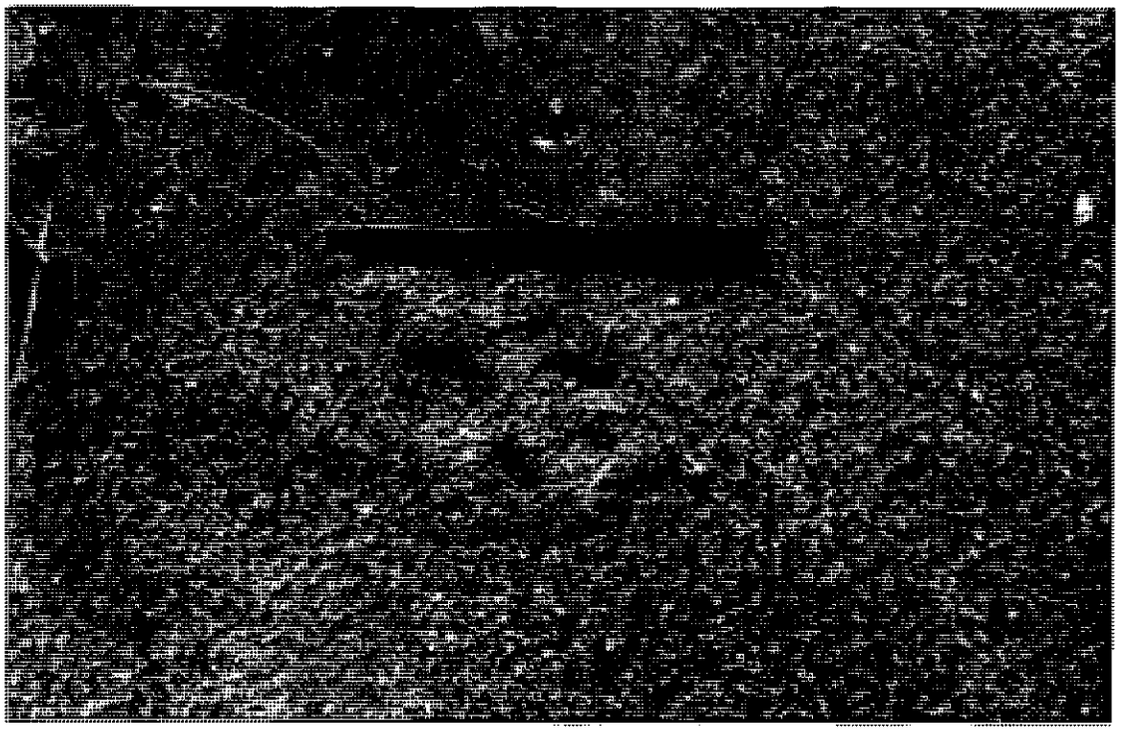


**Plate 8: A mammalian Foot Print**

**Plate 10: Panorama of ECHEM Site Boundary Showing SEGAS and Container Yar d Area**

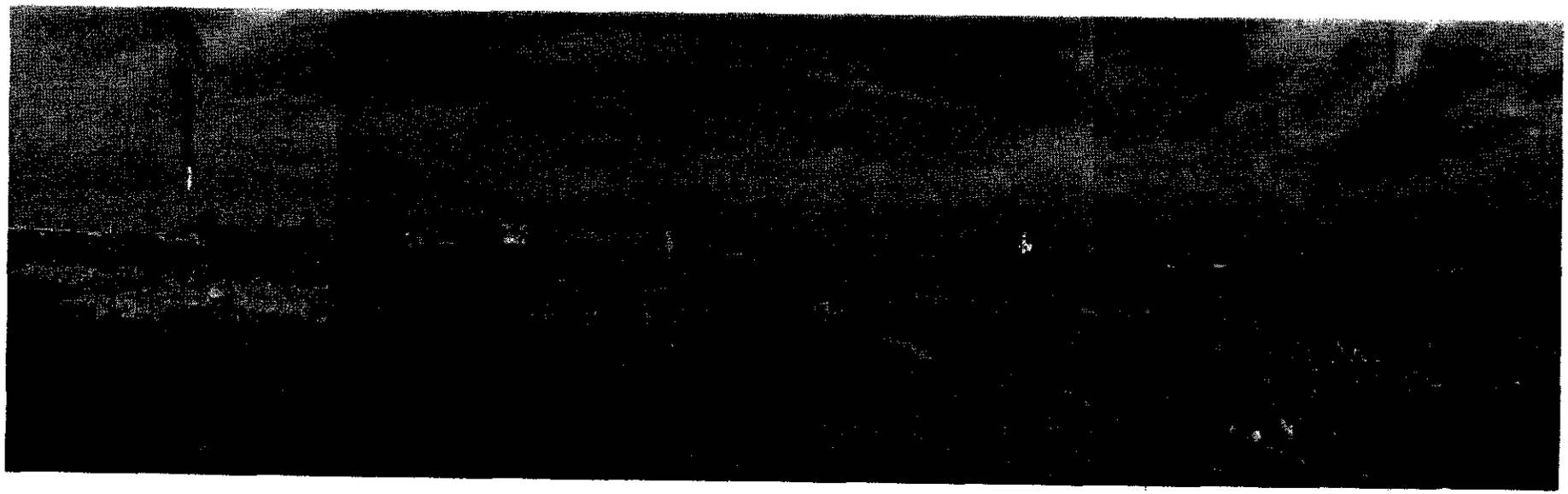


**Plate 9: Panorama for the Site from Inside**

**Plate 11: Small Shelters Exist to the East of the Public Road**

**Plate 12: Livestock Grazing Taking Place to the East of the Public Road**

**Plate 13: A Permanent Village – Ezzbat Khamsa- Exists to the West of the Public Road**

**Plate 14: Wastewater Disposal into a Farm/Livestock Grazing Land**

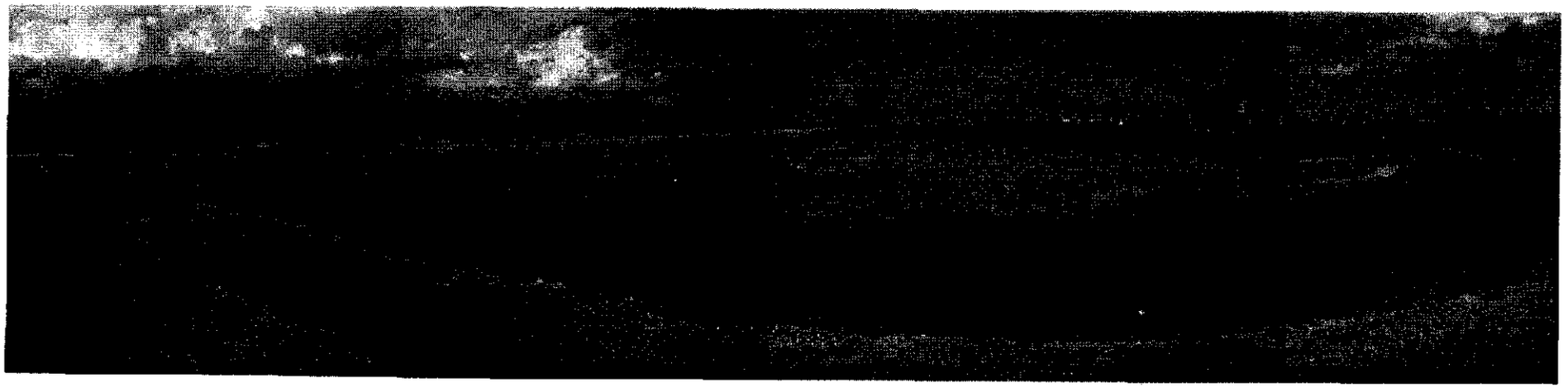
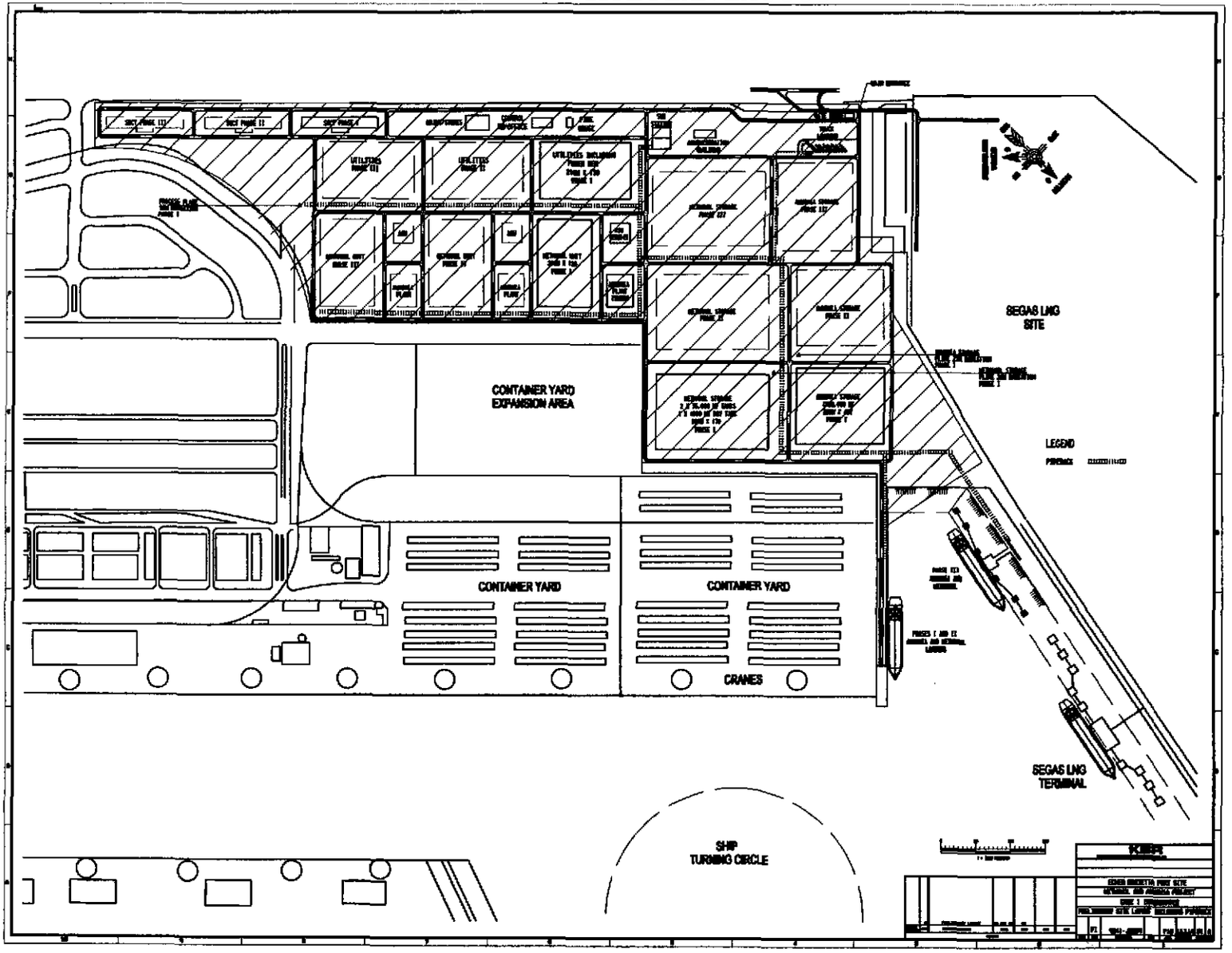


**Plate 15: Panorama Showing the Sandy Shoreline of the Site**

# APPENDIX II – SITE PLAN LAYOUT



ARAB REPUBLIC OF EGYPT
The Egyptian Meteorological Authority
Climate Directory

date :27/9 /2000
req. no. : 274
file no. : 36

## MONTHLY NORMAL FOR SOME METEOROLOGICAL ELEMENT

2000/10/8
[illegible] EATCO [illegible]
[illegible] (Final

**STATION : DEMIATTA**

| Meteorological Element↓ Month → | | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Maximume air temperature | (°C) | 18.2 | 18.8 | 20.3 | 23.1 | 26.4 | 29.2 | 30.6 | 30.9 | 29.3 | 27.3 | 23.6 | 19.7 |
| highest Maximume air temperature | (°C) | 26.5 | 31.9 | 35.8 | 38.8 | 45.6 | 40.8 | 39.5 | 38.6 | 37.9 | 36.1 | 35.4 | 28.5 |
| Date | (yy / dd) | 87/18 | 58/28 | 31/16 | 93/17 | 41/10 | 33/30 | 34/16 | 36/15 | 39/29 | 51/6 | 41/7 | 62/3 |
| lowest Maximume air temperature | (°C) | 10.6 | 8.8 | 10.3 | 15.3 | 19.5 | 23.8 | 26.0 | 27.0 | 23.5 | 20.3 | 15.1 | 11.9 |
| Date | (yy / dd) | 74/23 | 92/24 | 83/6 | 94/3 | 87/1 | 90/4 | 69/15 | 68/24 | 70/30 | 65/30 | 94/29 | 71/23 |
| Minimume air temperature | (°C) | 8.6 | 9.0 | 11.0 | 13.6 | 16.8 | 20.0 | 21.4 | 21.6 | 20.2 | 18.4 | 15.1 | 10.7 |
| highest Minimume air temperature | (°C) | 17.0 | 15.6 | 17.6 | 21.7 | 23.4 | 24.8 | 25.8 | 26.4 | 25.0 | 24.4 | 23.2 | 17.7 |
| Date | (yy / dd) | 85/14 | 68/29 | 61/17 | 94/20 | 64/30 | 65/13 | 89/16 | 78/3 | 86/24 | 63/18 | 66/4 | 71/2 |
| lowest Minimume air temperature | (°C) | 1.5 | 0.7 | 3.8 | 4.6 | 9.5 | 7.0 | 169 | 16.3 | 14.7 | 11.4 | 6.8 | 3.7 |
| Date | (yy / dd) | 53/14 | 34/17 | 49/5 | 49/19 | 65/5 | 93/3 | 49/26 | 49/22 | 49/30 | 59/21 | 48/18 | 31/31 |
| Relative humidity | (%) | 76 | 75 | 73 | 71 | 71 | 71 | 72 | 76 | 75 | 75 | 76 | 76 |
| highest Relative humidity | (%) | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| Date | (yy / dd) | s.d | s.d | s.d | s.d | s.d | s.d | s.d | s.d | s.d | s.d | s.d | s.d |
| lowest Relative humidity | (%) | 26 | 24 | 20 | 16 | 13 | 21 | 24 | 25 | 31 | 29 | 25 | 31 |
| Date | (yy / dd) | 85/3 | 71/28 | 75/22 | 66/14 | 65/26 | 95/7 | 94/3 | 63/18 | 66/22 | 77/10 | 95/5 | 80/4 |

REMARKS :-
- s.d = several dayes
- this data coverd area about 50 km.
- HIS DATA PROVIDED TO " UNION FENOSA ACEX FACTO " as requested on 20/9/20000

Prepared by : ABD-ELAZIZ MAKRAM Girgis Farg

30.9.2000
Director of Climate

ATTACHMENT 2 A

ARAB REPUBLIC OF EGYPT
The Egyptian Meteorological Authority
Climate Directory

date 27/9/200
req. no. : 274
file no. : 36

## MONTHLY NORMAL FOR SOME METEOROLOGICAL ELEMENT

**STATION : DEMIATTA**

| Meteorological Element↓ Month → | | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Amount Of Rainfall | (mm / month) | 26 | 19.7 | 13.0 | 4.6 | 1.5 | 0.2 | trace | trace | 0.4 | 7.1 | 15.7 | 24.0 |
| highest Amount Of Rainfall | (mm / month) | 37.0 | 29.0 | 44.3 | 31.8 | 15.8 | 8.5 | trace | trace | 18.0 | 35.8 | 58.0 | 40.1 |
| Date | (yy / dd) | 32/28 | 93/13 | 91/22 | 86/1 | 61/6 | 79/4 | 34/21 | 42/19 | 57/30 | 37/27 | 53/5 | 93/22 |
| Dry temperature | (°C) | 12.9 | 13.4 | 15.3 | 18.1 | 21.0 | 24.5 | 25.8 | 26.0 | 24.5 | 22.4 | 18.4 | 14.6 |
| highest Dry temperature | (°C) | 17.1 | 17.8 | 19.4 | 22.0 | 25.1 | 28.2 | 29.1 | 29.9 | 28.4 | 26.1 | 23.6 | 18.8 |
| lowest Dry temperature | (°C) | 9.8 | 9.9 | 11.3 | 14.0 | 16.8 | 19.9 | 21.3 | 21.4 | 20.2 | 18.4 | 15.3 | 11.5 |
| pressure on mean sea level | | 1018.5 | 1017.0 | 1015.3 | 1013.6 | 1021.6 | 1011.2 | 1008.4 | 1008.5 | 1012.5 | 1015.6 | 1015.4 | 1018.2 |
| highest pressure on mean sea level | | 1032.5 | 1029.9 | 1028.8 | 1026.3 | 1024.4 | 1019.4 | 1016.4 | 1016.3 | 1028.3 | 1024.8 | 1028.4 | 1028.8 |
| Date | (yy / dd) | 92/4 | 89/3 | 92/3 | 83/20 | 95/8 | 90/5 | 79/11 | 71/24 | 92/28 | 91/27 | 88/14 | 63/26 |
| lowest pressure on mean sea level | | 929.9 | 997.9 | 1000.8 | 993.6 | 999.4 | 1000.1 | 999.7 | 1001.6 | 1003.6 | 1001.5 | 1000.5 | 999.3 |
| Date | (yy / dd) | 69/21 | 86/5 | 93/6 | 71/11 | 92/7 | 88/11 | 95/2 | 77/7 | 67/8 | 69/9 | 76/24 | 62/18 |
| number of dayes fog | | 0.2 | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 | 0.03 | 0.0 | 0.1 | 0.03 | 0.2 | 0.1 |

REMARKS :-
- this data coverd area about 50 km.
- Trace = amount of rainfall < 0.1 mm.

THIS DATA PROVIDED TO " UNION FENOSA ACEX FACTO " as requested on 20/9/20000

Prepared by : ABD EL AZIZ MAKRAM Girgis Farg

30.9.2000
Director of Climat

EGYPT METEOROLOGICAL AUTHORITY
CLIMATOLOGICAL AVERAGES OF SOME ELEMENTS,
OCCURRENCE OF SOME PHENOMENA, AND WIND ROSE
FOR
STATION DEKHEILA 330
PERIOD : 68-99

*** MONTH : 01 ***

PATH:4 PERCENTAGE OF HOURS OF OCCURRENCE OF CONCURRENT SURFACE WIND AND DIRECTION WITHIN SPECIFIED RANGES

| DIREC./SPEED CALM | 01-03 | 04-06 | 07-10 | 11-16 | 17-21 | 22-27 | 28-33 | 34-40 | 41-47 | 48-55 | 56-63 | >63 | ALL SPEEI 05.2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| VARIABL | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 |
| 345-014 | 01.5 | 01.2 | 01.0 | 00.4 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 04.1 |
| 015-044 | 01.8 | 02.1 | 02.4 | 01.3 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 07.7 |
| 045-074 | 01.5 | 01.5 | 01.8 | 01.1 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 06.0 |
| 075-104 | 01.1 | 00.8 | 00.8 | 00.3 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 03.1 |
| 105-134 | 01.6 | 01.1 | 00.6 | 00.2 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 03.5 |
| 135-164 | 01.6 | 01.2 | 00.7 | 00.1 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 03.7 |
| 165-194 | 02.4 | 01.2 | 01.2 | 00.4 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 05.2 |
| 195-224 | 04.3 | 06.3 | 03.8 | 01.5 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 15.9 |
| 225-254 | 04.3 | 08.5 | 06.9 | 02.3 | 00.1 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 22.1 |
| 255-284 | 02.1 | 02.3 | 01.9 | 01.1 | 00.2 | 00.1 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 07.6 |
| 285-314 | 01.6 | 01.6 | 02.3 | 01.6 | 00.3 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 07.4 |
| 315-344 | 02.8 | 02.0 | 02.4 | 01.1 | 00.2 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 08.6 |
| ALL DIRC | 26.7 | 29.8 | 25.8 | 11.4 | 00.9 | 00.2 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 |

EGYPT METEOROLOGICAL AUTHORITY
CLIMATOLOGICAL AVERAGES OF SOME ELEMENTS,
OCCURRENCE OF SOME PHENOMENA, AND WIND ROSE
FOR
STATION DEKHEILA 330
PERIOD : 68-99

*** MONTH : 02 ***

PATH:4 PERCENTAGE OF HOURS OF OCCURRENCE OF CONCURRENT SURFACE WIND AND DIRECTION WITHIN SPECIFIED RANGES

| DIREC./SPEED CALM | 01-03 | 04-06 | 07-10 | 11-16 | 17-21 | 22-27 | 28-33 | 34-40 | 41-47 | 48-55 | 56-63 | >63 | ALL SPEEI 04.0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| VARIABL | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 |
| 345-014 | 01.9 | 01.4 | 01.4 | 00.8 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 05.5 |
| 015-044 | 01.6 | 02.4 | 03.2 | 01.1 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 08.3 |
| 045-074 | 01.3 | 02.2 | 02.9 | 01.5 | 00.1 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 08.0 |
| 075-104 | 01.2 | 01.2 | 01.3 | 00.5 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 04.3 |
| 105-134 | 01.4 | 01.5 | 01.0 | 00.2 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 04.1 |
| 135-164 | 01.5 | 01.4 | 00.9 | 00.2 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 04.0 |
| 165-194 | 01.9 | 01.2 | 01.1 | 00.3 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 04.5 |
| 195-224 | 03.3 | 04.0 | 02.9 | 01.1 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 11.4 |
| 225-254 | 03.4 | 06.7 | 05.6 | 02.1 | 00.1 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 18.2 |
| 255-284 | 01.6 | 02.0 | 02.2 | 01.9 | 00.2 | 00.1 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 08.1 |
| 285-314 | 01.5 | 01.7 | 02.0 | 02.9 | 00.3 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 09.4 |
| 315-344 | 02.6 | 02.4 | 03.2 | 01.9 | 00.2 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 10.3 |
| ALL DIRC | 23.2 | 28.2 | 29.0 | 14.5 | 01.0 | 00.2 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 |

EGYPT, METEOROLOGICAL AUTHORITY
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OCCURANCE OF SOME PHENOMENA,AND WIND ROSE
FOR
STATION DEKAITTA 330
PERIOD : 68-99

*** MONTH : 03 ***

PATH:4 PERCENTAGE OF HOURS OF OCCURANCE OF CONCURRENT SURFACE WIND AND DIRECTION WITHIN SPECIFIED RANGES

| DIREC./SPEED CALM | 01-03 | 04-06 | 07-10 | 11-16 | 17-21 | 22-27 | 28-33 | 34-40 | 41-47 | 48-55 | 56-63 | >63 | ALL SPEEDS 02.8 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| VARIABL | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 |
| 345-014 | 01.9 | 01.9 | 02.1 | 00.6 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 06.7 |
| 015-044 | 01.5 | 03.1 | 04.2 | 01.0 | 00.2 | 00.1 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 11.1 |
| 045-074 | 01.2 | 02.7 | 04.1 | 02.1 | 00.2 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 10.1 |
| 075-104 | 01.3 | 01.5 | 02.4 | 01.4 | 00.1 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 06.7 |
| 105-134 | 00.9 | 01.5 | 01.2 | 00.4 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 04.0 |
| 135-164 | 00.7 | 01.0 | 01.0 | 00.2 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 03.0 |
| 165-194 | 00.9 | 00.8 | 00.8 | 00.2 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 02.8 |
| 195-224 | 01.9 | 02.5 | 02.2 | 00.8 | 00.1 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 07.5 |
| 225-254 | 02.6 | 04.2 | 04.0 | 01.8 | 00.2 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 12.7 |
| 255-284 | 01.4 | 01.6 | 02.0 | 02.1 | 00.3 | 00.1 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 07.5 |
| 285-314 | 01.2 | 01.8 | 01.6 | 04.8 | 00.5 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 11.9 |
| 315-344 | 02.7 | 02.7 | 04.5 | 03.1 | 00.1 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 13.1 |
| ALL DIRC | 18.2 | 25.4 | 32.0 | 19.7 | 01.7 | 00.2 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 |

EGYPT, METEOROLOGICAL AUTHORITY
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OCCURANCE OF SOME PHENOMENA,AND WIND ROSE
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PERIOD : 68-99

*** MONTH : 04 ***

PATH:4 PERCENTAGE OF HOURS OF OCCURANCE OF CONCURRENT SURFACE WIND AND DIRECTION WITHIN SPECIFIED RANGES

| DIREC./SPEED CALM | 01-03 | 04-06 | 07-10 | 11-16 | 17-21 | 22-27 | 28-33 | 34-40 | 41-47 | 48-55 | 56-63 | >63 | ALL SPEEDS 02.2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| VARIABL | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 |
| 345-014 | 01.8 | 02.3 | 03.0 | 01.3 | 00.1 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 08.6 |
| 015-044 | 02.0 | 03.6 | 05.3 | 02.5 | 00.1 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 13.5 |
| 045-074 | 01.5 | 02.9 | 04.4 | 02.3 | 00.1 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 11.5 |
| 075-104 | 01.5 | 01.9 | 02.1 | 01.5 | 00.1 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 06.8 |
| 105-134 | 01.0 | 01.5 | 01.7 | 00.4 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 04.7 |
| 135-164 | 00.7 | 01.2 | 00.7 | 00.1 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 02.7 |
| 165-194 | 00.7 | 00.7 | 00.4 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 01.9 |
| 195-224 | 01.5 | 01.5 | 01.0 | 00.2 | 00.1 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 04.1 |
| 225-254 | 02.1 | 02.8 | 01.9 | 00.7 | 00.1 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 07.6 |
| 255-284 | 00.9 | 01.2 | 01.3 | 01.3 | 00.1 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 04.8 |
| 285-314 | 01.3 | 02.3 | 04.1 | 05.0 | 00.4 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 13.1 |
| 315-344 | 03.1 | 04.1 | 06.3 | 04.9 | 00.3 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 18.7 |
| ALL DIRC | 18.1 | 25.6 | 32.0 | 20.4 | 01.3 | 00.1 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 |

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OCCURRENCE OF SOME PHENOMENA,AND WIND ROSE
FOR
STATION DEMIATTA 330
PERIOD : 68-99

*** MONTH : 05 ***

PATH:4 PERCENTAGE OF HOURS OF OCCURRENCE OF CONCURRENT SURFACE WIND AND DIRECTION WITHIN SPECIFIED RANGES

| DIREC./SPEED | 01-03 | 04-06 | 07-10 | 11-16 | 17-21 | 22-27 | 28-33 | 34-40 | 41-47 | 48-55 | 56-63 | >63 | ALL SPEEDS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CALM | | | | | | | | | | | | | 02.8 |
| VARIABL | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 |
| 345-014 | 02.5 | 03.0 | 04.4 | 01.8 | 00.1 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 11.8 |
| 015-044 | 02.3 | 03.8 | 04.5 | 02.1 | 00.1 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 12.8 |
| 045-074 | 01.7 | 02.3 | 02.9 | 01.3 | 00.1 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 08.2 |
| 075-104 | 01.2 | 01.3 | 01.4 | 00.7 | 00.1 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 04.8 |
| 105-134 | 01.0 | 01.1 | 00.8 | 00.3 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 03.2 |
| 135-164 | 00.8 | 00.9 | 00.4 | 00.1 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 02.1 |
| 165-194 | 00.5 | 00.2 | 00.1 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.9 |
| 195-224 | 01.7 | 00.6 | 00.1 | 00.1 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 02.4 |
| 225-254 | 02.6 | 01.6 | 00.6 | 00.2 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 05.2 |
| 255-284 | 01.4 | 01.3 | 00.9 | 00.6 | 00.1 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 04.3 |
| 285-314 | 02.1 | 03.1 | 04.3 | 03.9 | 00.2 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 13.6 |
| 315-344 | 05.5 | 06.2 | 09.4 | 06.5 | 00.1 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 27.8 |
| ALL DIRC | 23.3 | 25.6 | 29.8 | 17.7 | 00.8 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 |

EGYPT, METEOROLOGICAL AUTHORITY
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PERIOD : 68-99

*** MONTH : 06 ***

PATH:4 PERCENTAGE OF HOURS OF OCCURRENCE OF CONCURRENT SURFACE WIND AND DIRECTION WITHIN SPECIFIED RANGES

| DIREC./SPEED | 01-03 | 04-06 | 07-10 | 11-16 | 17-21 | 22-27 | 28-33 | 34-40 | 41-47 | 48-55 | 56-63 | >63 | ALL SPEEDS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CALM | | | | | | | | | | | | | 03.1 |
| VARIABL | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 |
| 345-014 | 01.9 | 02.0 | 02.6 | 00.9 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 07.7 |
| 015-044 | 01.7 | 02.0 | 01.7 | 00.5 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 06.0 |
| 045-074 | 01.0 | 01.1 | 00.8 | 00.3 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 03.2 |
| 075-104 | 00.7 | 00.4 | 00.2 | 00.1 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 01.5 |
| 105-134 | 00.7 | 00.3 | 00.3 | 00.1 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 01.4 |
| 135-164 | 00.9 | 00.4 | 00.1 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 01.4 |
| 165-194 | 00.6 | 00.2 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 01.0 |
| 195-224 | 02.3 | 00.6 | 00.1 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 03.0 |
| 225-254 | 03.3 | 02.2 | 00.6 | 00.1 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 06.2 |
| 255-284 | 02.2 | 02.0 | 01.2 | 00.7 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 06.1 |
| 285-314 | 03.8 | 05.4 | 07.6 | 06.3 | 00.2 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 23.3 |
| 315-344 | 07.8 | 08.5 | 12.8 | 07.1 | 00.1 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 36.3 |
| ALL DIRC | 27.1 | 25.2 | 26.2 | 16.2 | 00.1 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 |

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STATION DAMIATTA 330
PERIOD : 68-99

*** MONTH : 07 ***

PATH:4 PERCENTAGE OF HOURS OF OCCURRENCE OF CONCURRENT SURFACE WIND AND DIRECTION WITHIN SPECIFIED RANGES

| DIREC./SPEED CALM | 01-03 | 04-06 | 07-10 | 11-16 | 17-21 | 22-27 | 28-33 | 34-40 | 41-47 | 48-55 | 56-63 | >63 | ALL SPEEDS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| VARIABL | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 02.2 |
| 345-014 | 01.8 | 01.4 | 01.3 | 00.5 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 04.8 |
| 015-044 | 00.6 | 00.7 | 00.3 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 01.9 |
| 045-074 | 00.3 | 00.1 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.4 |
| 075-104 | 00.2 | 00.1 | 00.1 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.4 |
| 105-134 | 00.2 | 00.1 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.3 |
| 135-164 | 00.4 | 00.1 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.6 |
| 165-194 | 00.8 | 00.2 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 01.1 |
| 195-224 | 03.4 | 01.0 | 00.2 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 04.8 |
| 225-254 | 06.1 | 03.7 | 00.7 | 00.1 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 10.6 |
| 255-284 | 03.5 | 02.9 | 01.9 | 01.2 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 09.5 |
| 285-314 | 05.4 | 07.4 | 09.1 | 06.7 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 28.6 |
| 315-344 | 07.4 | 09.0 | 13.4 | 05.1 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 34.9 |
| ALL DIRC | 36.9 | 26.7 | 27.1 | 13.9 | 00.1 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 |

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STATION DAMIATTA 330
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*** MONTH : 08 ***

PATH:4 PERCENTAGE OF HOURS OF OCCURRENCE OF CONCURRENT SURFACE WIND AND DIRECTION WITHIN SPECIFIED RANGES

| DIREC./SPEED CALM | 01-03 | 04-06 | 07-10 | 11-16 | 17-21 | 22-27 | 28-33 | 34-40 | 41-47 | 48-55 | 56-63 | >63 | ALL SPEEDS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| VARIABL | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 02.8 |
| 345-014 | 02.0 | 01.9 | 01.1 | 00.3 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 05.4 |
| 015-044 | 00.9 | 01.2 | 00.4 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 02.5 |
| 045-074 | 00.4 | 00.3 | 00.1 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.8 |
| 075-104 | 00.2 | 00.1 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.3 |
| 105-134 | 00.2 | 00.1 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.4 |
| 135-164 | 00.4 | 00.1 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.5 |
| 165-194 | 01.0 | 00.2 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 01.3 |
| 195-224 | 04.8 | 01.0 | 00.1 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 05.9 |
| 225-254 | 08.4 | 03.2 | 00.3 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 12.1 |
| 255-284 | 03.7 | 02.5 | 01.0 | 00.5 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 07.6 |
| 285-314 | 05.3 | 07.0 | 07.8 | 04.2 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 24.2 |
| 315-344 | 09.2 | 09.9 | 13.5 | 03.6 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 36.3 |
| ALL DIRC | 36.7 | 27.4 | 24.5 | 08.5 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 |

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STATION DEKHEILA 330
PERIOD : 68-99

*** MONTH : 09 ***

PATH14 PERCENTAGE OF HOURS OF OCCURRENCE OF CONCURRENT SURFACE WIND AND DIRECTION WITHIN SPECIFIED RANGES

| DIREC./SPEED | 01-03 | 04-06 | 07-10 | 11-16 | 17-21 | 22-27 | 28-33 | 34-40 | 41-47 | 48-55 | 56-63 | >63 | ALL SPEEDS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CALM | | | | | | | | | | | | | 05.5 |
| VARIABL | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 |
| 345-014 | 03.9 | 03.3 | 03.0 | 00.6 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 10.9 |
| 015-044 | 01.8 | 02.6 | 02.2 | 00.6 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 07.2 |
| 045-074 | 00.9 | 00.7 | 00.5 | 00.1 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 02.2 |
| 075-104 | 00.4 | 00.2 | 00.1 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.7 |
| 105-134 | 00.4 | 00.3 | 00.1 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.8 |
| 135-164 | 00.5 | 00.3 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.8 |
| 165-194 | 00.8 | 00.2 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 01.1 |
| 195-224 | 03.1 | 00.9 | 00.2 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 04.1 |
| 225-254 | 06.9 | 02.6 | 00.3 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 10.0 |
| 255-284 | 02.7 | 00.9 | 00.4 | 00.2 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 04.3 |
| 285-314 | 04.6 | 03.4 | 04.3 | 02.7 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 15.0 |
| 315-344 | 11.0 | 09.8 | 13.0 | 03.6 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 37.4 |
| ALL DIRC | 37.1 | 25.5 | 24.0 | 07.8 | 00.1 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 |

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OCCURRENCE OF SOME PHENOMENA, AND WIND ROSE
FOR
STATION DEKHEILA 330
PERIOD : 68-99

*** MONTH : 10 ***

PATH14 PERCENTAGE OF HOURS OF OCCURRENCE OF CONCURRENT SURFACE WIND AND DIRECTION WITHIN SPECIFIED RANGES

| DIREC./SPEED | 01-03 | 04-06 | 07-10 | 11-16 | 17-21 | 22-27 | 28-33 | 34-40 | 41-47 | 48-55 | 56-63 | >63 | ALL SPEEDS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CALM | | | | | | | | | | | | | 05.7 |
| VARIABL | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 |
| 345-014 | 05.1 | 03.7 | 03.8 | 01.1 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 13.8 |
| 015-044 | 02.8 | 05.1 | 05.8 | 01.8 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 15.5 |
| 045-074 | 01.1 | 01.6 | 01.7 | 00.6 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 05.0 |
| 075-104 | 00.6 | 00.6 | 00.4 | 00.1 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 01.7 |
| 105-134 | 00.7 | 00.8 | 00.4 | 00.1 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 01.9 |
| 135-164 | 00.7 | 00.3 | 00.2 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 01.5 |
| 165-194 | 00.9 | 00.4 | 00.1 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 01.4 |
| 195-224 | 02.4 | 01.4 | 00.3 | 00.1 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 04.2 |
| 225-254 | 04.5 | 03.7 | 00.9 | 00.2 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 09.3 |
| 255-284 | 02.5 | 01.4 | 00.7 | 00.3 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 04.9 |
| 285-314 | 02.7 | 02.0 | 02.7 | 01.7 | 00.1 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 09.2 |
| 315-344 | 08.7 | 04.7 | 07.7 | 02.7 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 25.9 |
| ALL DIRC | 32.8 | 28.0 | 24.7 | 08.6 | 00.2 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 |

EGYPT, METEOROLOGICAL AUTHORITY
CLIMATOLOGICAL AVERAGES OF SOME ELEMENTS,
OCCURRENCE OF SOME PHENOMENA,AND WIND ROSE
FOR
STATION : DEKHEILA 330
PERIOD : 68-99

*** MONTH : 11 ***

PATH:4 PERCENTAGE OF HOURS OF OCCURRENCE OF CONCURRENT SURFACE WIND AND DIRECTION WITHIN SPECIFIED RANGES

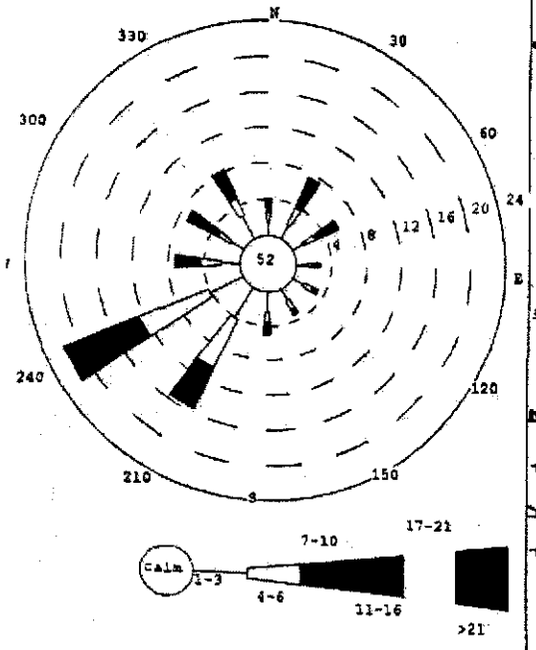
| DIREC./SPEED | 01-03 | 04-06 | 07-10 | 11-16 | 17-21 | 22-27 | 28-33 | 34-40 | 41-47 | 48-55 | 56-63 | >63 | ALL SPEED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CALM | | | | | | | | | | | | | 05.7 |
| VARIABL | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 |
| 345-014 | 03.3 | 03.0 | 03.1 | 01.3 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 10.8 |
| 015-044 | 03.1 | 04.5 | 05.6 | 02.3 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 15.6 |
| 045-074 | 01.4 | 01.7 | 01.8 | 00.6 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 05.4 |
| 075-104 | 00.7 | 00.5 | 00.4 | 00.1 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 01.7 |
| 105-134 | 00.8 | 00.6 | 00.2 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 01.7 |
| 135-164 | 01.2 | 00.6 | 00.4 | 00.2 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 02.5 |
| 165-194 | 01.6 | 00.7 | 00.7 | 00.3 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 03.4 |
| 195-224 | 03.3 | 02.9 | 01.4 | 00.6 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 08.2 |
| 225-254 | 04.8 | 06.1 | 02.7 | 00.6 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 14.3 |
| 255-284 | 02.5 | 02.2 | 01.2 | 00.6 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 06.5 |
| 285-314 | 02.5 | 01.9 | 02.7 | 01.6 | 00.1 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 08.8 |
| 315-344 | 05.2 | 04.1 | 04.4 | 01.7 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 15.4 |
| ALL DIRC | 30.3 | 29.1 | 24.0 | 09.9 | 00.4 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 |

EGYPT, METEOROLOGICAL AUTHORITY
CLIMATOLOGICAL AVERAGES OF SOME ELEMENTS,
OCCURRENCE OF SOME PHENOMENA,AND WIND ROSE
FOR
STATION : DEKHEILA 330
PERIOD : 68-99

*** MONTH : 12 ***

PATH:4 PERCENTAGE OF HOURS OF OCCURRENCE OF CONCURRENT SURFACE WIND AND DIRECTION WITHIN SPECIFIED RANGES

| DIREC./SPEED | 01-03 | 04-06 | 07-10 | 11-16 | 17-21 | 22-27 | 28-33 | 34-40 | 41-47 | 48-55 | 56-63 | >63 | ALL SPEED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CALM | | | | | | | | | | | | | 06.0 |
| VARIABL | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 |
| 345-014 | 02.0 | 01.5 | 01.4 | 00.6 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 05.5 |
| 015-044 | 01.8 | 02.9 | 03.7 | 01.3 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 09.7 |
| 045-074 | 01.1 | 01.5 | 01.6 | 00.9 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 04.6 |
| 075-104 | 00.7 | 00.6 | 00.5 | 00.1 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 01.9 |
| 105-134 | 01.0 | 00.9 | 00.4 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 02.3 |
| 135-164 | 01.5 | 01.2 | 00.4 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 03.1 |
| 165-194 | 02.3 | 01.2 | 01.0 | 00.4 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 05.1 |
| 195-224 | 04.8 | 06.1 | 03.8 | 01.1 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 15.8 |
| 225-254 | 04.6 | 09.4 | 05.8 | 01.7 | 00.1 | 00.1 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 21.6 |
| 255-284 | 02.6 | 05.0 | 02.0 | 00.9 | 00.1 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 08.8 |
| 285-314 | 01.9 | 01.6 | 02.3 | 01.3 | 00.1 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 07.3 |
| 315-344 | 02.9 | 02.3 | 02.3 | 00.7 | 00.1 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 08.3 |
| ALL DIRC | 27.4 | 32.1 | 25.3 | 08.6 | 00.5 | 00.1 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 |




E.M.A

COMPUTER DEPARTMENT

STATION:

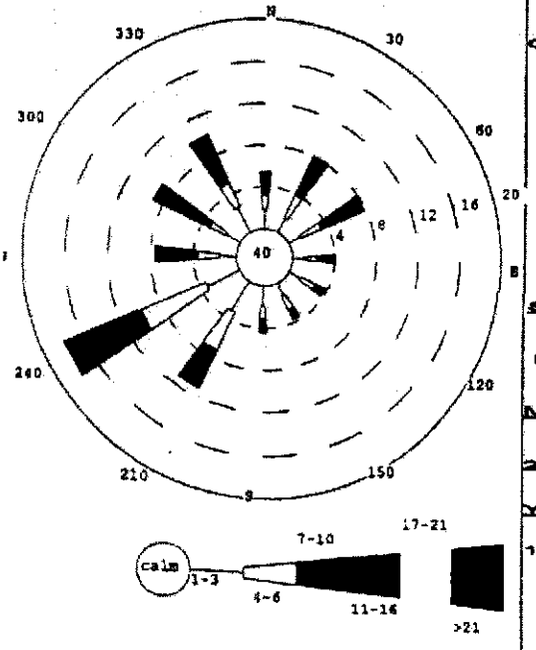
DAMIETTA

MONTHE(S) NO.:

1

YEARS:

1988-1999




E.M.A

COMPUTER DEPARTMENT

STATION:

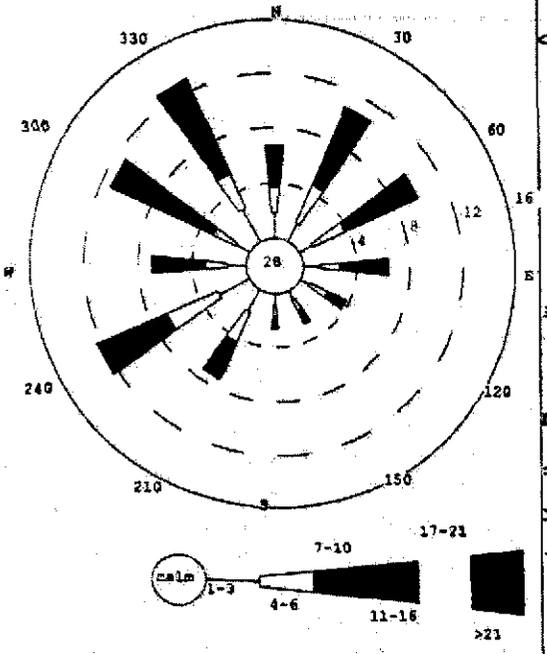
DAMIETTA

MONTHE(S) NO.:

2

YEARS:

1988-1999

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COMPUTER DEPARTMENT

STATION:

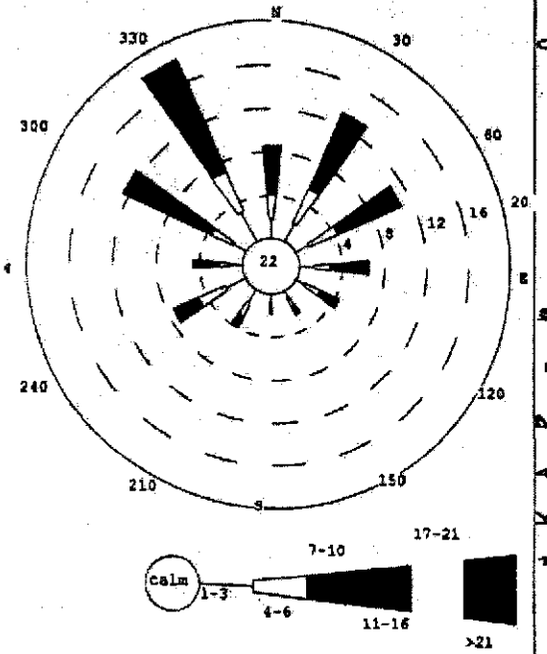
DAMIETTA

MONTHE(S) NO.:

3

YEARS:

1988-1999□□




E.M.A

COMPUTER DEPARTMENT

STATION:

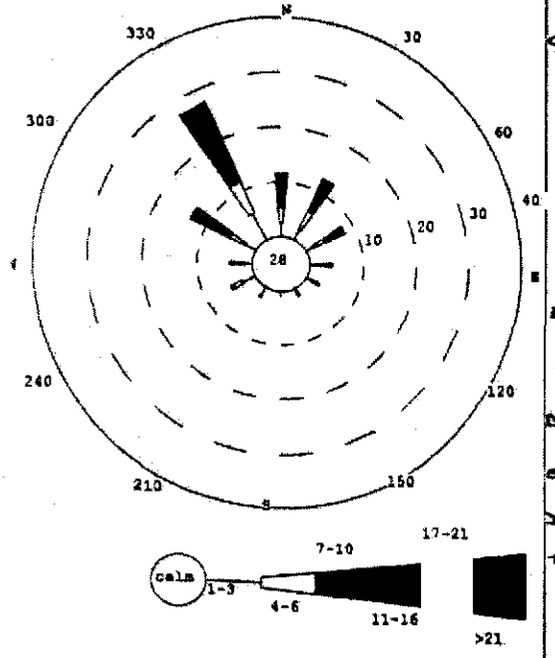
DAMIETTA

MONTHE(S) NO.:

4

YEARS:

1988-1999□□




E.M.A

COMPUTER DEPARTMENT

STATION:

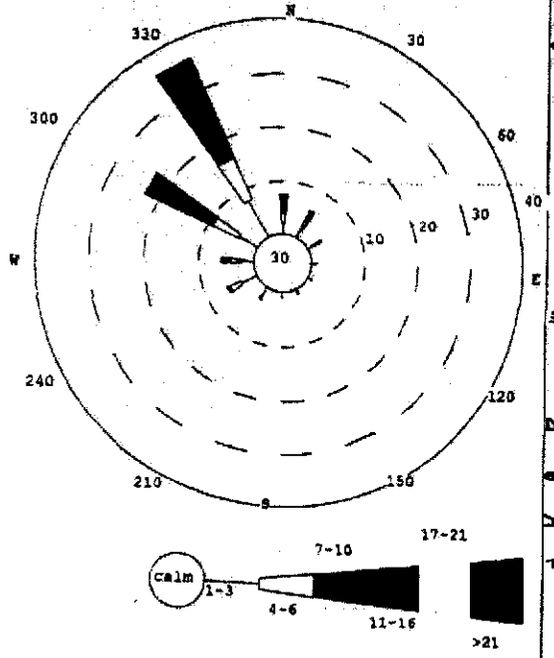
DAMIETTA

MONTHE(S) NO.:

5

YEARS:

1988-1999




E.M.A

COMPUTER DEPARTMENT

STATION:

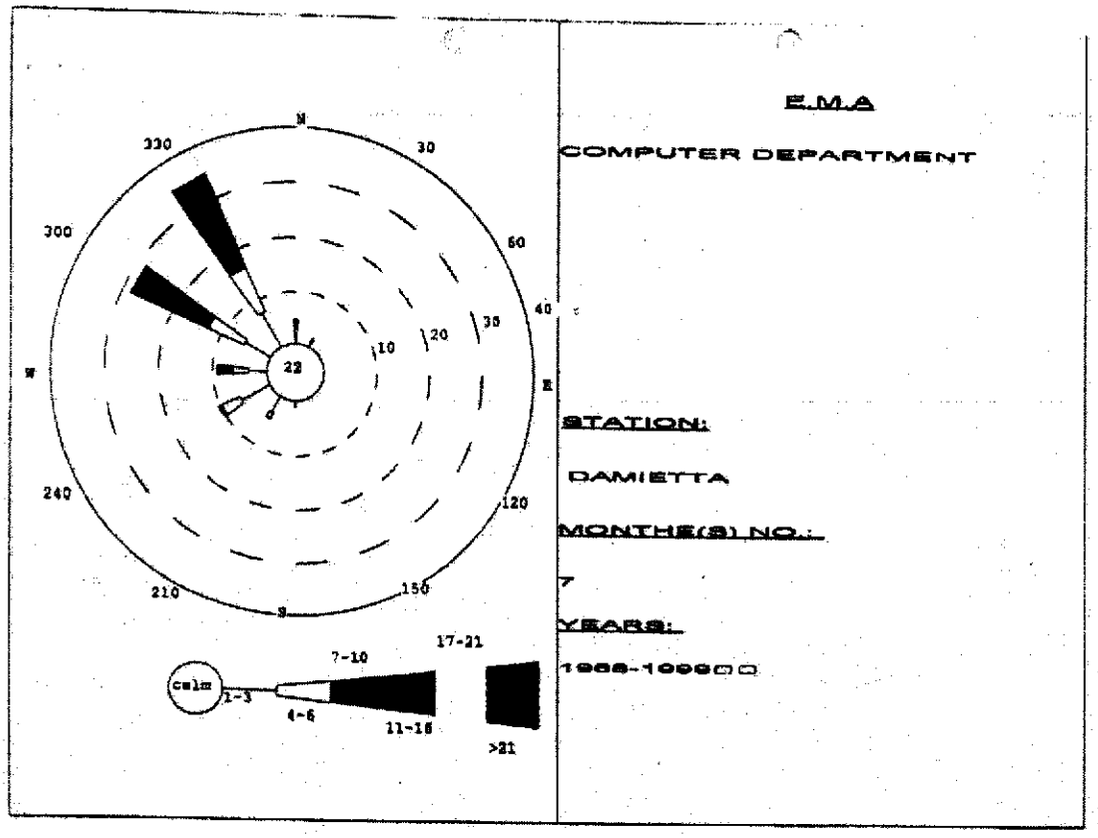
DAMIETTA

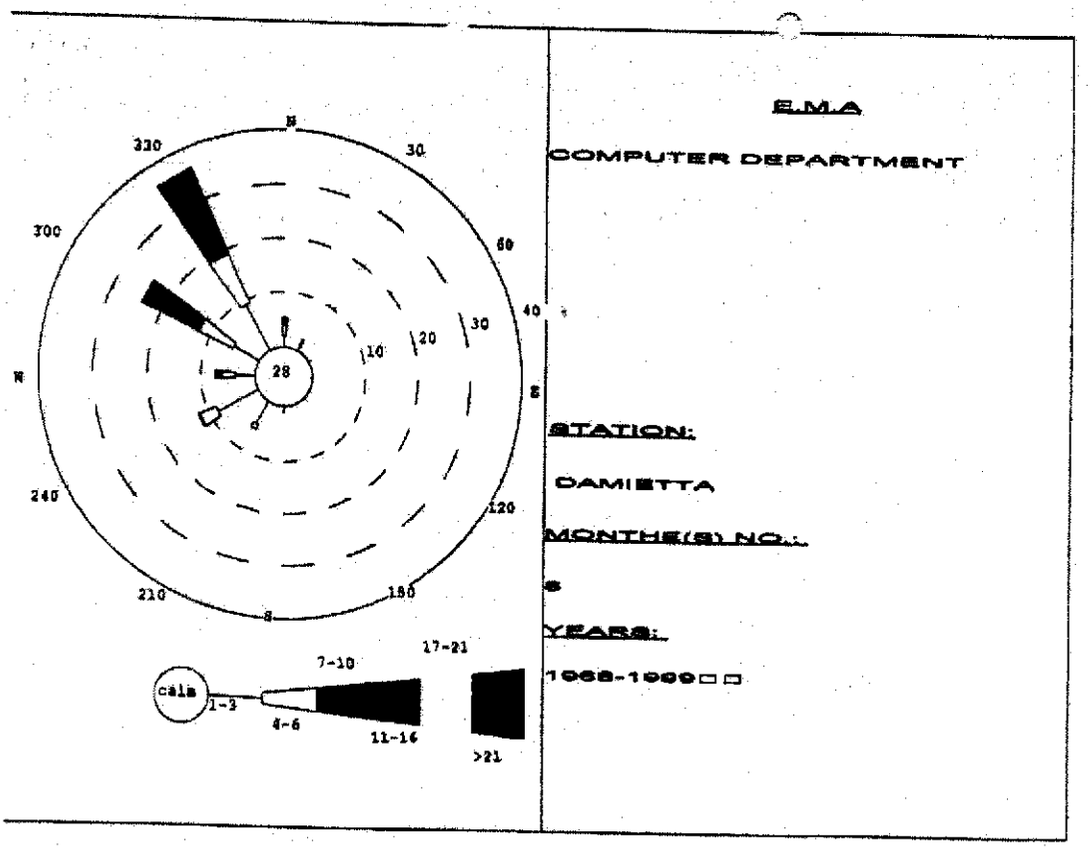
MONTHE(S) NO.:

6

YEARS:

1988-1999


E.M.A
COMPUTER DEPARTMENT
N
30
60
E
120
150
S
210
240
W
300
330
10
20
30
40
22
STATION:
DAMIETTA
MONTHE(S) NO.:
7
YEARS:
1968-1999
calm
1-3
4-6
7-10
11-16
17-21
>21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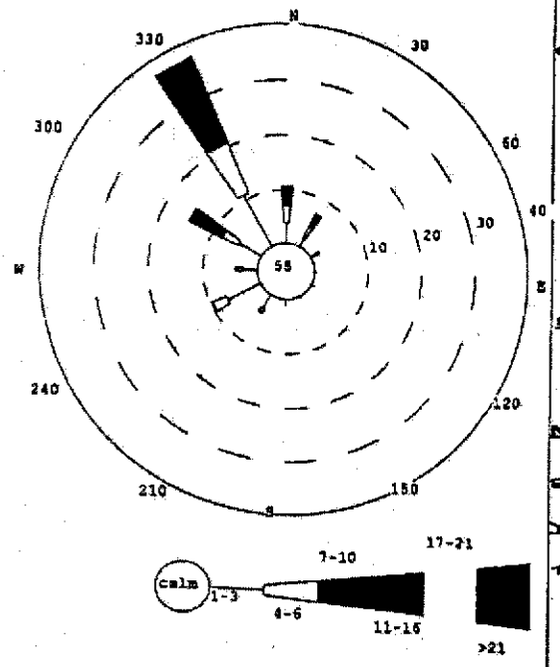
COMPUTER DEPARTMENT
N
30
60
E
120
150
S
210
240
W
300
330
10
20
30
40
28
STATION:
DAMIETTA
MONTHE(S) NO.:
8
YEARS:
1968-1999
calm
1-3
4-6
7-10
11-16
17-21
>21




E.M.A

COMPUTER DEPARTMENT

STATION:

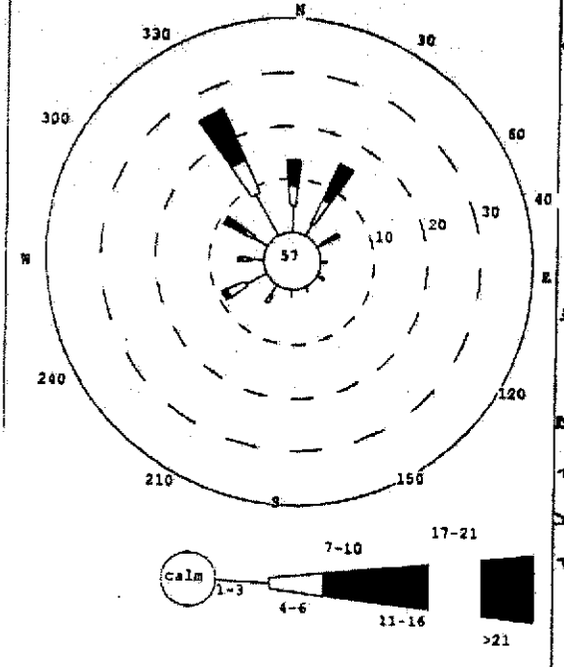
DAMIETTA

MONTHE(S) NO.:

9

YEARS:

1988-1999□□




E.M.A

COMPUTER DEPARTMENT

STATION:

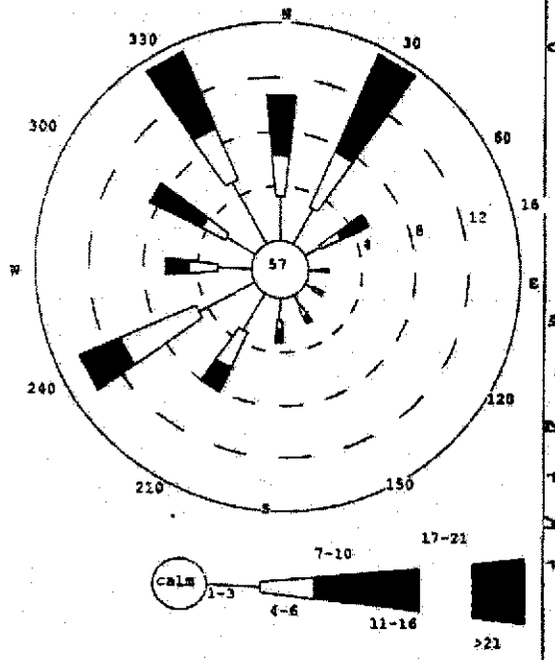
DAMIETTA

MONTHE(S) NO.:

10

YEARS:

1988-1999□□




E.M.A

COMPUTER DEPARTMENT

STATION:

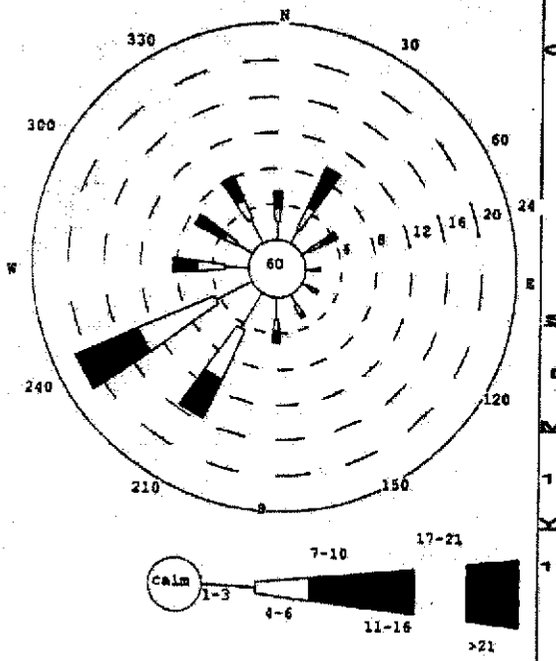
DAMIETTA

MONTHE(S) NO.:

11

YEARS:

1988-1999□□




E.M.A

COMPUTER DEPARTMENT

STATION:

DAMIETTA

MONTHE(S) NO.:

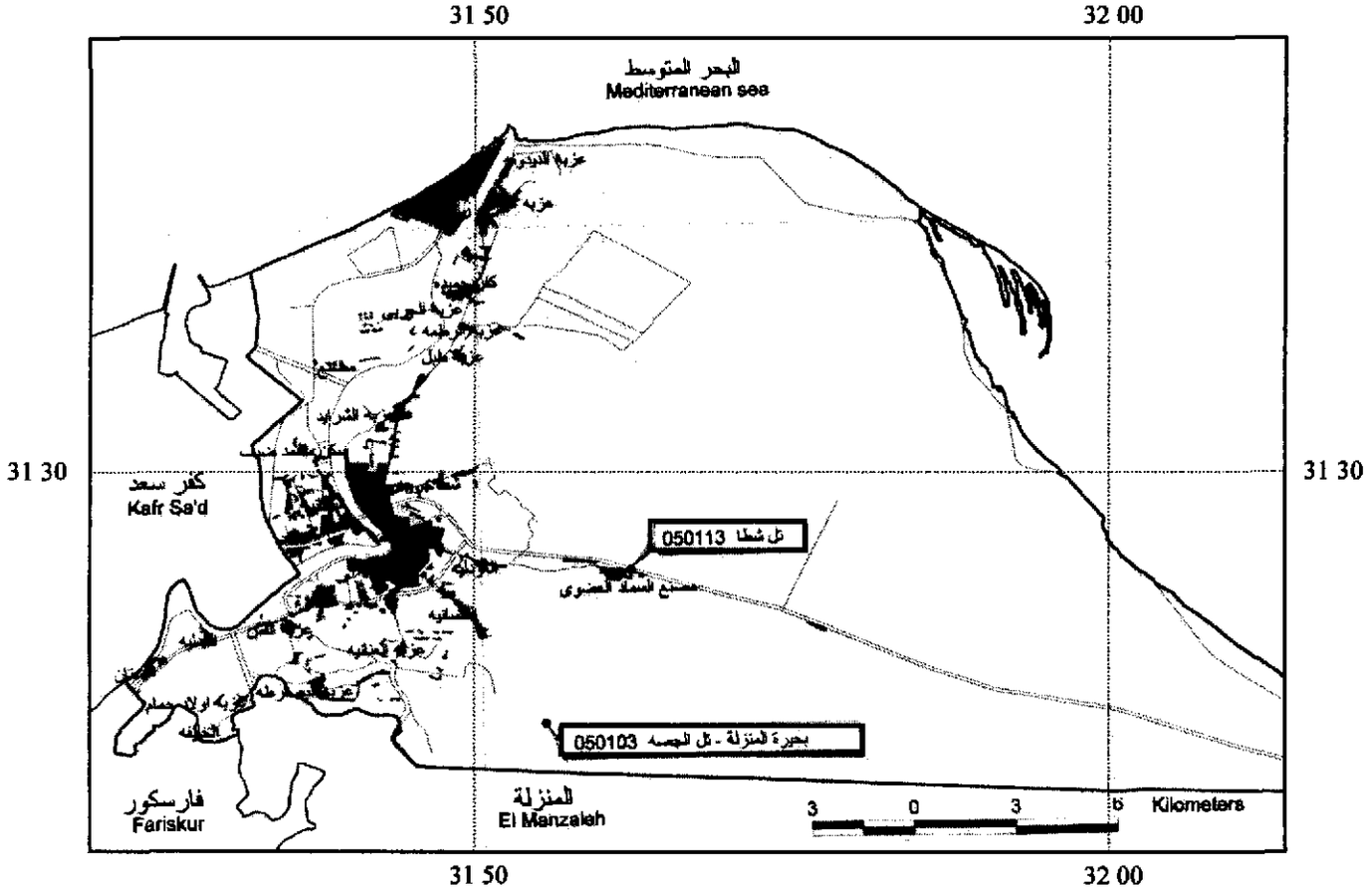
12

YEARS:

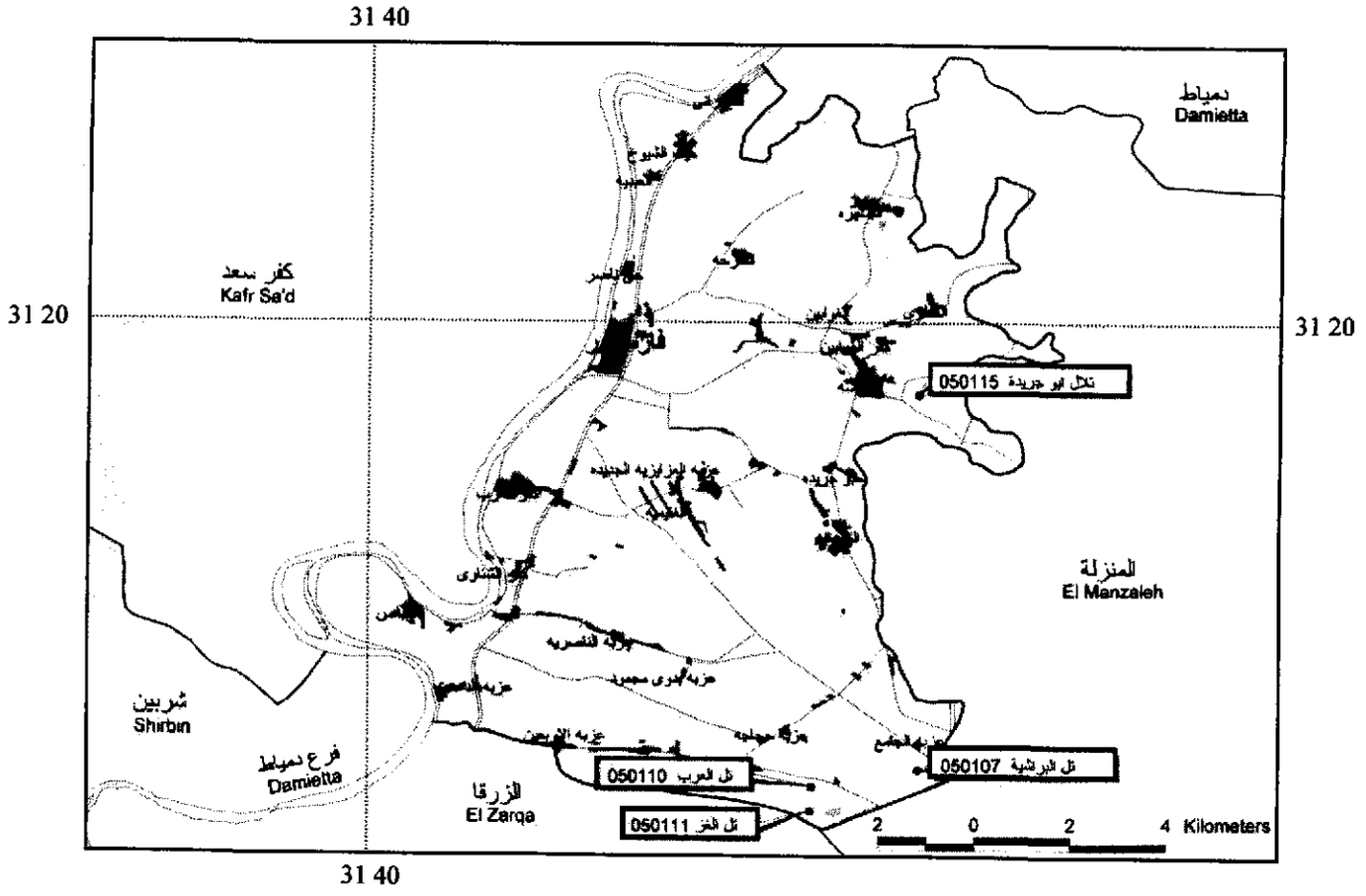
1988-1999□□

# Appendix IV

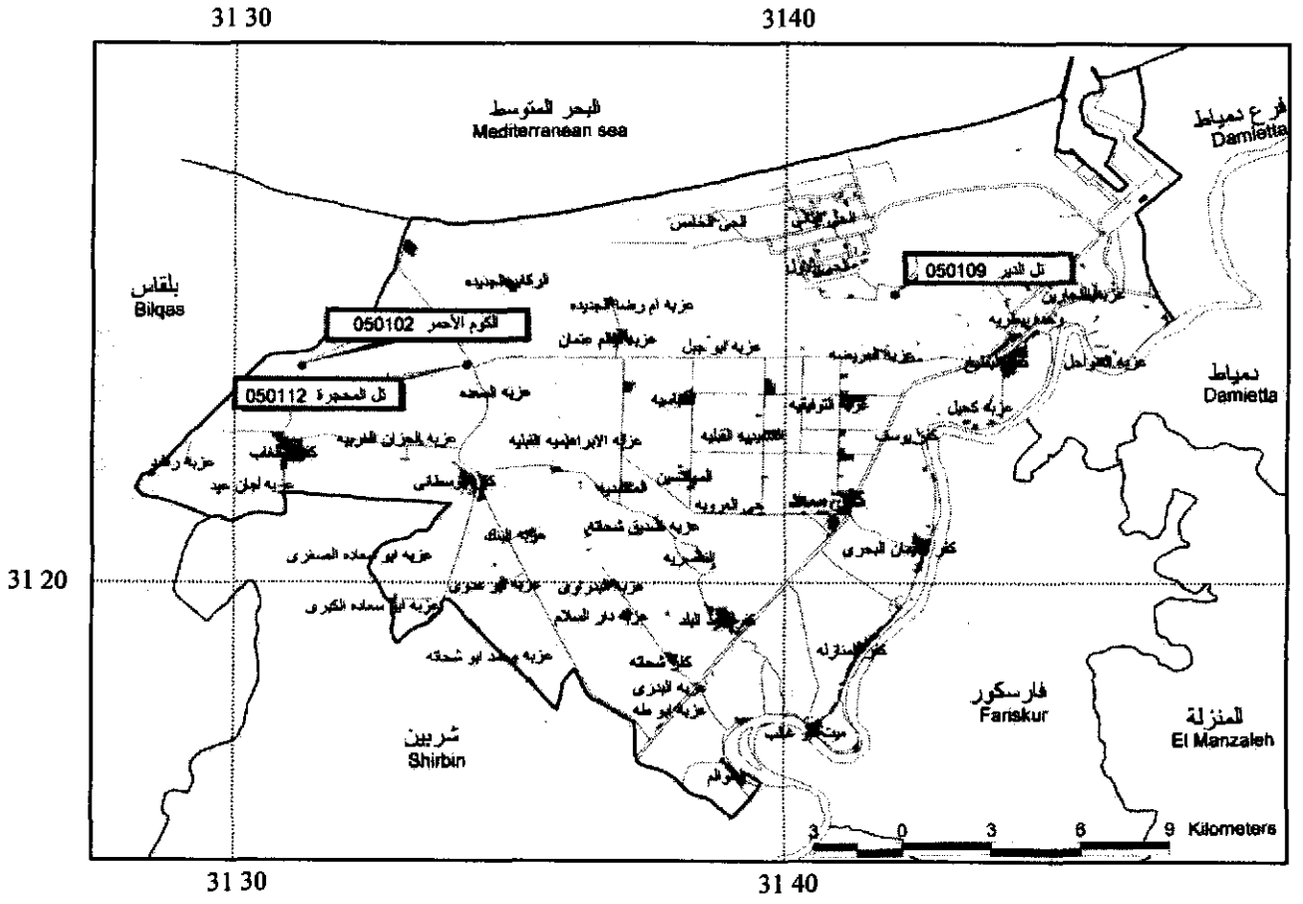
# ARCHAEOLOGICAL AREAS IN DAMIETTA




| Markaz Damietta | |
|---|---|
| 050113 | Tell Shata |
| 050103 | Manzaleh lake – Tell Gasseh |




| Markaz Fariskur | |
|---|---|
| 050107 | Tell El Barashyeh |
| 050110 | Tell El Arab, Tell El'arab |
| 050111 | Tell El Gaz |
| 050116 | Telal Abu Geriedeh |




| Markaz Kafr Sa'd | |
|---|---|
| 050102 | El Kom El Ahmer (vi) |
| 050109 | Tell El Dier |
| 050112 | Tell El Mahgareh |

# Appendix V

## LIST OF HAZARDOUS CATALYSTS

**List of hazardous Catalysts**

| Catalyst type | Hazard record | Human health effects | Other Hazards |
|---|---|---|---|
| Nickel [c, d] | Nickel metal and its compounds are regulated as hazardous substances by OSHA[a, #] and CERCLA[b, ##]. | • Nickel is a carcinogen. It needs to be handled with extreme caution. Other chronic effects include allergies, kidney and liver functions damage.<br>• Acute exposure to Nickel dusts and fumes may cause severe shortness of breath | • Nickel powder is highly flammable, and produces poisonous gases, such as Nickel carbonyl.<br>• Nickel catalyst is susceptible to spontaneous ignition and catching fire after it has already been extinguished.<br>• If Nickel powder is spilled, it may be necessary to be contained and disposed as a hazardous waste |
| Cu [c, d] on $Al_2O_3$ [c, d]/ CaO [c, d] with promoter | • As mentioned above, Copper and Alumina are hazardous substances.<br>• Calcium oxide is regulated as a hazardous substance by OSHA[a] | • As mentioned above, acute and chronic adverse health effects may result from exposure to Copper and Alumina.<br>• Acute exposure to calcium oxide can burn the skin, eyes, and cause lung irritation. Exposure to high concentrations can lead to a build-up of fluid in the lungs, associated with cough and severe shortness of breath. Chronic exposure can cause ulceration and perforation of the nasal septum. It can also cause nails to become brittle. | • Refer to above mentioned fire hazards of Copper and Alumina.<br>• Calcium oxide is a corrosive chemical. CaO itself is not combustible; however, the heat generated upon its contact with water may cause nearby combustible materials to ignite. Poisonous gases are produced when CaO is put to fire, and containers may explode in fire.<br>• If Cu, $Al_2O_3$ / CaO is spilled, it may be necessary to be contained and disposed as a hazardous waste |
| Co[c, d]- Mo[c] | • Cobalt compounds are regulated as hazardous by CERCLA[b]. Cobalt forms such as the metal dust & fume are regulated as hazardous by OSHA[a]<br>• Molybdenum compounds are regulated as hazardous by OSHA[a]. | • Exposure to Molybdenum may also cause skin, eye, and respiratory irritation, in addition to chronic exposure symptoms such as liver and kidney damage and anemia.<br>• Acute exposure to Cobalt dust may cause severe shortness of breath, build-up of fluid in the lungs, and cough. Other acute symptoms include skin, eye, nose, and throat irritation. Cobalt compounds may cause genetic mutations and may possibly be carcinogenic to humans. Other chronic symptoms include damage of the heart, thyroid, and kidneys | • Molybdenum dust may cause combustion and explosion hazards and produces poisonous gases upon fire.<br>• Powdered Cobalt may ignite upon contact with air or oxygen.<br>• If Co-Mo is spilled, it may be necessary to be contained and disposed as a hazardous waste. |

| 10.1.1 Catalyst type | Hazard record | 11 HUMAN HEALTH EFFECTS | 12 OTHER HAZARDS |
|---|---|---|---|
| Zeolite[1, 2, 3, 4] | Zeolite molecular sieve dryers are mainly crystalline, highly porous materials, which belong to the chemical family of aluminosilicates. They are considered hazardous, as crystalline silica is on the OSHA[a] Hazardous Chemical List. | Acute exposure to Zeolite dust may cause irritation of respiratory tract (if inhaled), burns in the mouth and digestive tract (if ingested), in addition to skin and eye irritation due to the dying effect of Zeolite. Chronic inhalation of Zeolite dust may damage the lung. | If Zeolite is spilled, it may be necessary to be contained and disposed as a hazardous waste. |
| 12.1 Zinc oxide[c, d] | Zinc oxide dust and fume are regulated as hazardous by OSHA[a]. | Acute exposure to zinc oxide may cause respiratory irritation and metal fume fever. Chronic exposure may cause skin eruptions. | • Zinc oxide is not combustible. Toxic gases may be released in a fire.<br>• If Zinc oxide is spilled, it may be necessary to be contained and disposed as a hazardous waste. |
| Iron/Pre-reduced[5, 6] | Iron is listed as a toxic substance on the TSCA### inventory[b]. OSHA[a] regulates hazardous Iron forms such as Iron Oxide fume ($Fe_2O_3$), as Fe, Iron soluble salts, as Fe, etc. | • Acute exposure to iron dust or powder may cause irritation to the respiratory system, skin and eye irritation, and possibly iron poisoning.<br>• Acute exposure to high levels of ferrous compounds can cause liver and kidney damage.<br>• Chronic exposure to iron fine dust and powder may cause pulmonary fibrosis, pathological iron deposition in the body tissue, damage to the liver, and iron poisoning. | |

# **OSHA**: Occupational Safety & Health Administration. U.S. Department of Labor.

## **CERCLA**: Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), commonly known as Superfund. CERCLA was enacted by Congress on December 11, 1980, and amended by the Superfund Amendments and Reauthorization Act (SARA) on October 17, 1986.

### **TSCA**: The Toxic Substances Control Act (TSCA) provides various control methods to avoid unreasonable risks from chemicals. The enforcement agency is the Environmental Protection Agency (EPA).

[a] Centers for Disease Control and Prevention (2001). Department of Health and Human Services, Atlanta, Georgia, USA. OSHA list of hazardous chemicals. (http://www.cdc.gov/od/ohs/manual/chemical/chmsfapp2.htm#osha2)

[b] Electronic Code of Federal Regulations (e-CFR). Title 40: Protection of Environment. Part 302—Designation, Reportable Quantities, And Notification. § 302.4 Designation of hazardous substances (1989, last updated 2004). Table 302.4_List of Hazardous Substances and Reportable Quantities.

(http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr&sid=e370d70c0cb67f6781715b13a564a271&rgn=div8&view=text&node=40:26.0.1.1.2.0.1.4&idno=40)

[c] New Jersey Department of Health and Senior Services. Right to Know Program. Right to Know Hazardous Substance Fact Sheet.
(http://www.state.nj.us/health/eoh/rtkweb/rtkhsfs.htm)

[d] International Labor Organization. International Occupational Safety and Health Information Centre (CIS). International chemical safety cards (ICSC).
(http://www.ilo.org/public/english/protection/safework/cis/products/icsc/dtasht/index.htm)

[1] Powermann (2003). Molecular Sieve Dryers.
(http://www.powermann.co.uk/molecular_sieve_dryers.htm)

[2] Grace Davison. Your Global Supplier of Catalysts and Silicas. Grace Davison Zeolite Molecular Sieves.
(http://www.gracedavison.com/eusilica/Adsorbents/product/zeolite_molecular_sieve.htm)

[3] (OSHA (1991). Labeling Requirements for Crystalline Silica Products.
(http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_id=20406&p_table=INTERPRETATIONS)

[4] Zeochem (2004). Material Safety Data Sheet. Zeolite.
(http://www.zeochem.com/msds/M83%20IG%20MSDS%20040817.PDF)

[5] Electronic Space Products International (2002). Material Safety Data Sheet. Iron.
(http://www.espi-metals.com/msds's/iron.htm)

[6] Grand Rapids Community College (2000). Material Safety Data Sheet. EM Science. Iron.
(http://web.grcc.cc.mi.us/Pr/msds/physicalscience/EM%20SCIENCE%20Iron%20(Fe).pdf)

## Forms of Hazardness

**Nickel hazardous forms regulated by OSHA[a]**
NICKEL, METAL
NICKEL, INSOLUBLE COMPOUNDS, AS NI NICKEL, SOLUBLE COMPOUNDS, AS NI
NICKEL CARBONYL, AS NI
NICKEL SULFIDE ROASTING, FUME & DUST, AS NI

**Nickel (CERCLA[b]): hazardous substance list includes:**
NICKEL; NICKEL AND COMPOUNDS, NICKEL COMPOUNDS, etc…

**Aluminum hazardous forms regulated by OSHA[a]**
ALUMINA
ALUMINUM, METAL DUST, AS AL
ALUMINUM, PYRO POWDERS, AS AL
ALUMINUM, SOLUBLE SALTS, AS AL
ALUMINUM, WELDING FUMES, AS AL
ALUMINUM, ALKYLS, NOT OTHERWISE
CLASSIFIED, AS AL
ALUMINUM OXIDE, AS AL

**Chromium hazardous forms regulated by OSHA[a]**
CHROMATES, ALKALINE, AS CR
CHROMIC ACID AND CHROMATES, AS CRO3
CHROMITE ORE PROCESSING (CHROMATE), AS CR

CHROMIUM (II) COMPOUNDS, AS CR
CHROMIUM (III) COMPOUNDS, AS CR
CHROMIUM (VI) COMPOUNDS, AS CR, WATER SOLUBLE
CHROMIUM (VI) COMPOUNDS, AS CR, CERTAIN WATER INSOLUBLE
CHROMIUM METAL
CHROMIUM TRIOXIDE
CHROMYL CHLORIDE

**Copper hazardous forms regulated by OSHA[a]**
COPPER FUME
COPPER DUSTS & MISTS, AS CU

**Copper (CERCLA[b]): hazardous substance list includes:**
COPPER; COPPER AND COMPOUNDS, etc...

**Cobalt hazardous forms regulated by OSHA[a]**
COBALT, METAL DUST & FUME, AS CO
COBALT CARBONYL, AS CO
COBALT HYDROCARBONYL, AS CO

**Cobalt (CERCLA[b]): hazardous substance list includes:**
COBALT COMPOUNDS, etc...

**Zin (CERCLA[b]): hazardous substance list includes:**
ZINC; ZINC AND COMPOUNDS, etc...

**Molybdenum hazardous forms regulated by OSHA[a]**
MOLYBDENUM, SOLUBLE COMPOUNDS, AS MO
MOLYBDENUM, INSOLUBLE COMPUNDS, AS MO

**Platinum hazardous forms regulated by OSHA[a]**
PLATINUM, METAL
PLATINUM, SOLUBLE SALTS, AS PT

**Iron hazardous forms regulated by OSHA[a]**
IRON SALTS, SOLUBLE, AS FE
IRON DEXTRAN COMPLEX
IRON OXIDE FUME (Fe2O3), AS FE
IRON PENTACARBONYL, AS FE

# Appendix VI

# ENVIRONMENTAL IMPACT MATRICES

**Valued Environmental Components (VEC) Identified for the Proposed Methanol/Ammonia Plant - Damietta**

| Component | VEC |
|---|---|
| Biotic | Plankton |
| | Pelagic Fish |
| | Demersal Fish |
| | Crustaceans |
| | Mollusks |
| | Birds |
| | Marine Mammals |
| | Onshore vegetation |
| | Onshore Mammals |
| | Reptiles |
| Abiotic | Coastal Morphology |
| | Sediment Dynamics |
| | Soil and Groundwater |
| Social | Existing Site users |
| | Nearby Village |
| | Local Fishing |
| | Local Farmers |

Table 1: Seawater Intake

| Impact Classification: 1=Significant, major impact. 2= Significant, moderate impact. 3= Insignificant, minor impact. 4= Insignificant impact. 5= Unknown impact | | Biotic | | | | | | | | | | Abiotic | | | Social | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Seawater Intake** | | Plankton | Pelagic Fish | Demersal Fish | Crustaceans | Molluscs | Birds | Marine Mammals | Onshore vegetation | Onshore Mammals | Reptiles | Coastal Morphology | Sediment Dynamics | Soil and Groundwater | Existing Site users | Nearby Village | Local Fishing | Local Farmers |
| **Activities** | **Pathways** | | | | | | | | | | | | | | | | | |
| **1.Construction** | Building of solid structures causing loss of habitat | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 4 | 4 | 4 | 3 | 4 |
| | Increased turbidity due to dredging | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 4 | 4 | 4 | 4 | 3 | 3 | 4 | 4 | 3 | 4 |
| | Sedimentation due to alteration of current structure | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 4 | 4 | 4 | 3 | 3 | 3 | 4 | 4 | 4 | 4 |
| | Air emission of exhaust fumes (marine and onshore support vehicles) | 4 | 4 | 4 | 4 | 4 | 3 | 4 | 3 | 3 | 3 | 4 | 4 | 3 | 3 | 3 | 3 | 3 |
| | Dredging impacts at intake location | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 4 | 4 | 4 | 3 | 3 | 4 | 4 | 4 | 3 | 4 |
| | Disposal of spoil from trenching - onsite usage | 4 | 4 | 4 | 4 | 4 | 3 | 4 | 3 | 3 | 3 | 4 | 3 | 3 | 4 | 4 | 4 | 4 |
| | Disposal of spoil from drendging - offshore | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 4 | 4 | 4 | 4 | 3 | 4 | 4 | 4 | 3 | 4 |
| | General litter and wastes from human activities | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 4 | 4 | 3 | 3 | 3 | 3 | 4 |
| | Increased Noise due to increased machinery | 4 | 3 | 3 | 3 | 3 | 3 | 3 | 4 | 3 | 3 | 4 | 4 | 4 | 3 | 3 | 3 | 3 |
| | | | | | | | | | | | | | | | | | | |
| **2. Operational** | Marine Biofouling | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 4 | 4 | 4 | 4 | 4 | 3 | 4 | 4 | 3 | 4 |
| | Fish Intake | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 3 | 4 |
| | Maintenance dredging | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 4 | 4 | 4 | 3 | 3 | 4 | 4 | 4 | 3 | 4 |
| | | | | | | | | | | | | | | | | | | |
| **3. Accidental Events and environmental non-compliance** | Screen Rupture | 2 | 2 | 2 | 3 | 2 | 3 | 3 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 2 | 4 |
| | Leakage, Rupture | 4 | 4 | 4 | 4 | 4 | 3 | 4 | 3 | 3 | 3 | 4 | 4 | 2 | 3 | 4 | 4 | 4 |
| | | | | | | | | | | | | | | | | | | |

Table 2: Marine Outfall

| Impact Classification: 1=Significant, major impact. 2= Significant, moderate impact. 3= Insignificant, minor impact. 4= Insignificant impact. 5= Unknown impact | | Biotic | | | | | | | | | | Abiotic | | | Social | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Marine Outfall** | | Plankton | Pelagic Fish | Demersal Fish | Crustaceans | Molluscs | Birds | Marine Mammals | Onshore vegetation | Onshore Mammals | Reptiles | Coastal Morphology | Sediment Dynamics | Soil and Groundwater | Existing Site users | Nearby Village | Local Fishing | Local Farmers |
| **Activities** | **Pathways** | | | | | | | | | | | | | | | | | |
| **1.Construction** | Building of solid structures causing loss of habitat | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 4 | 4 | 4 | 3 | 4 |
| | Increased turbidity due to dredging along outfall corridor | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 4 | 4 | 4 | 4 | 3 | 3 | 4 | 4 | 3 | 4 |
| | Sedimentation due to alteration of current structure | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 4 | 4 | 4 | 3 | 3 | 3 | 4 | 4 | 4 | 4 |
| | Air emission of exhaust fumes (marine and onshore support vehicles) | 4 | 4 | 4 | 4 | 4 | 3 | 4 | 3 | 3 | 3 | 4 | 4 | 3 | 3 | 3 | 3 | 3 |
| | Dredging impacts along corridor of proposed outfall - removal of habitat | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 4 | 4 | 4 | 3 | 3 | 4 | 4 | 4 | 3 | 4 |
| | Disposal of spoil from trenching - onsite usage | 4 | 4 | 4 | 4 | 4 | 3 | 4 | 3 | 3 | 3 | 4 | 3 | 3 | 4 | 4 | 4 | 4 |
| | Disposal of spoil from drendging - offshore | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 4 | 4 | 4 | 4 | 3 | 4 | 4 | 4 | 3 | 4 |
| | General litter and wastes from human activities at sea | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 4 | 4 | 3 | 3 | 3 | 3 | 4 |
| | Increased Noise due to traffic, heavy machinery | 4 | 3 | 3 | 3 | 3 | 3 | 3 | 4 | 3 | 3 | 4 | 4 | 4 | 3 | 3 | 3 | 3 |
| | | | | | | | | | | | | | | | | | | |
| **2. Operational** | Change of biological community structure along corridor | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 4 | 3 | 4 | 3 | 4 |
| | Change of water quality | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 4 | 4 | 4 | 4 | 4 | 3 | 3 | 4 | 3 | 4 |
| | Marine Biofouling on ports, pipeline etc | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 4 | 4 | 4 | 4 | 4 | 3 | 4 | 4 | 3 | 4 |
| | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | |
| **3. Accidental Events and environmental non-compliance** | Accidental fuel spills during construction | 2 | 2 | 2 | 2 | 2 | 3 | 2 | 3 | 3 | 3 | 4 | 4 | 3 | 3 | 4 | 2 | 4 |
| | Accidental exceedances during operation - Chlorine | 2 | 2 | 2 | 2 | 2 | 3 | 2 | 3 | 3 | 3 | 4 | 4 | 3 | 3 | 4 | 2 | 4 |
| | Accidental exceedances during operation - contaminated wastes | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 4 | 4 | 3 | 3 | 4 | 2 | 4 |
| | Accidental exceedances during operation - Sanitation water | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 4 | 4 | 4 | 4 | 4 | 3 | 4 | 4 | 3 | 4 |
| | Accidental exceedances during operation - Desalination brine | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 4 | 4 | 4 | 4 | 4 | 3 | 4 | 4 | 3 | 4 |
| | Leakage, rupture | 4 | 4 | 4 | 4 | 4 | 3 | 4 | 3 | 3 | 3 | 4 | 4 | 2 | 3 | 4 | 4 | 3 |
| | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | |

Table 3: Dredging "Berths and Revetments"

| Impact Classification: 1=Significant, major impact 2= Significant, moderate impact 3= Insignificant, minor impact 4= Insignificant impact 5= Unknown impact | | Biotic | | | | | | | | | | Abiotic | | | Social | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Dredging "Berths and Revetments"** | | Plankton | Pelagic Fish | Demersal Fish | Crustaceans | Molluscs | Birds | Marine Mammals | Onshore vegetation | Onshore Mammals | Reptiles | Coastal Morphology | Sediment Dynamics | Salt and Groundwater | Existing Site users | Nearby Village | Local Fishing | Local Farmers |
| **Activities** | **Pathways** | | | | | | | | | | | | | | | | | |
| **1.Construction** | Loss of habitat | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 4 | 4 | 4 | 3 | 3 | 3 | 3 | 4 | 3 | 4 |
| | Increased Tubidity due to dredging activity | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 4 | 4 | 4 | 3 | 3 | 3 | 3 | 4 | 3 | 4 |
| | General decrease in water quality | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 4 | 4 | 4 | 4 | 4 | 3 | 4 | 4 | 3 | 4 |
| | Increased Noise due to marine traffic | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 4 | 3 | 3 | 4 | 4 | 4 | 3 | 3 | 3 | 3 |
| | Increased Light during construction activities | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 4 | 3 | 3 | 4 | 4 | 4 | 3 | 3 | 3 | 3 |
| | | | | | | | | | | | | | | | | | | |
| **2. Operational** | Maintenance dredging | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 4 | 4 | 4 | 3 | 3 | 3 | 3 | 4 | 3 | 4 |
| | Increased Tubidity | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 4 | 4 | 4 | 3 | 3 | 3 | 3 | 4 | 3 | 4 |
| | General decrease in water quality | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 4 | 4 | 4 | 4 | 4 | 3 | 4 | 4 | 3 | 4 |
| | Increased Noise due to marine traffic | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 4 | 3 | 3 | 4 | 4 | 4 | 3 | 3 | 3 | 3 |
| | | | | | | | | | | | | | | | | | | |
| **3. Accidental Events and environmental non-compliance** | General litter and wastes from human activities. | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 4 | 3 | 3 | 4 | 4 | 3 | 3 | 3 | 3 | 3 |
| | Disposal of wastes and litter from boats during all phases of development | 3 | 2 | 2 | 3 | 2 | 3 | 2 | 4 | 3 | 4 | 4 | 4 | 3 | 3 | 3 | 3 | 3 |
| | Spill of ballast water from dredgers | 3 | 2 | 2 | 2 | 2 | 3 | 2 | 4 | 3 | 3 | 4 | 4 | 3 | 3 | 3 | 3 | 3 |
| | Accidental fuel spill | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 4 | 4 | 2 | 3 | 3 | 2 | 3 |
| | Collision | 2 | 2 | 2 | 2 | 2 | 3 | 2 | 4 | 4 | 4 | 4 | 4 | 4 | 3 | 3 | 2 | 4 |
| | | | | | | | | | | | | | | | | | | |

Table 4: Excavation Works and Roads

| Impact Classification: 1=Significant, major impact 2= Significant, moderate impact 3= Insignificant, minor impact 4= Insignificant impact 5= Unknown impact | | Biotic | | | | | | | | | | Abiotic | | | Social | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Excavation works and Roads** | | Plankton | Pelagic Fish | Demersal Fish | Crustaceans | Molluscs | Birds | Marine Mammals | Onshore vegetation | Onshore Mammals | Reptiles | Coastal Morphology | Sediment Dynamics | Soil and Groundwater | Existing Site users | Nearby Village | Local Fishing | Local Farmers |
| **Activities** | **Pathways** | | | | | | | | | | | | | | | | | |
| **1.Construction** | Loss of marginal habitat | 4 | 4 | 4 | 4 | 4 | 3 | 4 | 3 | 3 | 3 | 3 | 4 | 3 | 3 | 4 | 4 | 4 |
| | Increase in demolotion wastes | 4 | 4 | 4 | 4 | 4 | 3 | 4 | 3 | 3 | 3 | 3 | 4 | 3 | 3 | 3 | 4 | 3 |
| | Increased Traffic | 4 | 4 | 4 | 4 | 4 | 3 | 4 | 3 | 3 | 3 | 4 | 4 | 4 | 3 | 3 | 4 | 4 |
| | Increased Noise | 4 | 4 | 4 | 4 | 4 | 3 | 3 | 4 | 3 | 3 | 4 | 4 | 4 | 3 | 3 | 4 | 3 |
| | Increased Dust | 3 | 4 | 4 | 4 | 4 | 3 | 4 | 3 | 3 | 3 | 4 | 4 | 4 | 3 | 3 | 3 | 3 |
| | | | | | | | | | | | | | | | | | | |
| **2. Operational** | Increased Traffic | 4 | 4 | 4 | 4 | 4 | 3 | 4 | 3 | 3 | 3 | 4 | 4 | 4 | 3 | 3 | 4 | 4 |
| | Increased Noise | 4 | 4 | 4 | 4 | 4 | 3 | 3 | 4 | 3 | 3 | 4 | 4 | 4 | 3 | 3 | 4 | 3 |
| | Increased Dust | 3 | 4 | 4 | 4 | 4 | 3 | 4 | 3 | 3 | 3 | 4 | 4 | 4 | 3 | 3 | 3 | 3 |
| | Increased light during night time operations | 4 | 4 | 4 | 4 | 4 | 3 | 3 | 4 | 3 | 3 | 4 | 4 | 4 | 3 | 3 | 3 | 3 |
| | | | | | | | | | | | | | | | | | | |
| **3. Accidental Events and environmental non-compliance** | Collision | 4 | 4 | 4 | 4 | 4 | 3 | 3 | 2 | 2 | 2 | 4 | 4 | 3 | 2 | 3 | 3 | 3 |
| | Fuel spillage | 4 | 4 | 4 | 4 | 4 | 2 | 3 | 2 | 2 | 2 | 4 | 4 | 2 | 2 | 3 | 3 | 3 |
| | Fire, Fatalities | 4 | 4 | 4 | 4 | 4 | 2 | 3 | 2 | 2 | 2 | 4 | 4 | 4 | 2 | 3 | 3 | 3 |
| | Spill, leaks from sanitation, waste container vehicles | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 2 | 2 | 3 | 3 | 3 |
| | | | | | | | | | | | | | | | | | | |

Table 5; Stacks, Vents and Flare Emissions

| Impact Classification: 1=Significant, major impact 2= Significant, moderate impact 3= Insignificant, minor impact 4= Insignificant impact 5= Unknown impact | | Biotic | | | | | | | | | | Abiotic | | | Social | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Stacks, vents and flare emissions** | | Plankton | Pelagic Fish | Demersal Fish | Crustaceans | Molluscs | Birds | Marine Mammals | Onshore vegetation | Onshore Mammals | Reptiles | Coastal Morphology | Sediment Dynamics | Soil and Groundwater | Existing Site users | Nearby Village | Local Fishing | Local Farmers |
| **Activities** | **Pathways** | | | | | | | | | | | | | | | | | |
| **1.Construction** | Loss of habitat due to construction | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 3 | 4 | 3 | 3 | 3 | 4 | 4 |
| | Raw Materials brought to site via sea | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 4 | 4 | 4 | 3 | 3 | 3 | 3 | 4 | 3 | 4 |
| | Increased traffic across the site | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 4 | 4 | 4 |
| | Increased Noise | 4 | 4 | 4 | 4 | 4 | 3 | 4 | 3 | 3 | 3 | 4 | 4 | 4 | 3 | 3 | 3 | 3 |
| | Increased light from construction activities at night | 4 | 4 | 4 | 4 | 4 | 3 | 4 | 3 | 3 | 3 | 4 | 4 | 4 | 3 | 3 | 3 | 3 |
| | | | | | | | | | | | | | | | | | | |
| **2. Operational** | Increased air emissions | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 4 | 4 | 3 | 2 | 2 | 2 | 2 |
| | Increased noise from normal operations | 4 | 4 | 4 | 4 | 4 | 3 | 4 | 3 | 3 | 3 | 4 | 4 | 4 | 3 | 3 | 3 | 3 |
| | Increased Light from flares | 4 | 4 | 4 | 4 | 4 | 3 | 4 | 3 | 3 | 3 | 4 | 4 | 4 | 3 | 3 | 3 | 3 |
| | | | | | | | | | | | | | | | | | | |
| **3. Accidental Events and environmental non-compliance** | Reduction in Air Quality due to fugutive emissions and non-compliance | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 4 | 4 | 3 | 2 | 2 | 2 | 2 |
| | Leakage | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 4 | 4 | 2 | 2 | 2 | 2 | 2 |
| | Fire, Explosion | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 2 | 2 | 2 | 3 | 4 | 2 | 2 | 2 | 2 | 2 |
| | | | | | | | | | | | | | | | | | | |

Table 6: Sanitation Water

| Impact Classification: 1=Significant, major impact 2= Significant, moderate impact 3= Insignificant, minor impact 4= Insignificant impact 5= Unknown impact | | Biotic | | | | | | | | | | Abiotic | | | Social | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sanitation Water (Design A)** | | Plankton | Pelagic fish | Demersal Fish | Crustaceans | Molluscs | Birds | Marine Mammals | Onshore vegetation | Onshore Mammals | Reptiles | Coastal Morphology | Sediment Dynamics | Soil and Groundwater | Existing Site users | Nearby Village | Local Fishing | Local Farmers |
| **Activities** | **Pathways** | | | | | | | | | | | | | | | | | |
| **1.Construction** | Loss of habitat due to trenching of pipelines | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 4 | 3 | 4 |
| | Loss of habitat due to outfall construction | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 4 | 3 | 4 |
| | Increased solid wastes due to construction | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 4 | 3 | 3 | 3 | 3 | 3 |
| | Increased construction traffic | 4 | 4 | 4 | 4 | 4 | 3 | 4 | 3 | 3 | 3 | 3 | 4 | 3 | 3 | 3 | 3 | 3 |
| | Increased garbage from personnel | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| | Increased noise due to construction | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 4 | 4 | 4 | 3 | 3 | 3 | 3 |
| | | | | | | | | | | | | | | | | | | |
| **2. Operational** | Change in water quality | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 4 | 4 | 4 | 4 | 4 | 3 | 4 | 4 | 3 | 4 |
| | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | |
| **3. Accidental Events and environmental non-compliance** | Spillage of hazardous treatment chemicals | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 4 | 4 | 2 | 2 | 2 | 2 | 2 |
| | Rupture of underground system | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 2 | 4 | 3 | 2 | 3 | 3 | 3 | 3 |
| | Accidental reduction in water quality | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 4 | 4 | 2 | 2 | 2 | 2 | 2 |
| | | | | | | | | | | | | | | | | | | |

Table 7: Solid wastes

| Impact Classification: 1=Significant, major impact. 2= Significant, moderate impact. 3= Insignificant, minor impact. 4= Insignificant impact. 5= Unknown impact | | Biotic | | | | | | | | | | Abiotic | | | Social | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Solid Waste (Design A)** | | Plankton | Pelagic Fish | Demersal Fish | Crustaceans | Molluscs | Birds | Marine Mammals | Onshore vegetation | Onshore Mammals | Reptiles | Coastal Morphology | Sediment Dynamics | Soil and Groundwater | Existing Site users | Nearby Village | Local Fishing | Local Farmers |
| **Activities** | **Pathways** | | | | | | | | | | | | | | | | | |
| **1.Construction** | Increase in solid wastes during the construction phase due to demolition activities (of existing buildings and roadways) | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 2 | 3 |
| | Increased garbage due to number of personnel | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 3 | 2 | 2 | 3 | 3 | 3 | 2 | 2 | 2 | 2 |
| | | | | | | | | | | | | | | | | | | |
| **1. Construction** | Increased garbage due to number of personnel | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 4 | 4 | 3 | 3 | 3 | 3 | 3 |
| | Increase waste due to storage containers, process material packaging etc | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 4 | 3 | 3 | 3 | 3 | 3 |
| | | | | | | | | | | | | | | | | | | |
| | Increased garbage due to number of personnel | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 4 | 4 | 3 | 3 | 3 | 3 | 3 |
| **2. Operational** | Increase waste due to storage containers, process material packaging etc | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 4 | 3 | 3 | 3 | 3 | 3 |
| | Increase in solid waste from water treatment and on site processes | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 4 | 3 | 3 | 3 | 3 | 3 |
| | Increase in traffic due to routine on site removal of solid waste | 4 | 4 | 4 | 4 | 4 | 3 | 4 | 3 | 3 | 3 | 4 | 4 | 3 | 3 | 3 | 4 | 4 |
| | Increase in noise due to traffic and routine operation of solid waste collection | 4 | 4 | 4 | 4 | 4 | 3 | 4 | 4 | 3 | 3 | 4 | 4 | 4 | 3 | 3 | 3 | 3 |
| | | | | | | | | | | | | | | | | | | |
| **3. Accidental Events and environmental non-compliance** | Paper and plastic blowing across site | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 4 | 4 | 3 | 3 | 3 | 3 | 3 |
| | Solid waste blown into Mediterranean | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 4 | 4 | 4 | 3 | 3 | 3 | 3 | 4 | 3 | 4 |
| | Fire, explosion | 4 | 4 | 4 | 4 | 4 | 3 | 4 | 2 | 2 | 2 | 3 | 3 | 3 | 2 | 2 | 2 | 2 |
| | Stock piles attracting rats | 4 | 4 | 4 | 4 | 4 | 3 | 4 | 3 | 3 | 3 | 3 | 4 | 3 | 3 | 3 | 4 | 3 |
| | Increased odour | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 3 | 3 | 4 | 4 | 4 | 2 | 2 | 4 | 2 |
| | Leakage of hazardous solid waste | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 2 | 2 | 2 |
| | | | | | | | | | | | | | | | | | | |

## APPENDIX 2 – HALCROW MARINE TERMINAL REPORT*

The marine terminal investigation report is primarily prepared by Halcrow Group Limited with input from KBR. Halcrow was subcontracted by Agrium Inc to undertake extended preliminary marine terminal studies on the proposed project sites.

The excerpt from the Halcrow Report included in this Appendix 2 is reproduced with the approval of Halcrow Group and Agrium Inc. The report reflects considerations valid in October 2004 which may change as the project evolves.

**Granherne Inc wishes to acknowledge Agrium U.S. Inc.'s and Halcrow Group Limited agreement to include sections of their Jetty Engineering Support Scoping Study in this Report*

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Halcrow Group Limited has prepared this report in accordance with the instructions of their client, Agrium, for their sole and specific use. Any other persons who use any information contained herein do so at their own risk.

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# Summary

Agrium has identified a need to develop a world scale fertilizer plant in Egypt. The plant will export urea and ammonia. The proposed facility may be shared with Methanex who have identified a need for a methanol export plant. Development of marine facilities may be in three phases to accommodate an anticipated increase in future shipping exports.

Four potential locations have been identified on Egypt's Mediterranean coast - three Greenfield sites at Idku, Gamasah, Damietta Echem and one Brownfield site at Damietta Port.

The scoping study shows that two sites remain feasible – Idku and Damietta Port. Damietta Port appears to be favoured, due to the lower marine capital and operating costs, however the shipping delays may be unacceptable and require further investigation. The Gamasah and Damietta Echem sites are more expensive. If Damietta Port proves unattractive, then the Idku site could be progressed.

Further, the following conclusions can be drawn:

- For Phases 1 and 2, a combined jetty for all products would be possible. For Phase 3, two berths would be required – one for urea and one for ammonia/methanol
- At Idku, a layout has been developed based on sharing the existing ELNG dredged channel, to reduce costs. Discussions would be required with ELNG to confirm that this is acceptable and associated costs
- At Gamasah, a new port facility would be required, with an approach trestle to deeper water and breakwater protection
- At Damietta Port, the berths can be located within the existing Port. The Port Authority and SEGAS would need to agree to the proposed berth layout. A major concern with this option is the high level of current and future traffic at the Port, which may lead to shipping delays
- At Damietta Echem site, a separate dredged channel to deep water would be required, sharing with Damietta Port would not be permitted
- Capital costs for marine works (all phases) are
    - Idku US$128.9 million
    - Gamasah US$254.2 million
    - Damietta Echem US$200.4 million
    - Damietta Port US$46.8 million
- Damietta Port Phase 1 costs are US$35.59 million

- Port operator/ maintenance costs are provided
- Shipping delay costs at Damietta Port are provided.

It is recommended that for the selected site, the following should be undertaken;

- data on the offshore wave conditions should be collected and confirmed
- a bathymetric survey including shoreline should be made to a water depth of approximately 17m
- historical data on the shoreline should be collated and assessed
- a shoreline evolution model should be undertaken to include Shore Protection Authority and National shoreline protection plans
- water levels must be assessed w.r.t Egyptian Survey Datum
- optimisation of marine structure designs
- site investigations (boreholes, CPTs) will be required to confirm ground conditions
- topographic survey to confirm site levels and position.

The concept layouts can then be further developed and accuracy of costs improved.

If Damietta Port is taken forward, a shipping simulation study with data collection on shipping behaviour at the port would help assess shipping delays. A navigation study would assist with DPA and SEGAS approval of the new berth layout.

For the Idku site, coastal process modelling (wave refraction, hydrodynamic and sediment transport) would allow optimisation of the breakwater position and capital and maintenance dredging requirements. A navigation study would allow optimisation of the berth positions. The on land position of the Echem site needs to be confirmed.

# Introduction

*1.1* ***Introduction***

Agrium has identified a need to develop a world scale fertilizer plant in Egypt. The plant will export urea and ammonia and will therefore include a low cost and low risk ship loading facility in close proximity to the plant site for their export. At the same time, Methanex wish to develop a methanol export plant in Egypt. Agrium and Methanex are seeking to share port facilities, if possible. Both companies will collaborate with Echem. KBR is undertaking a study of potential ammonia/ urea/ methanol sites in Egypt, for the US Trade and Development Agency (USTDA) /Echem.

Four potential locations have been identified on Egypt's Mediterranean coast - three Greenfield sites at Idku, Gamasah, Damietta Echem and one Brownfield site at Damietta Port. Future provision for a second and third phase of marine facility expansion is also considered.

On-land process plant costs are likely to be similar for each site, with the capital and operating cost differentiators being marine facilities (berths, dredging, breakwaters, tugs), site preparation (clearance, filling), cooling water requirements, piping/conveyor lengths and land rental/port charges.

Agrium has appointed Halcrow to undertake a scoping study for the jetty engineering aspects of the development. This report presents a review of existing environment data, concept layouts; shipping assumptions and ship loading requirements; design recommendations and outline cost estimates for the marine facilities.

Cooling water requirements, site preparation costs and piping/conveyor lengths and costs are being addressed by KBR and land rental by Agrium/Methanex/Echem. KBR is being assisted by KOMEX on environmental issues and by ECMA on coastal issues including: calculation of water level variation; recommendation for land fill; conceptual design and cost estimate for the flood protection bund; coastal processes and a summary of permits.

The purpose of this report is to consider, for the most part, the marine implications of the development and to recommend the most favourable options to provide a basis for site selection and the development of future project stages.

*1.2* ***Site Locations***

Locations of the three proposed sites are shown in Figures (1.a), (1.b) and (1.c) for Damietta, Idku and Gamasah, respectively. The coordinates for each location is summarized in the following table

Coordinates of the Proposed Locations

| Location | Latitude | Longitude |
|---|---|---|
| **Idku** | 31° 23' 00"N | 30° 20' 10"E |
| **Gamasah** | 31° 32' 30"N | 31° 20' 00"E |
| **Damietta** | 31° 29' 10"N | 31° 46' 10"E |

**Table 0-1:** Approximate co-ordinates of site locations

- **Idku**: located on the coastline in Abu-Qir Bay approximately 9 km. west of Rosetta Nile branch outlet, 200km west of Port Said and 45east of Alexandria. The site is adjacent to the British Gas LNG project in Abu Qir Bay
- **Gamasah**: located on the coastline approximately 75km west of Port Said
- **Damietta Echem** site: located on the coastline approximately 1km east of the port at Damietta
- **Damietta Port** : located within the port at Damietta, some 50km west of Port Said. The site is on the west side of the dredged channel between the Union Fenosa/SEGAS LNG site and the container terminal.

A general location map of all the sites is presented in Appendix A.

# 2 Review of Existing Environment Data

## 2.1 *Introduction*

This section of the report lists the data gathered during the scoping study, by Halcrow and ECMA. The review included any data relevant to the project sites and also data collected from other sites along Egypt's northern coastline, which may have relevance to the project.

### 2.1.1 *Bathymetric Data – All sites*

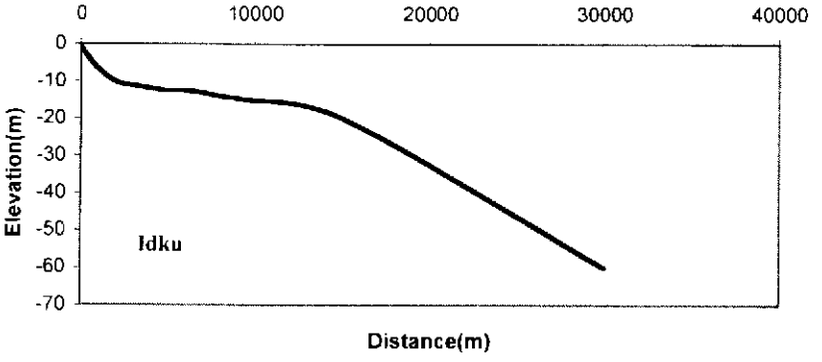
The table below summarises the distance from the coastline to bathymetric contours at each of the proposed sites. These distances are based on British Admiralty charts for the Egyptian North Coast.

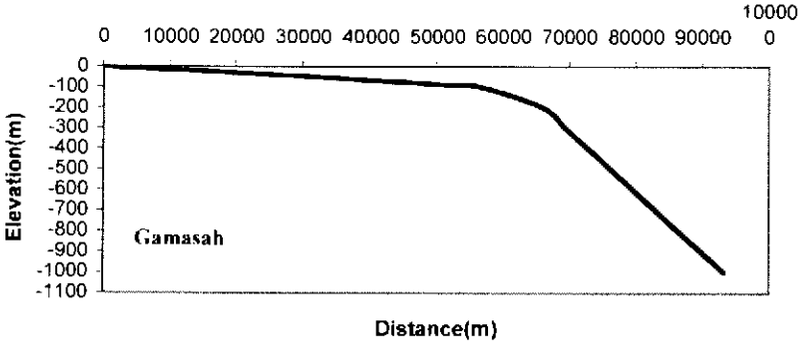
| SITE | APPROX. DISTANCE IN METERS TO DEPTH CONTOURS (m) (According to current British Admiralty Charts) | | | | NOTES[1] |
|---|---|---|---|---|---|
| | **Depth 5m** | **Depth 10m** | **Depth 14m** | **Depth 15m** | |
| **Idku** | 500 | 1800 | 6400 | 8400 | ELNG constructed a 2400m trestle jetty to the 11 m contour (surveyed) and a further 4000 m dredged channel to the 14 m contour **(6400m total).** |
| **Gamasah** | 1200 | 4000 | 13000 | 14500 | |
| **Damietta Echem and Port Sites** | 850 | 2500 | 8000 | 11300 | The Port Basin is maintained at 14.5m. The access navigation channel is maintained at 15.0 m and extends **11300m** from port entrance. |

**Table 2-1:** Approx. distance from coast to depth contours

*Notes.*
1. *Source: KBR.*

Shore profiles in the following figure are extracted from Admiralty Chart number 2681 for Idku and Admiralty Chart number 2574 for Gamasah and Damietta. The profiles are shown in the following Figures for the three locations, respectively. In absence of local survey w.r.t Egyptian Survey Datum, calculations in this report shall be based on the Admiralty Chart datum which is the ACD = 0.0.



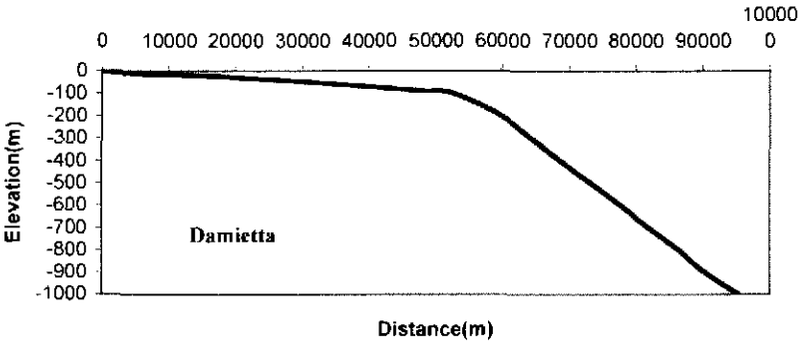



**Figure 2-1:** Shore profile for the three locations used in the calculation of the wave set-up as extracted from the Admiralty Charts

*2.1.2* *Wind Data*

Wind frequency data for Alexandria for the period 1983 to 1999 has previously been obtained and indicates that there is a very dominant prevailing north-westerly wind throughout the year with a frequency of occurrence of 25.8% for the direction 320 degrees to 340 degrees.

Wind data (Dar Al-Handasah, 2000) included wind statistics off the coast of Alexandria for the period 1856 to 1997, obtained from Met Office, UK. The data was analysed and indicated that the prevailing wind direction is north-west with frequency of occurrence of 28.9%. For directions west and north, the frequencies of occurrence are 21.2% and 15.3% respectively. Extreme wind speeds for different return periods resulting from the analysis of these three directions are shown in Table 2-2: Extreme wind speeds (knots).

| Wind Direction | Return Period (years) | | |
|---|---|---|---|
| | 1 | 10 | 100 |
| North West | 42 | 48 | 53 |
| West | 44 | 50 | 56 |
| North | 27 | 42.5 | 47 |

**Table 2-2:** Extreme wind speeds (knots)

The above wind is useful and considered reasonably representative of Damietta.

Table below provides a summary for the extreme wind speeds in the vicinity of the project site near Rosetta and may be considered representative for all three sites. For wind setup calculations, a wind speed of 20.0 m/s (about 40 knots) is considered to represent the 100 Year condition, Radi (1998).

| Direction with North | 100 Year Return Period |
|---|---|
| 270 | 20 |
| 300 | 20 |
| 330 | 19 |
| 0 | 14.5 |
| 30 | 14 |
| 60 | 15 |

**Table 2-3:** Extreme hourly averaged wind speeds (m/s)

2.1.3 *Wave Data*

Data from the CoRI (August 2000) has been collected for the years between 1971 and 1999, using a number of different measurement systems. A summary of the extreme analysis results is shown in the table below.

| Return period (years) | Significant wave height (m) | Wave period (secs) |
|---|---|---|
| **1** | 2.9 | 5.6 |
| **2** | 3.4 | 5.9 |
| **5** | 4.1 | 6.5 |
| **10** | 4.5 | 6.8 |
| **25** | 5.2 | 7.3 |
| **50** | 5.6 | 7.6 |
| **100** | 6.1 | 7.9 |

**Table 2-4:** Extreme offshore wave conditions – Damietta area

The direction of the majority of the waves come from the WNW and NE sectors while the waves greater than 2.0m come from the N and the NNE sector. Digital data was not available, unfortunately.

Data from the KMNI (1998) relates to statistics concerning swells in the area. These statistics were based on observations of chosen ships in the quadrilateral delimited by the meridians 27E – 30E and the parallels 32N-33N. This observation zone is situated to the west of Port-Said meridian and the statistics obtained here give an accurate picture of the swells out at the sea between Port-Said and Damietta. The observation period is from 1961 to 1967.

The results of the analysis of the observations show that the prevailing wave period varies between 3.0 and 7.0 seconds and prevailing deep water wave direction varies between west northwest (WNW) and north northwest (NNW), and the most frequent wave heights range from 1.00 to 1.5 metres.

### 2.2 *Land Fill*

#### 2.2.1 *Maximum Plant Levels*

Based on the assessed soil conditions, it is concluded that the plant (at any of the three locations) must be elevated by land fill. The plant level is recommended to be at +2.00 m (ACD) by adding a value of 0.15 to 0.20 m above the static level as a factor of safety. Please note that this study does not take into consideration the type of soil in each area or the type of foundations used, settlements could be a factor in future land subsidence and this is an area specific.

## 3 Shipping Data

### 3.1 *General*

The shipping facility is to be a calm water facility capable of loading ammonia, urea, and possibly methanol. It is assumed that a dedicated berth will be required for a urea ship loader and a second berth will, if required, be shared for the ammonia and methanol load-out facilities. Methanex is separately considering loading methanol via a single point mooring system.

Typical specific gravities of liquid gases at proposed maritime carriage conditions are 0.683t/m$^3$ for liquid ammonia and 0.792t/m$^3$ for liquid methanol. Urea is exported in white granular form with a bulk density of 0.745t/m$^3$.

### 3.2 *Berth occupancy*

It is necessary first to ascertain the number of berths needed in order to keep ship waiting time down to an economic level. The initial assumption is one berth for urea and one liquids berth for both ammonia and methanol. Based on the ship sizes and loading rates, port time per ship type was calculated.

| Vessel Carrier Type | Vessel Port Time | | | |
|---|---|---|---|---|
| | Size (mt) | Fill time (hrs) | Docking (hrs) | Total |
| Ammonia | 15 000 | 20 | 12 | 32 |
| | 23 500 | 31 | 12 | 33 |
| | 43 350 | 58 | 12 | 70 |
| Methanol | 5 000 | 2 | 10 | 12 |
| | 30 000 | 11 | 10 | 21 |
| | 48 000 | 18 | 10 | 28 |
| Urea | 25 000 | 29 | 10 | 39 |
| | 30 000 | 35 | 10 | 45 |
| | 45 000 | 53 | 10 | 63 |

**Table 3-1:** Vessel Port Times

Finally, the annual port time per berth was determined.

| Vessel Carrier Type | Annual Port Time – Phase 1 | | | |
|---|---|---|---|---|
| | Size (mt) | Total vessels/ year | Hours/year | Days/year |
| **Ammonia** | 23 500 | 6 | 198 | 8.3 |
| | 43 350 | 1 | 70 | 2.9 |
| **Methanol** | 5 000 | 10 | 120 | 5.0 |
| | 30 000 | 15 | 315 | 13.1 |
| | 48 000 | 17 | 476 | 19.8 |
| **Total for Liquids Berth** | | | | **49.1** |
| **Urea** | 25 000 | 36 | 1404 | 58.5 |
| | 30 000 | 8 | 360 | 15.0 |
| **Total for Urea Berth** | | | | **73.5** |

**Table 3-2:** Annual Port Times

From the Egypt N2 project preliminary design information and assumed loading rates and throughput, annual berth usage times are as follows:

- Ammonia/ Methanol Berth 49.1 days/ year (49 ships)
- Urea Berth 73.5 days/ year (44 ships)

This gives berth occupancy rates of 13.5% and 20.1% for the liquid and urea berths respectively, for Phase 1. By completion of Phase 3, single berth occupancy would increase to 40% (147.3 days) and 60% (220.5 days) respectively. The ammonia/ methanol berth percentages are acceptable. Urea berth utilisation could be reduced with provision of a higher ship unloading capacity in future phases. These percentages would then become acceptable allowing for ship scheduling and downtime (berth repairs, product non-availability, high wind etc). Typical recommended maximum berth occupancy is 60%, for multi-user berths, with higher values possible for dedicated facilities with regular shipping schedules.

During Phase 1 and 2, a shared berth for all products would be possible. This would require the liquid loading arms to be located underneath the urea loader crane. This option will be considered for Phases 1 and 2 only. There would be some additional equipment costs in changing liquid loading to a separate berth in Phase 3.

# 4 Marine Concept Designs

## 4.1 *Marine Planning Principles*

This section describes the planning of new berth layout(s). The aspects described below include berth layout, vessel draft, port traffic, marine access and dredging.

### 4.1.1 *Berth Layout*

For the berth/ marine facilities layout, consideration has been given to overall dimensions. The berth layouts were arrived at using the following guidelines and requirements.

(a) Vessel Size – A number of vessel sizes per product have been considered initially. These are described in section 3.

(b) Jetty Position – The following factors were taken into account:

- Safety distance: The loading arm / manifold should ideally be as far as reasonably possible from the edge of any port entrance channel, as a safety requirement.
- The length & beam of the design vessel
- Tug requirements. Manoeuvring distance between the stern of the vessel and the end of any basin and between any berths.
- Separation of berths. Based on two times vessel beam plus 30m tug manoeuvring allowance.
- Berth orientation. Approximately parallel to prevailing wind direction.
- The distance of the berthing jetty from land/breakwater. This takes into account the total depth from bottom of the dredged basin to top of breakwater and the dredged/breakwater slope;

(c) Wave Protection – Provision of shelter at berth by means of breakwater. Due to the short timeframe, it was not possible to undertake numerical modelling of wave transformation from offshore to berth, taking into account wave refraction and diffraction. Normal practice would be to ensure significant wave heights at the berth were less than 1m for up to 30,000 DWT vessels, and 1.5m for 60,000 DWT vessels, to minimise downtime.

*4.1.2* *Vessel Draft*

The vessel size and its draft will be a major factor in determining the dredge depth required. It is considered acceptable and prudent to retain an under keel clearance of 2m for the approach channel and turning circle and 1.5m at the proposed berths. This gives the dredged depth requirement at the berth with higher values being required in exposed approaches, to allow for wave effects.

*4.1.3* *Port Traffic*

In evaluating the berth locations, it will be necessary to consider the number of vessel movements, with regard to safety of navigation and potential delays. For existing ports such as Damietta, information would be needed on navigation rules and traffic levels at the proposed locations.

*4.1.4* *Marine Access*

Deep water for marine access should ideally be close to shore. A berth will require a turning circle of minimum two times ship length (assuming tugs or bow thrusters). A turning circle of 450m diameter has been assumed on the new sites at Gamasah and Damietta Echem. The existing turning circles at Damietta Port and Idku ELNG are sufficient.

Ideally all ships should be able to leave berth in emergencies without tug assistance. Berths should be orientated to allow ease of departure. Ship stopping distance may need to be 4 times ship length in ballast and 8 times ship length if loaded.

*4.1.5* *Dredging*

Capital dredging will be required for many of the options presently under consideration. Approach channel bottom width should be 3.6-6 times maximum beam width for single-lane channels (more for channels with curves), depending on sea and wind conditions. An approach channel bottom width of approximately 5 times the maximum beam width has been assumed with channel depth to -15m. The berth areas will be dredged to -14.5m.

No information on maintenance dredging requirements is available. It is assumed that dredged material can be dumped offshore near to the port locations. The effect of new berths/breakwaters and reclamation on coastal processes and siltation/maintenance dredging will need to be considered at a later stage.

# 5 Cost Estimates

## 5.1 *Basis of Cost Estimates*

Capital cost estimates have been prepared, including:

- Construction of a breakwater for various options;
- Dredging of turning circle, harbour basin, approach channel etc for various options;
- Construction of a urea loading platform and liquid loading platform;
- Construction of an approach trestle for various options;
- Construction of three berthing and four mooring dolphins where required;
- Tug purchase where necessary.
- Construction of a flood protection bund

The estimate is based on year 2004 prices, with rates taken from the following and other sources:

- Budget quotations obtained from contractors
- Prices of work items for recent contracts.

## 5.2 *Capital Cost Estimates*

Base case capital cost estimates have been prepared for the option layouts. The cost estimates are summarised below. The capital cost estimates include an allowance for preliminaries of 25% for berths, 20% for the breakwater and 12.5% for dredging. Further details are provided in Appendix C.

The table below summarises cost estimates for ALL Phases.

| | Option 1 | Option 2 | Option 3 | Option 4 |
|---|---|---|---|---|
| | Idku | Gamasah | Damietta Echem | Damietta Port |
| **Total Cost ($M US)** | 128.94 | 254.22 | 200.37 | 46.83 |

**Table 5-1:** Summary of Capital Cost Estimates for all Phases

Capital costs at the Port of Damietta will be $35.59M US for Phases 1 and 2 as the loading of urea/ ammonia and methanol will be shared on a single berth. Damietta Port costs (Phase 3) could be reduced by utilising the existing UGDC berth within the port. However, associated pipes and ancillaries would have to be considered.

A potential for further cost savings could be realised at Idku, Gamasah and Damietta Echem sites, if suitable dredge material could be pumped onshore to raise the ground level.

The summary of costs illustrates that the option 4 - Port of Damietta costs are significantly lower than the other options. This is largely due to no requirement to construct a new breakwater and lengthy jetty approach trestle.

## *5.3 Operating Costs*

### *5.3.1 Damietta Port Charges*

| Vessel Carrier Type | Annual Port Charges – Phase 1 | | | |
|---|---|---|---|---|
| | Size (mt) | Total ships/ year | Cost/ship | Cost |
| Ammonia | 23 500 | 6 | 9,009.25 | 54,055.50 |
| | 37 500 | 1 | 12,684.25 | 12,684.25 |
| **Total for Ammonia** | | | | **66,739.75** |
| Methanol | 5 000 | 10 | 4,153.00 | 41,530.00 |
| | 30 000 | 15 | 10,715.50 | 160,732.50 |
| | 48 000 | 17 | 15,440.50 | 262,488.50 |
| **Total for Methanol** | | | | **464,751.00** |
| Urea | 25 000 | 36 | 6,562.50 | 236,250.00 |
| | 30 000 | 8 | 10,715.50 | 85,724.00 |
| **Total for Urea** | | | | **321,974.00** |
| **TOTAL PORT CHARGES PER PHASE** | | | | **853,464.75** |

**Table 5-2:** Damietta Port: Annual Port Charges

The total annual port charges for Phase 3 are therefore US$2,560,394.25 at Damietta. This includes for maintenance dredging.

### *5.3.2 Other Port Location Operating Costs*

For Gamasah and the Damietta Echem site, port operating costs will be based on maintenance dredging costs and the cost of port operations (primarily tugs and pilots). For Idku, these port operating costs may potentially be shared with the

ELNG project. It would be prudent to allow US$1,000,000 for Gamasah and Damietta Echem and US$500,000 for Idku per annum, at this stage.

In addition, maintenance dredging would be required. At this stage, simple estimates have been made per site as follows – Idku 500,000m$^3$, Gamasah 1,500,000m$^3$ and Damietta Echem 1,000,000m$^3$ per annum at US$6.50/m3 plus US$1,000,000 mobilisation equates to Idku US$4,250,000 for Idku, US$10,750,000 for Gamasah and Damietta Echem US$7,500,000 per annum.

Maintenance costs for breakwater would be in the region of 2% and for the jetty/other structures 1.5% of capital costs per annum.

Land rental and other on-land costs have not been illustrated here.

## 5.4 *Conclusions*

A scoping study into the marine issues associated with export facilities for urea, ammonia and methanol has been undertaken. Four sites on Egypt's Mediterranean coast have been considered – Idku, Gamasah, Damietta Port and Damietta Echem sites. The following conclusions can be drawn:

- For Phases 1 and 2, a combined jetty for all products would be possible. For Phase 3, two berths would be required – one for urea and one for ammonia/methanol

- At Idku, a layout has been developed based on sharing the existing ELNG dredged channel, to reduce costs. Discussions would be required with ELNG to confirm that this is acceptable and associated costs

- At Gamasah, a new port facility would be required, with an approach trestle to deeper water and breakwater protection

- At Damietta Port, the berths can be located within the existing Port. The Port Authority and SEGAS would need to agree to the proposed berth layout. A major concern with this option is the high level of current and future traffic at the Port, which may lead to shipping delays

- At Damietta Echem site, a separate dredged channel to deep water would be required, sharing with Damietta Port would not be permitted

- Capital costs for marine works (all phases) including loading arms and other loading equipment are
    - Idku US$128.9 million
    - Gamasah US$254.2 million
    - Damietta Echem US$200.4 million
    - Damietta Port US$46.8 million
- Damietta Port Phase 1 costs are US$35.59 million
- Port operator/ maintenance costs are provided
- Shipping delay costs at Damietta Port are provided.

5.5 ***Recommendations***

The scoping study shows that two sites remain feasible – Idku and Damietta Port. Damietta Port appears to be favoured, due to the lower marine capital and operating costs, however the shipping delays may be unacceptable and require further investigation. The Gamasah and Damietta Echem sites are more expensive. If Damietta Port proves unattractive, then the Idku site could be progressed.

For the selected site, the following should be undertaken;

- data on the offshore wave conditions should be collected and confirmed
- a bathymetric survey including shoreline should be made to a water depth of approximately 17m
- historical data on the shoreline should be collated and assessed
- a shoreline evolution model should be undertaken to include Shore Protection Authority and National shoreline protection plans
- water levels must be assessed w.r.t Egyptian Survey Datum
- optimisation of marine structure designs
- site investigations (boreholes, CPTs) will be required to confirm ground conditions
- topographic survey to confirm site levels and position.

The concept layouts can then be further developed and accuracy of costs improved.

If Damietta Port is taken forward, a shipping simulation study with data collection on shipping behaviour at the port would help assess shipping delays. A navigation study would assist with DPA and SEGAS approval of the new berth layout.

For the Idku site, coastal process modelling (wave refraction, hydrodynamic and sediment transport) would allow optimisation of the breakwater position and capital and maintenance dredging requirements. A navigation study would allow optimisation of the berth positions. The onland position of the Echem site needs to be confirmed.

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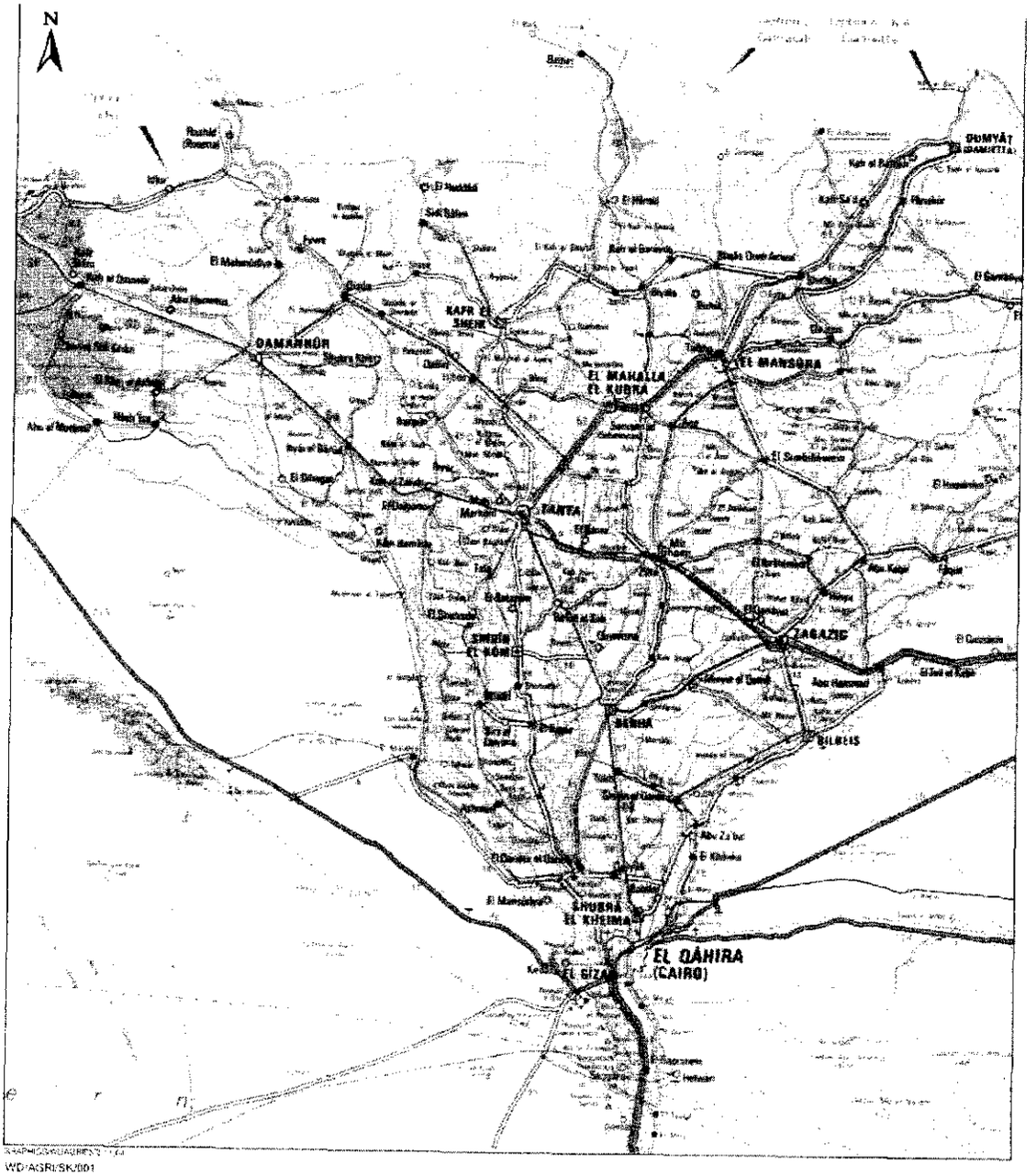
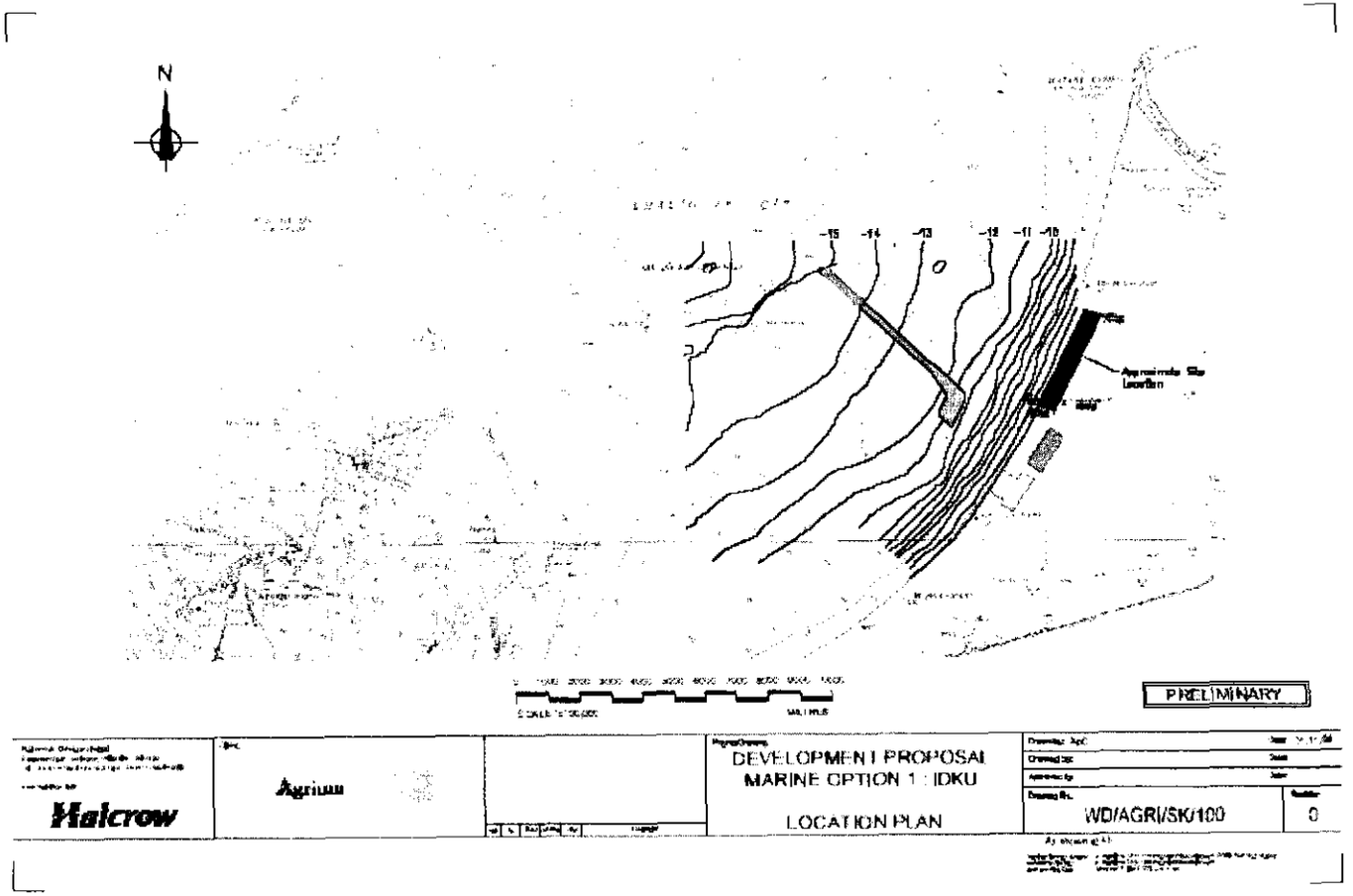
# A General Location




WD/AGR/SK/001

SITE OPTIONS - GENERAL LOCATIONS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-14
-13
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-11
-10
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Halcrow
Agrium
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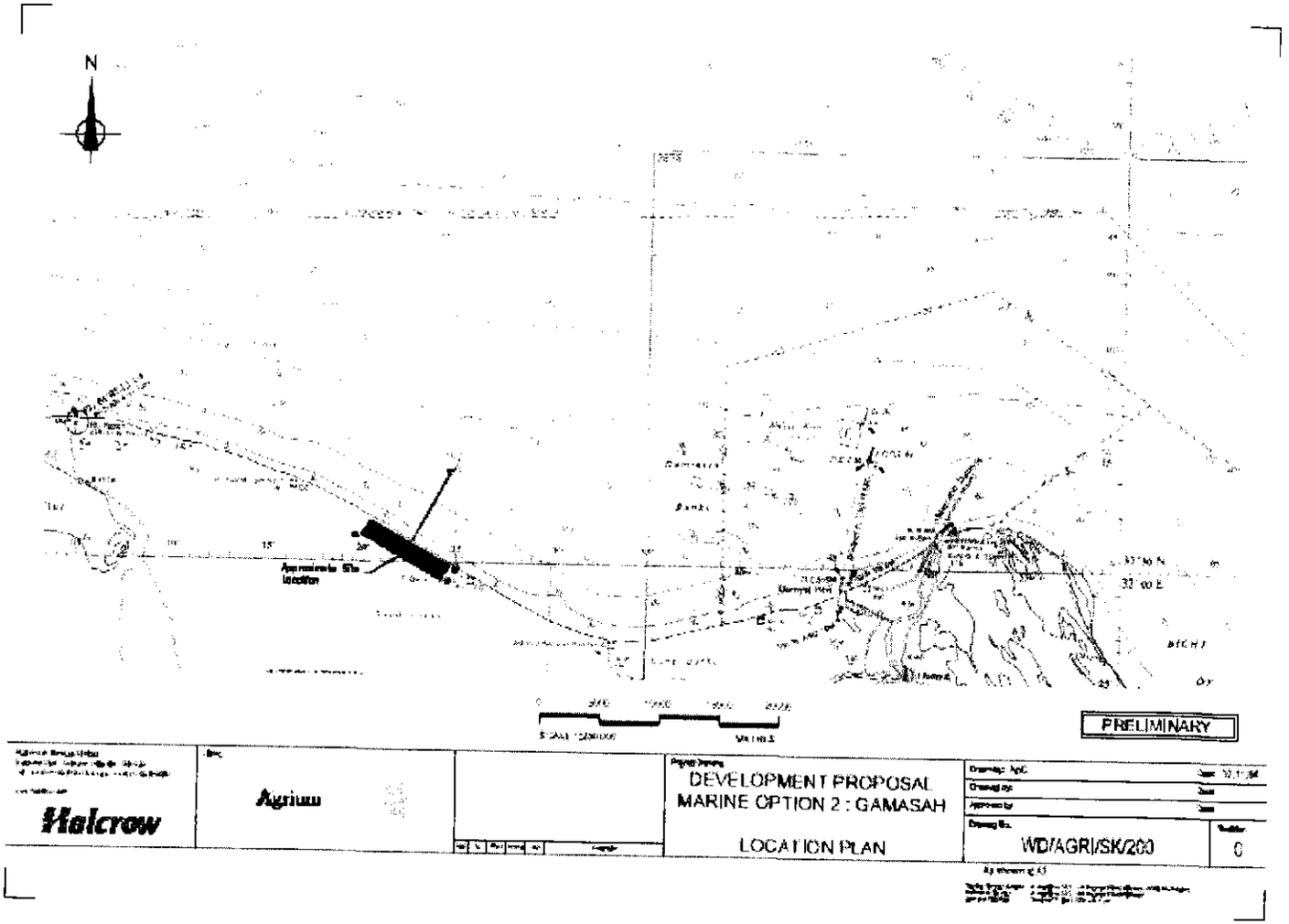
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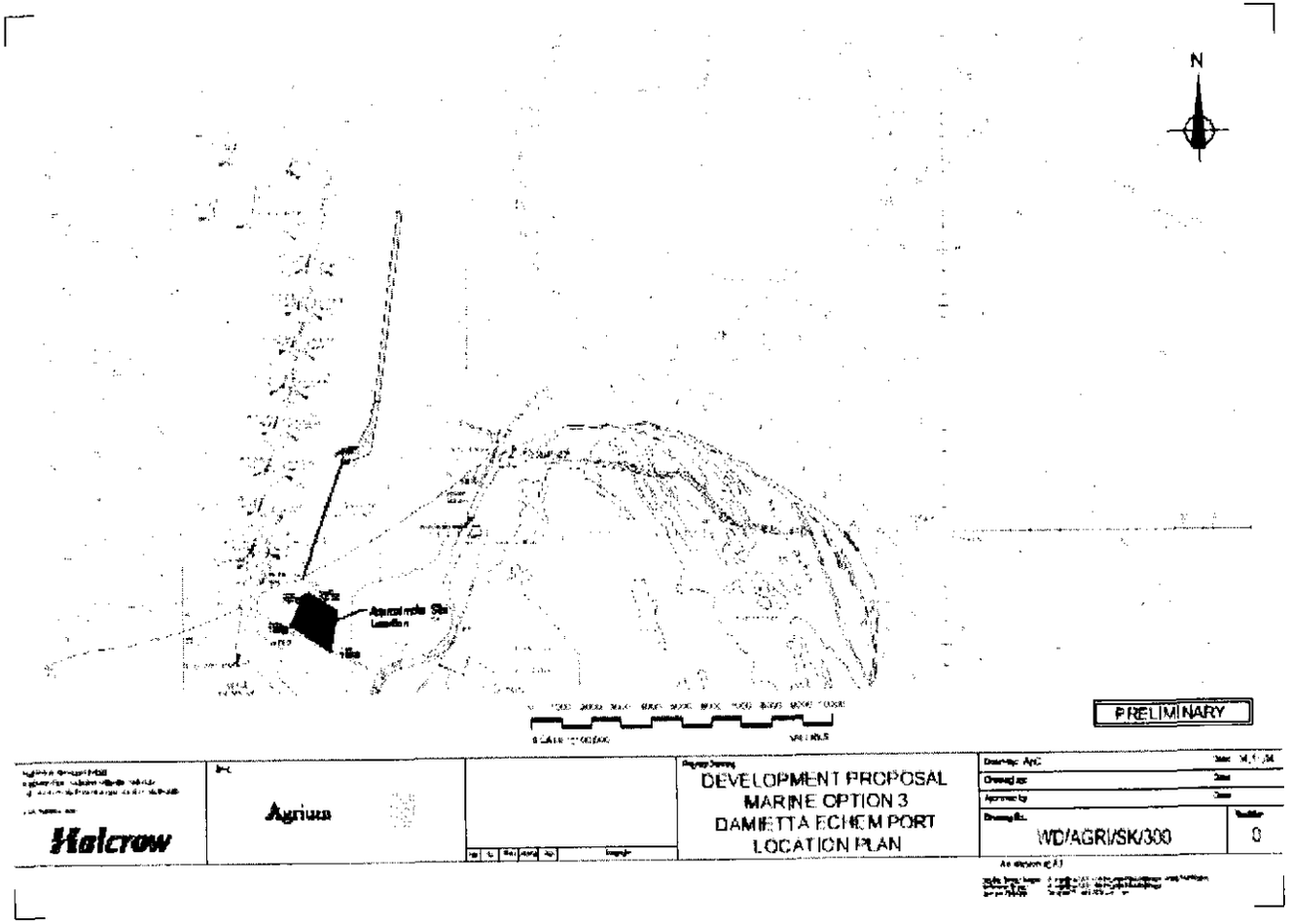
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MARINE OPTION 3
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LOCATION PLAN
WD/AGRI/SK/300
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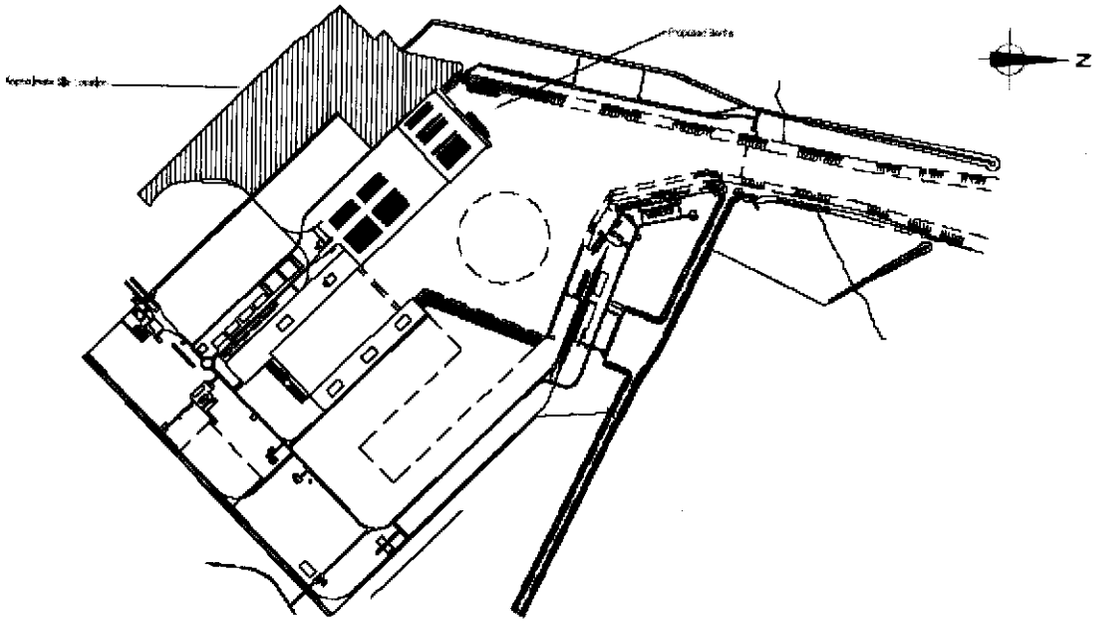
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PRELIMINARY
Halcrow
Agrium
DEVELOPMENT PROPOSAL
MARINE OPTION 4
DAMIETTA PORT
LOCATION PLAN
WD/AGRI/SK/400
0

## EGYPT N2 MARINE COST ESTIMATES - ALL PHASES

### Halcrow Scoping Study - November 2004

| Cost Summary - All Phases | | Idku | Gamasah | Damietta Echem | Damietta Port |
|---|---|---|---|---|---|
| Item | Item Description | Amount | Amount | Amount | Amount |
| 1.0 | Berth | | | | |
| *1.1* | *Loading Platform & Dolphins* | 19,534,500 | 19,534,500 | 19,534,500 | 19,534,500 |
| *1.2* | *Jetty Approach Trestle* | 38,937,500 | 126,936,250 | 76,317,500 | 1,869,000 |
| *1.3* | *Berth Ancillaries* | 6,971,440 | 6,971,440 | 6,971,440 | 6,971,440 |
| 2.0 | Breakwaters/ Revetments | 31,250,000 | 23,692,500 | 22,572,000 | 3,090,000 |
| 3.0 | Tug Provision | 0 | 15,000,000 | 15,000,000 | 0 |
| 4.0 | Dredging Works | 7,674,624 | 15,984,450 | 25,557,631 | 6,490,100 |
| 5.0 | Excavation Works | 0 | 0 | 0 | 355,640 |
| 6.0 | Flood Protection Mound | 1,000,000 | 1,000,000 | 1,000,000 | 0 |
| 7.0 | Contractor's Preliminaries and General Items | 23,570,188 | 45,097,104 | 33,414,964 | 8,522,998 |
| TOTAL FOR MARINE WORKS | | 128,938,252 | 254,216,244 | 200,368,034 | 46,833,678 |

## EGYPT N2 MARINE COST ESTIMATES - PHASE 1

### Halcrow Scoping Study - November 2004

| Cost Summary - Phase 1 | | Idku | Gamasah | Damietta Echem | Damietta Port |
|---|---|---|---|---|---|
| Item | Item Description | Amount | Amount | Amount | Amount |
| 1.0 | Marine Works - Berth | | | | |
| 1.1 | Loading Platform & Dolphins | 19,534,500 | 19,534,500 | 19,534,500 | 11,475,000 |
| 1.2 | Jetty Approach Trestle | 38,937,500 | 126,936,250 | 76,317,500 | 934,500 |
| 1.3 | Berth Ancillaries | 6,971,440 | 6,971,440 | 6,971,440 | 6,971,440 |
| 2.0 | Marine Works - Breakwaters/ Revetments | 31,250,000 | 23,692,500 | 22,572,000 | 3,090,000 |
| 3.0 | Service Tugs | 0 | 15,000,000 | 15,000,000 | 0 |
| 4.0 | Dredging Works | 7,674,624 | 15,984,450 | 25,557,631 | 6,490,100 |
| 5.0 | Excavation Works | 0 | 0 | 0 | 355,640 |
| 6.0 | Flood Protection Mound | 1,000,000 | 1,000,000 | 1,000,000 | 0 |
| 7.0 | Contractor's Preliminaries and General Items | 23,570,188 | 45,097,104 | 33,414,964 | 6,274,498 |
| TOTAL FOR MARINE WORKS | | 128,938,252 | 254,216,244 | 200,368,034 | 35,591,178 |

## APPENDIX 2 – HALCROW MARINE TERMINAL REPORT*

The marine terminal investigation report is primarily prepared by Halcrow Group Limited with input from KBR. Halcrow was subcontracted by Agrium Inc to undertake extended preliminary marine terminal studies on the proposed project sites.

The excerpt from the Halcrow Report included in this Appendix 2 is reproduced with the approval of Halcrow Group and Agrium Inc. The report reflects considerations valid in October 2004 which may change as the project evolves.

**Granherne Inc wishes to acknowledge Agrium U.S. Inc.'s and Halcrow Group Limited agreement to include sections of their Jetty Engineering Support Scoping Study in this Report*

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Halcrow Group Limited has prepared this report in accordance with the instructions of their client, Agrium, for their sole and specific use. Any other persons who use any information contained herein do so at their own risk.

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# Summary

Agrium has identified a need to develop a world scale fertilizer plant in Egypt. The plant will export urea and ammonia. The proposed facility may be shared with Methanex who have identified a need for a methanol export plant. Development of marine facilities may be in three phases to accommodate an anticipated increase in future shipping exports.

Four potential locations have been identified on Egypt's Mediterranean coast - three Greenfield sites at Idku, Gamasah, Damietta Echem and one Brownfield site at Damietta Port.

The scoping study shows that two sites remain feasible – Idku and Damietta Port. Damietta Port appears to be favoured, due to the lower marine capital and operating costs, however the shipping delays may be unacceptable and require further investigation. The Gamasah and Damietta Echem sites are more expensive. If Damietta Port proves unattractive, then the Idku site could be progressed.

Further, the following conclusions can be drawn:

- For Phases 1 and 2, a combined jetty for all products would be possible. For Phase 3, two berths would be required – one for urea and one for ammonia/methanol
- At Idku, a layout has been developed based on sharing the existing ELNG dredged channel, to reduce costs. Discussions would be required with ELNG to confirm that this is acceptable and associated costs
- At Gamasah, a new port facility would be required, with an approach trestle to deeper water and breakwater protection
- At Damietta Port, the berths can be located within the existing Port. The Port Authority and SEGAS would need to agree to the proposed berth layout. A major concern with this option is the high level of current and future traffic at the Port, which may lead to shipping delays
- At Damietta Echem site, a separate dredged channel to deep water would be required, sharing with Damietta Port would not be permitted
- Capital costs for marine works (all phases) are
    - Idku US$128.9 million
    - Gamasah US$254.2 million
    - Damietta Echem US$200.4 million
    - Damietta Port US$46.8 million
- Damietta Port Phase 1 costs are US$35.59 million

- Port operator/ maintenance costs are provided
- Shipping delay costs at Damietta Port are provided.

It is recommended that for the selected site, the following should be undertaken:

- data on the offshore wave conditions should be collected and confirmed
- a bathymetric survey including shoreline should be made to a water depth of approximately 17m
- historical data on the shoreline should be collated and assessed
- a shoreline evolution model should be undertaken to include Shore Protection Authority and National shoreline protection plans
- water levels must be assessed w.r.t Egyptian Survey Datum
- optimisation of marine structure designs
- site investigations (boreholes, CPTs) will be required to confirm ground conditions
- topographic survey to confirm site levels and position.

The concept layouts can then be further developed and accuracy of costs improved.

If Damietta Port is taken forward, a shipping simulation study with data collection on shipping behaviour at the port would help assess shipping delays. A navigation study would assist with DPA and SEGAS approval of the new berth layout.

For the Idku site, coastal process modelling (wave refraction, hydrodynamic and sediment transport) would allow optimisation of the breakwater position and capital and maintenance dredging requirements. A navigation study would allow optimisation of the berth positions. The on land position of the Echem site needs to be confirmed.

# Introduction

*1.1* ***Introduction***

Agrium has identified a need to develop a world scale fertilizer plant in Egypt. The plant will export urea and ammonia and will therefore include a low cost and low risk ship loading facility in close proximity to the plant site for their export. At the same time, Methanex wish to develop a methanol export plant in Egypt. Agrium and Methanex are seeking to share port facilities, if possible. Both companies will collaborate with Echem. KBR is undertaking a study of potential ammonia/ urea/ methanol sites in Egypt, for the US Trade and Development Agency (USTDA) /Echem.

Four potential locations have been identified on Egypt's Mediterranean coast - three Greenfield sites at Idku, Gamasah, Damietta Echem and one Brownfield site at Damietta Port. Future provision for a second and third phase of marine facility expansion is also considered.

On-land process plant costs are likely to be similar for each site, with the capital and operating cost differentiators being marine facilities (berths, dredging, breakwaters, tugs), site preparation (clearance, filling), cooling water requirements, piping/conveyor lengths and land rental/port charges.

Agrium has appointed Halcrow to undertake a scoping study for the jetty engineering aspects of the development. This report presents a review of existing environment data, concept layouts; shipping assumptions and ship loading requirements; design recommendations and outline cost estimates for the marine facilities.

Cooling water requirements, site preparation costs and piping/conveyor lengths and costs are being addressed by KBR and land rental by Agrium/Methanex/Echem. KBR is being assisted by KOMEX on environmental issues and by ECMA on coastal issues including: calculation of water level variation; recommendation for land fill; conceptual design and cost estimate for the flood protection bund; coastal processes and a summary of permits.

The purpose of this report is to consider, for the most part, the marine implications of the development and to recommend the most favourable options to provide a basis for site selection and the development of future project stages.

*1.2* ***Site Locations***

Locations of the three proposed sites are shown in Figures (1.a), (1.b) and (1.c) for Damietta, Idku and Gamasah, respectively. The coordinates for each location is summarized in the following table

Coordinates of the Proposed Locations

| Location | Latitude | Longitude |
|---|---|---|
| **Idku** | 31° 23' 00"N | 30° 20' 10"E |
| **Gamasah** | 31° 32' 30"N | 31° 20' 00"E |
| **Damietta** | 31° 29' 10"N | 31° 46' 10"E |

**Table 0-1:** Approximate co-ordinates of site locations

- **Idku**: located on the coastline in Abu-Qir Bay approximately 9 km. west of Rosetta Nile branch outlet, 200km west of Port Said and 45east of Alexandria. The site is adjacent to the British Gas LNG project in Abu Qir Bay
- **Gamasah**: located on the coastline approximately 75km west of Port Said
- **Damietta Echem** site: located on the coastline approximately 1km east of the port at Damietta
- **Damietta Port** : located within the port at Damietta, some 50km west of Port Said. The site is on the west side of the dredged channel between the Union Fenosa/SEGAS LNG site and the container terminal.

A general location map of all the sites is presented in Appendix A.

# 2 Review of Existing Environment Data

## 2.1 *Introduction*

This section of the report lists the data gathered during the scoping study, by Halcrow and ECMA. The review included any data relevant to the project sites and also data collected from other sites along Egypt's northern coastline, which may have relevance to the project.

### 2.1.1 *Bathymetric Data – All sites*

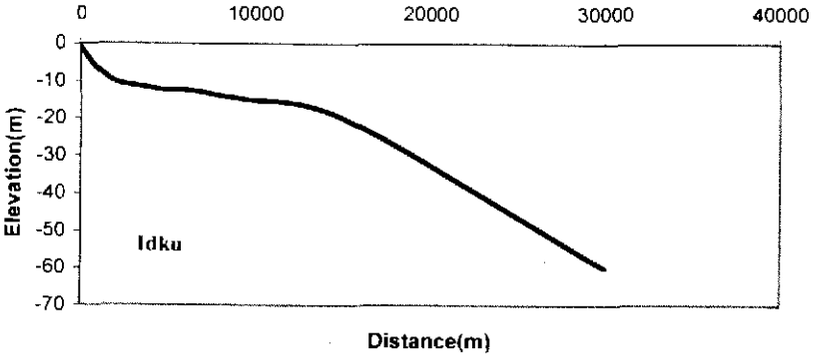
The table below summarises the distance from the coastline to bathymetric contours at each of the proposed sites. These distances are based on British Admiralty charts for the Egyptian North Coast.

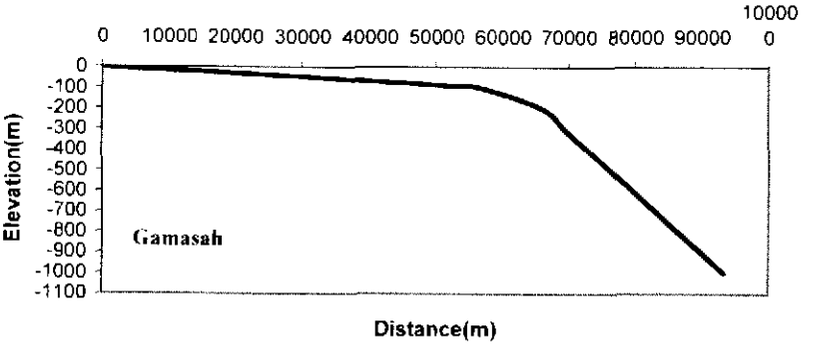
| SITE | APPROX. DISTANCE IN METERS TO DEPTH CONTOURS (m) (According to current British Admiralty Charts) | | | | NOTES[1] |
|---|---|---|---|---|---|
| | Depth 5m | Depth 10m | Depth 14m | Depth 15m | |
| **Idku** | 500 | 1800 | 6400 | 8400 | ELNG constructed a 2400m trestle jetty to the 11 m contour (surveyed) and a further 4000 m dredged channel to the 14 m contour **(6400m total).** |
| **Gamasah** | 1200 | 4000 | 13000 | 14500 | |
| **Damietta Echem and Port Sites** | 850 | 2500 | 8000 | 11300 | The Port Basin is maintained at 14.5m. The access navigation channel is maintained at 15.0 m and extends **11300m** from port entrance. |

**Table 2-1:** Approx. distance from coast to depth contours

*Notes.*
1. *Source: KBR.*

Shore profiles in the following figure are extracted from Admiralty Chart number 2681 for Idku and Admiralty Chart number 2574 for Gamasah and Damietta. The profiles are shown in the following Figures for the three locations, respectively. In absence of local survey w.r.t Egyptian Survey Datum, calculations in this report shall be based on the Admiralty Chart datum which is the ACD = 0.0.



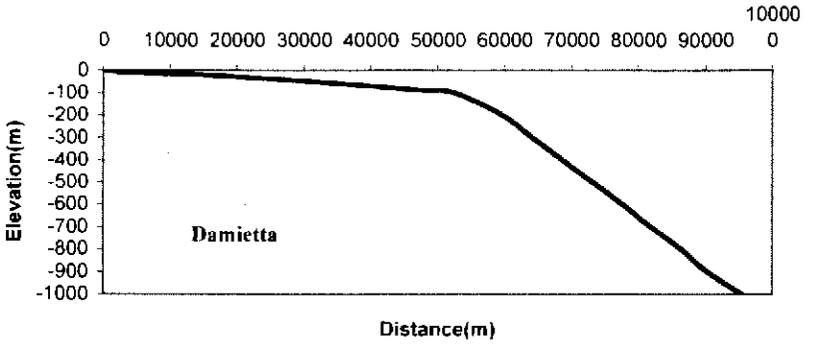



**Figure 2-1:** Shore profile for the three locations used in the calculation of the wave set-up as extracted from the Admiralty Charts

2.1.2 *Wind Data*

Wind frequency data for Alexandria for the period 1983 to 1999 has previously been obtained and indicates that there is a very dominant prevailing north-westerly wind throughout the year with a frequency of occurrence of 25.8% for the direction 320 degrees to 340 degrees.

Wind data (Dar Al-Handasah, 2000) included wind statistics off the coast of Alexandria for the period 1856 to 1997, obtained from Met Office, UK. The data was analysed and indicated that the prevailing wind direction is north-west with frequency of occurrence of 28.9%. For directions west and north, the frequencies of occurrence are 21.2% and 15.3% respectively. Extreme wind speeds for different return periods resulting from the analysis of these three directions are shown in Table 2-2: Extreme wind speeds (knots).

| Wind Direction | Return Period (years) | | |
|---|---|---|---|
| | 1 | 10 | 100 |
| North West | 42 | 48 | 53 |
| West | 44 | 50 | 56 |
| North | 27 | 42.5 | 47 |

**Table 2-2:** Extreme wind speeds (knots)

The above wind is useful and considered reasonably representative of Damietta.

Table below provides a summary for the extreme wind speeds in the vicinity of the project site near Rosetta and may be considered representative for all three sites. For wind setup calculations, a wind speed of 20.0 m/s (about 40 knots) is considered to represent the 100 Year condition, Radi (1998).

| Direction with North | 100 Year Return Period |
|---|---|
| 270 | 20 |
| 300 | 20 |
| 330 | 19 |
| 0 | 14.5 |
| 30 | 14 |
| 60 | 15 |

**Table 2-3:** Extreme hourly averaged wind speeds (m/s)

*2.1.3* *Wave Data*

Data from the CoRI (August 2000) has been collected for the years between 1971 and 1999, using a number of different measurement systems. A summary of the extreme analysis results is shown in the table below.

| Return period (years) | Significant wave height (m) | Wave period (secs) |
|---|---|---|
| **1** | 2.9 | 5.6 |
| **2** | 3.4 | 5.9 |
| **5** | 4.1 | 6.5 |
| **10** | 4.5 | 6.8 |
| **25** | 5.2 | 7.3 |
| **50** | 5.6 | 7.6 |
| **100** | 6.1 | 7.9 |

**Table 2-4:** Extreme offshore wave conditions – Damietta area

The direction of the majority of the waves come from the WNW and NE sectors while the waves greater than 2.0m come from the N and the NNE sector. Digital data was not available, unfortunately.

Data from the KMNI (1998) relates to statistics concerning swells in the area. These statistics were based on observations of chosen ships in the quadrilateral delimited by the meridians 27E – 30E and the parallels 32N-33N. This observation zone is situated to the west of Port-Said meridian and the statistics obtained here give an accurate picture of the swells out at the sea between Port-Said and Damietta. The observation period is from 1961 to 1967.

The results of the analysis of the observations show that the prevailing wave period varies between 3.0 and 7.0 seconds and prevailing deep water wave direction varies between west northwest (WNW) and north northwest (NNW), and the most frequent wave heights range from 1.00 to 1.5 metres.

### 2.2 *Land Fill*

#### 2.2.1 *Maximum Plant Levels*

Based on the assessed soil conditions, it is concluded that the plant (at any of the three locations) must be elevated by land fill. The plant level is recommended to be at +2.00 m (ACD) by adding a value of 0.15 to 0.20 m above the static level as a factor of safety. Please note that this study does not take into consideration the type of soil in each area or the type of foundations used, settlements could be a factor in future land subsidence and this is an area specific.

## 3 Shipping Data

### 3.1 *General*

The shipping facility is to be a calm water facility capable of loading ammonia, urea, and possibly methanol. It is assumed that a dedicated berth will be required for a urea ship loader and a second berth will, if required, be shared for the ammonia and methanol load-out facilities. Methanex is separately considering loading methanol via a single point mooring system.

Typical specific gravities of liquid gases at proposed maritime carriage conditions are 0.683t/m$^3$ for liquid ammonia and 0.792t/m$^3$ for liquid methanol. Urea is exported in white granular form with a bulk density of 0.745t/m$^3$.

### 3.2 *Berth occupancy*

It is necessary first to ascertain the number of berths needed in order to keep ship waiting time down to an economic level. The initial assumption is one berth for urea and one liquids berth for both ammonia and methanol. Based on the ship sizes and loading rates, port time per ship type was calculated.

| Vessel Carrier Type | Vessel Port Time | | | |
|---|---|---|---|---|
| | Size (mt) | Fill time (hrs) | Docking (hrs) | Total |
| Ammonia | 15 000 | 20 | 12 | 32 |
| | 23 500 | 31 | 12 | 33 |
| | 43 350 | 58 | 12 | 70 |
| Methanol | 5 000 | 2 | 10 | 12 |
| | 30 000 | 11 | 10 | 21 |
| | 48 000 | 18 | 10 | 28 |
| Urea | 25 000 | 29 | 10 | 39 |
| | 30 000 | 35 | 10 | 45 |
| | 45 000 | 53 | 10 | 63 |

**Table 3-1:** Vessel Port Times

Finally, the annual port time per berth was determined.

| Vessel Carrier Type | Annual Port Time – Phase 1 | | | |
|---|---|---|---|---|
| | Size (mt) | Total vessels/ year | Hours/year | Days/year |
| Ammonia | 23 500 | 6 | 198 | 8.3 |
| | 43 350 | 1 | 70 | 2.9 |
| Methanol | 5 000 | 10 | 120 | 5.0 |
| | 30 000 | 15 | 315 | 13.1 |
| | 48 000 | 17 | 476 | 19.8 |
| **Total for Liquids Berth** | | | | **49.1** |
| Urea | 25 000 | 36 | 1404 | 58.5 |
| | 30 000 | 8 | 360 | 15.0 |
| **Total for Urea Berth** | | | | **73.5** |

**Table 3-2:** Annual Port Times

From the Egypt N2 project preliminary design information and assumed loading rates and throughput, annual berth usage times are as follows:

- Ammonia/ Methanol Berth 49.1 days/ year (49 ships)
- Urea Berth 73.5 days/ year (44 ships)

This gives berth occupancy rates of 13.5% and 20.1% for the liquid and urea berths respectively, for Phase 1. By completion of Phase 3, single berth occupancy would increase to 40% (147.3 days) and 60% (220.5 days) respectively. The ammonia/ methanol berth percentages are acceptable. Urea berth utilisation could be reduced with provision of a higher ship unloading capacity in future phases. These percentages would then become acceptable allowing for ship scheduling and downtime (berth repairs, product non-availability, high wind etc). Typical recommended maximum berth occupancy is 60%, for multi-user berths, with higher values possible for dedicated facilities with regular shipping schedules.

During Phase 1 and 2, a shared berth for all products would be possible. This would require the liquid loading arms to be located underneath the urea loader crane. This option will be considered for Phases 1 and 2 only. There would be some additional equipment costs in changing liquid loading to a separate berth in Phase 3.

# 4 Marine Concept Designs

## 4.1 *Marine Planning Principles*

This section describes the planning of new berth layout(s). The aspects described below include berth layout, vessel draft, port traffic, marine access and dredging.

### 4.1.1 *Berth Layout*

For the berth/ marine facilities layout, consideration has been given to overall dimensions. The berth layouts were arrived at using the following guidelines and requirements.

(a) Vessel Size – A number of vessel sizes per product have heen considered initially. These are described in section 3.

(b) Jetty Position – The following factors were taken into account:

- Safety distance: The loading arm / manifold should ideally be as far as reasonably possible from the edge of any port entrance channel, as a safety requirement.
- The length & beam of the design vessel
- Tug requirements. Manoeuvring distance between the stern of tbe vessel and the end of any basin and between any berths.
- Separation of berths. Based on two times vessel beam plus 30m tug manoeuvring allowance.
- Berth orientation. Approximately parallel to prevailing wind direction.
- The distance of the berthing jetty from land/breakwater. This takes into account the total depth from bottom of the dredged basin to top of breakwater and the dredged/breakwater slope;

(c) Wave Protection – Provision of shelter at berth by means of breakwater. Due to the short timeframe, it was not possible to undertake numerical modelling of wave transformation from offshore to berth, taking into account wave refraction and diffraction. Normal practice would be to ensure significant wave heights at the berth were less than 1m for up to 30,000 DWT vessels, and 1.5m for 60,000 DWT vessels, to minimise downtime.

4.1.2 *Vessel Draft*

The vessel size and its draft will be a major factor in determining the dredge depth required. It is considered acceptable and prudent to retain an under keel clearance of 2m for the approach channel and turning circle and 1.5m at the proposed berths. This gives the dredged depth requirement at the berth with higher values being required in exposed approaches, to allow for wave effects.

4.1.3 *Port Traffic*

In evaluating the berth locations, it will be necessary to consider the number of vessel movements, with regard to safety of navigation and potential delays. For existing ports such as Damietta, information would be needed on navigation rules and traffic levels at the proposed locations.

4.1.4 *Marine Access*

Deep water for marine access should ideally be close to shore. A berth will require a turning circle of minimum two times ship length (assuming tugs or bow thrusters). A turning circle of 450m diameter has been assumed on the new sites at Gamasah and Damietta Echem. The existing turning circles at Damietta Port and Idku ELNG are sufficient.

Ideally all ships should be able to leave berth in emergencies without tug assistance. Berths should be orientated to allow ease of departure. Ship stopping distance may need to be 4 times ship length in ballast and 8 times ship length if loaded.

4.1.5 *Dredging*

Capital dredging will be required for many of the options presently under consideration. Approach channel bottom width should be 3.6-6 times maximum beam width for single-lane channels (more for channels with curves), depending on sea and wind conditions. An approach channel bottom width of approximately 5 times the maximum beam width has been assumed with channel depth to -15m. The berth areas will be dredged to -14.5m.

No information on maintenance dredging requirements is available. It is assumed that dredged material can be dumped offshore near to the port locations. The effect of new berths/breakwaters and reclamation on coastal processes and siltation/maintenance dredging will need to be considered at a later stage.

# 5 Cost Estimates

## 5.1 *Basis of Cost Estimates*

Capital cost estimates have been prepared, including:

- Construction of a breakwater for various options;
- Dredging of turning circle, harbour basin, approach channel etc for various options;
- Construction of a urea loading platform and liquid loading platform;
- Construction of an approach trestle for various options;
- Construction of three berthing and four mooring dolphins where required;
- Tug purchase where necessary.
- Construction of a flood protection bund

The estimate is based on year 2004 prices, with rates taken from the following and other sources:

- Budget quotations obtained from contractors
- Prices of work items for recent contracts.

## 5.2 *Capital Cost Estimates*

Base case capital cost estimates have been prepared for the option layouts. The cost estimates are summarised below. The capital cost estimates include an allowance for preliminaries of 25% for berths, 20% for the breakwater and 12.5% for dredging. Further details are provided in Appendix C.

The table below summarises cost estimates for ALL Phases.

| | Option 1 | Option 2 | Option 3 | Option 4 |
|---|---|---|---|---|
| | Idku | Gamasah | Damietta Echem | Damietta Port |
| **Total Cost ($M US)** | 128.94 | 254.22 | 200.37 | 46.83 |

**Table 5-1:** Summary of Capital Cost Estimates for all Phases

Capital costs at the Port of Damietta will be $35.59M US for Phases 1 and 2 as the loading of urea/ ammonia and methanol will be shared on a single berth. Damietta Port costs (Phase 3) could be reduced by utilising the existing UGDC berth within the port. However, associated pipes and ancillaries would have to be considered.

A potential for further cost savings could be realised at Idku, Gamasah and Damietta Echem sites, if suitable dredge material could be pumped onshore to raise the ground level.

The summary of costs illustrates that the option 4 - Port of Damietta costs are significantly lower than the other options. This is largely due to no requirement to construct a new breakwater and lengthy jetty approach trestle.

## *5.3 Operating Costs*

### *5.3.1 Damietta Port Charges*

| Vessel Carrier Type | Annual Port Charges – Phase 1 | | | |
|---|---|---|---|---|
| | Size (mt) | Total ships/ year | Cost/ship | Cost |
| **Ammonia** | 23 500 | 6 | 9,009.25 | 54,055.50 |
| | 37 500 | 1 | 12,684.25 | 12,684.25 |
| **Total for Ammonia** | | | | **66,739.75** |
| **Methanol** | 5 000 | 10 | 4,153.00 | 41,530.00 |
| | 30 000 | 15 | 10,715.50 | 160,732.50 |
| | 48 000 | 17 | 15,440.50 | 262,488.50 |
| **Total for Methanol** | | | | **464,751.00** |
| **Urea** | 25 000 | 36 | 6,562.50 | 236,250.00 |
| | 30 000 | 8 | 10,715.50 | 85,724.00 |
| **Total for Urea** | | | | **321,974.00** |
| **TOTAL PORT CHARGES PER PHASE** | | | | **853,464.75** |

**Table 5-2:** Damietta Port: Annual Port Charges

The total annual port charges for Phase 3 are therefore US$2,560,394.25 at Damietta. This includes for maintenance dredging.

### *5.3.2 Other Port Location Operating Costs*

For Gamasah and the Damietta Echem site, port operating costs will he based on maintenance dredging costs and the cost of port operations (primarily tugs and pilots). For Idku, these port operating costs may potentially be shared with the

ELNG project. It would be prudent to allow US$1,000,000 for Gamasah and Damietta Echem and US$500,000 for Idku per annum, at this stage.

In addition, maintenance dredging would be required. At this stage, simple estimates have been made per site as follows – Idku 500,000$m^3$, Gamasah 1,500,000$m^3$ and Damietta Echem 1,000,000$m^3$ per annum at US$6.50/m3 plus US$1,000,000 mobilisation equates to Idku US$4,250,000 for Idku, US$10,750,000 for Gamasah and Damietta Echem US$7,500,000 per annum.

Maintenance costs for breakwater would be in the region of 2% and for the jetty/other structures 1.5% of capital costs per annum.

Land rental and other on-land costs have not been illustrated here.

## 5.4 *Conclusions*

A scoping study into the marine issues associated with export facilities for urea, ammonia and methanol has been undertaken. Four sites on Egypt's Mediterranean coast have been considered – Idku, Gamasah, Damietta Port and Damietta Echem sites. The following conclusions can be drawn:

- For Phases 1 and 2, a combined jetty for all products would be possible. For Phase 3, two berths would be required – one for urea and one for ammonia/methanol

- At Idku, a layout has been developed based on sharing the existing ELNG dredged channel, to reduce costs. Discussions would be required with ELNG to confirm that this is acceptable and associated costs

- At Gamasah, a new port facility would be required, with an approach trestle to deeper water and breakwater protection

- At Damietta Port, the berths can be located within the existing Port. The Port Authority and SEGAS would need to agree to the proposed berth layout. A major concern with this option is the high level of current and future traffic at the Port, which may lead to shipping delays

- At Damietta Echem site, a separate dredged channel to deep water would be required, sharing with Damietta Port would not be permitted

- Capital costs for marine works (all phases) including loading arms and other loading equipment are
    - Idku US$128.9 million
    - Gamasah US$254.2 million
    - Damietta Echem US$200.4 million
    - Damietta Port US$46.8 million
- Damietta Port Phase 1 costs are US$35.59 million
- Port operator/ maintenance costs are provided
- Shipping delay costs at Damietta Port are provided.

## 5.5 *Recommendations*

The scoping study shows that two sites remain feasible – Idku and Damietta Port. Damietta Port appears to be favoured, due to the lower marine capital and operating costs, however the shipping delays may be unacceptable and require further investigation. The Gamasah and Damietta Echem sites are more expensive. If Damietta Port proves unattractive, then the Idku site could be progressed.

For the selected site, the following should be undertaken;

- data on the offshore wave conditions should be collected and confirmed
- a bathymetric survey including shoreline should be made to a water depth of approximately 17m
- historical data on the shoreline should be collated and assessed
- a shoreline evolution model should be undertaken to include Shore Protection Authority and National shoreline protection plans
- water levels must be assessed w.r.t Egyptian Survey Datum
- optimisation of marine structure designs
- site investigations (boreholes, CPTs) will be required to confirm ground conditions
- topographic survey to confirm site levels and position.

The concept layouts can then be further developed and accuracy of costs improved.

If Damietta Port is taken forward, a shipping simulation study with data collection on shipping behaviour at the port would help assess shipping delays. A navigation study would assist with DPA and SEGAS approval of the new berth layout.

For the Idku site, coastal process modelling (wave refraction, hydrodynamic and sediment transport) would allow optimisation of the breakwater position and capital and maintenance dredging requirements. A navigation study would allow optimisation of the berth positions. The onland position of the Echem site needs to be confirmed.

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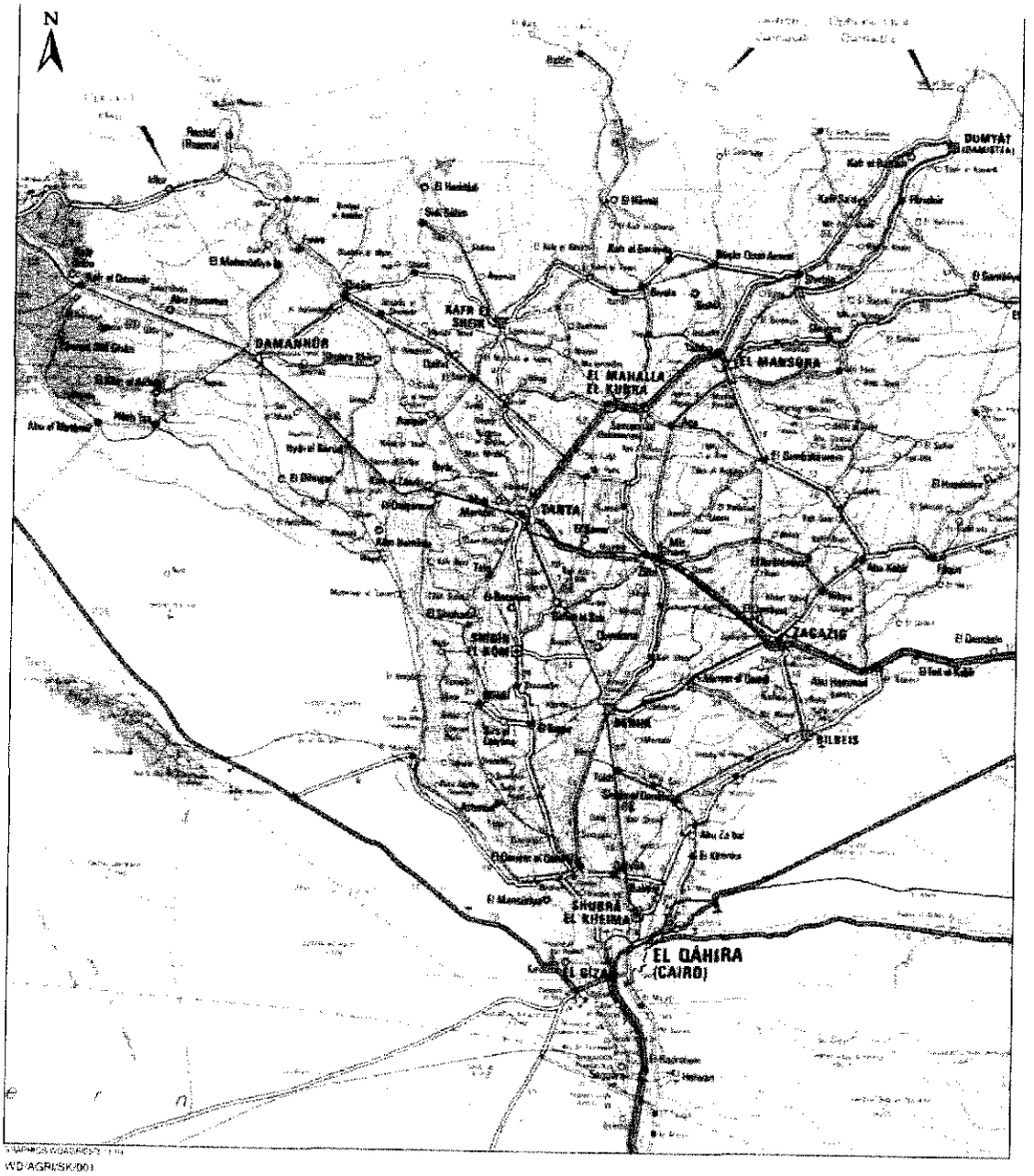
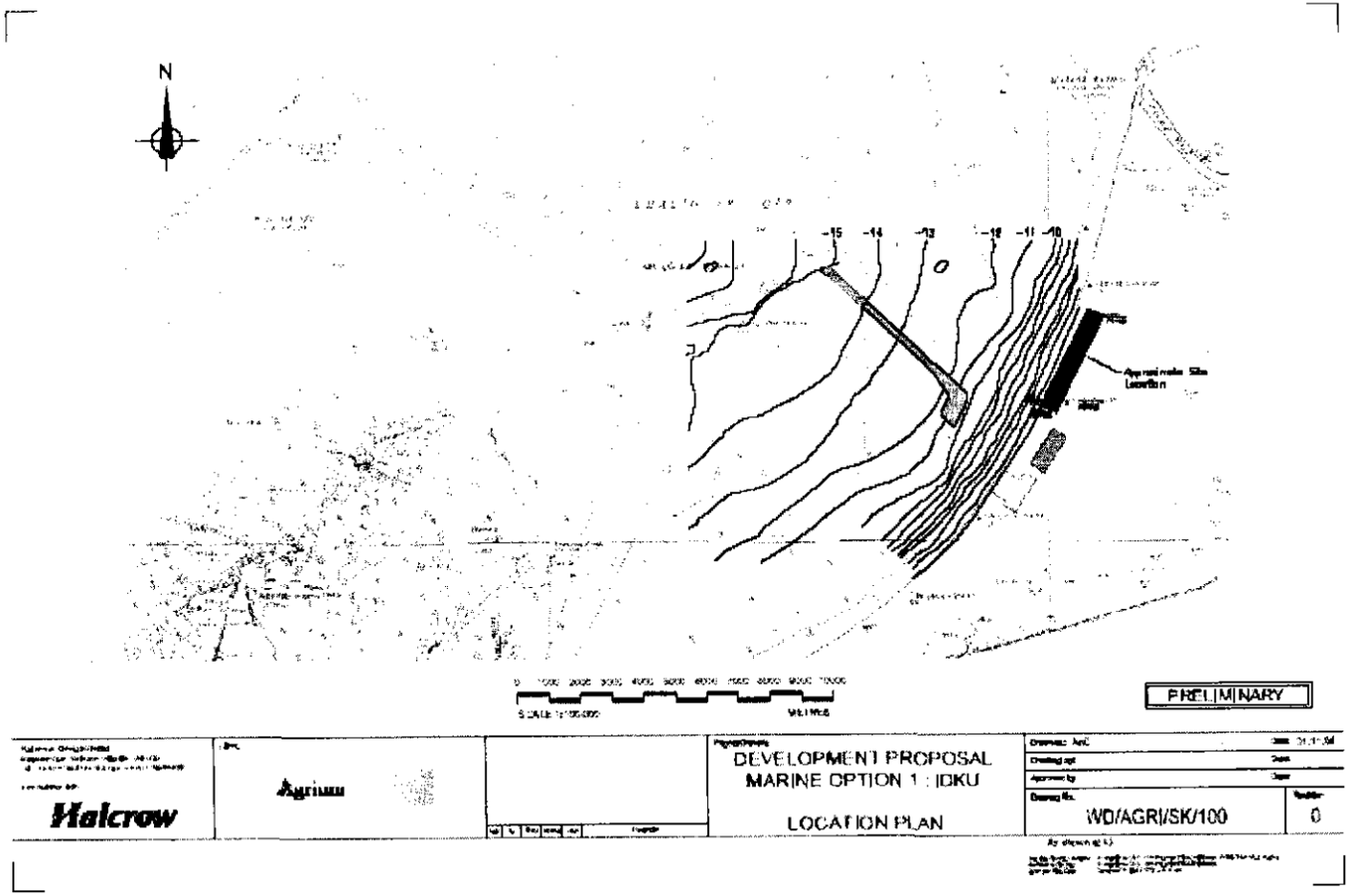
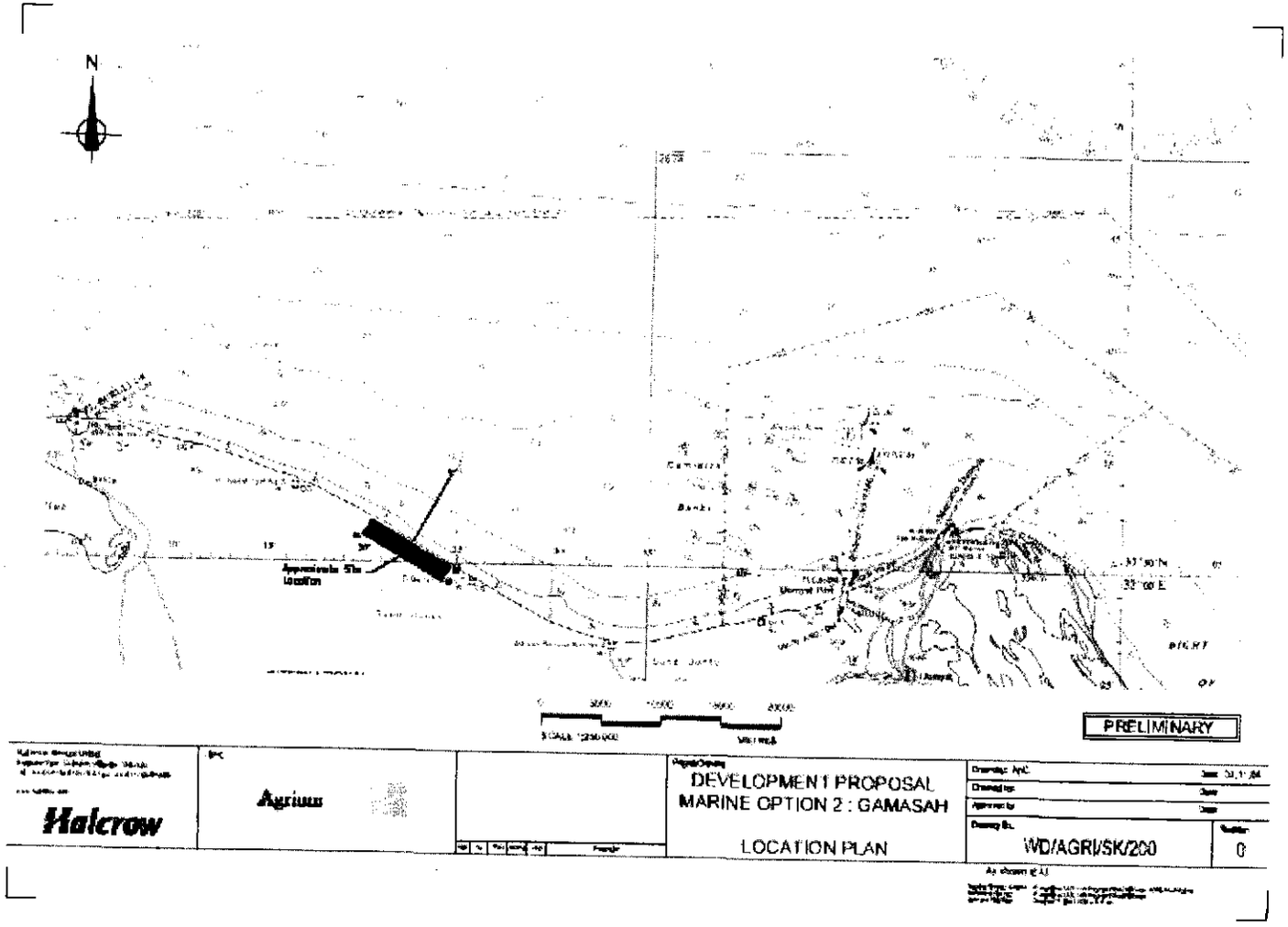
# A General Location




WD/AGR/SK-003

SITE OPTIONS - GENERAL LOCATIONS


N
-15
-14
-13
-12
-11
-10
PRELIMINARY
Halcrow
Agrium
DEVELOPMENT PROPOSAL
MARINE OPTION 1 : IDKU
LOCATION PLAN
WD/AGRI/SK/100
0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PRELIMINARY
Halcrow
Agrium
DEVELOPMENT PROPOSAL
MARINE OPTION 2 : GAMASAH
LOCATION PLAN
WD/AGRI/SK/200
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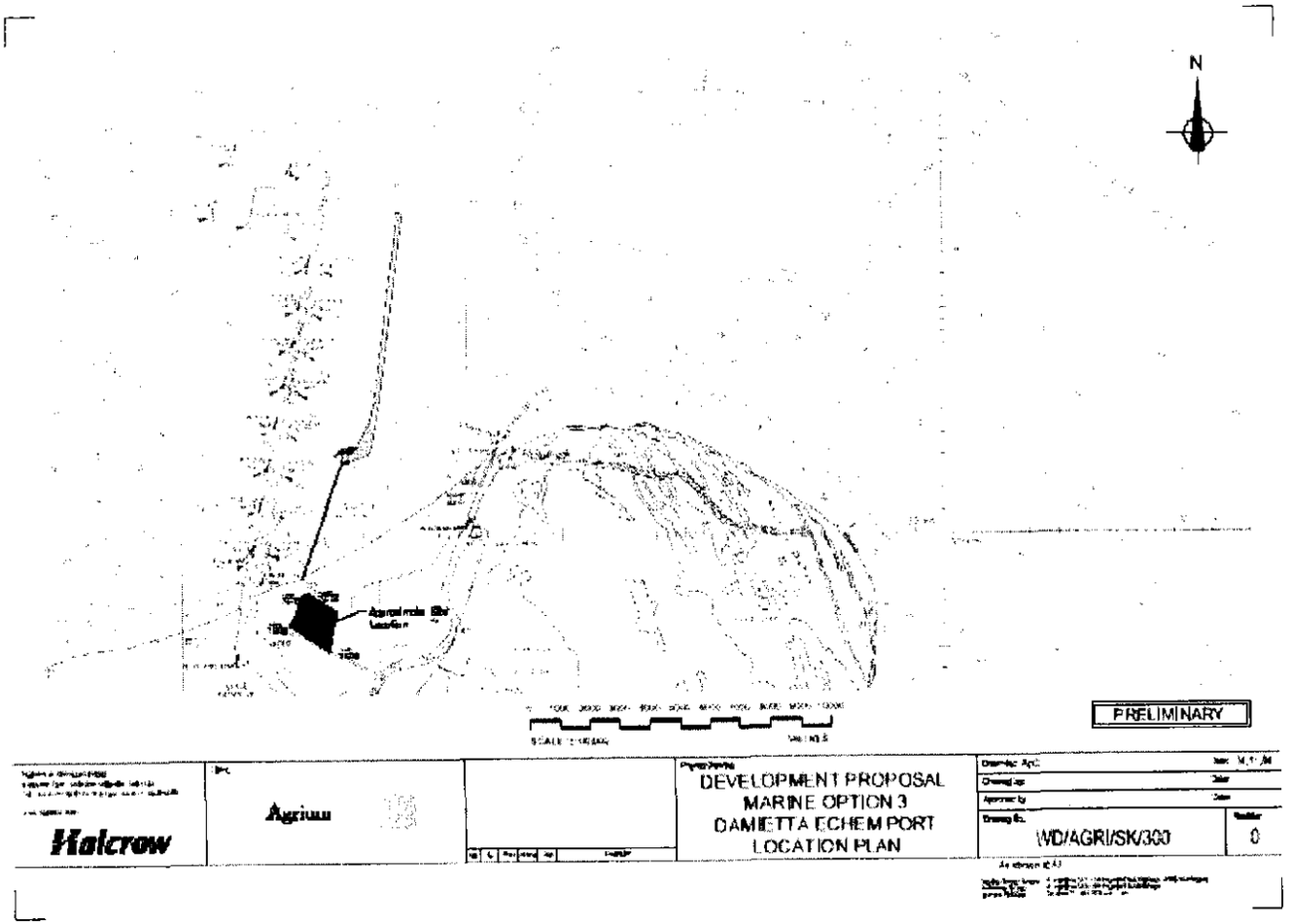
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PRELIMINARY
Halcrow
Agrium
DEVELOPMENT PROPOSAL
MARINE OPTION 3
DAMIETTA ECHEM PORT
LOCATION PLAN
WD/AGRI/SK/300
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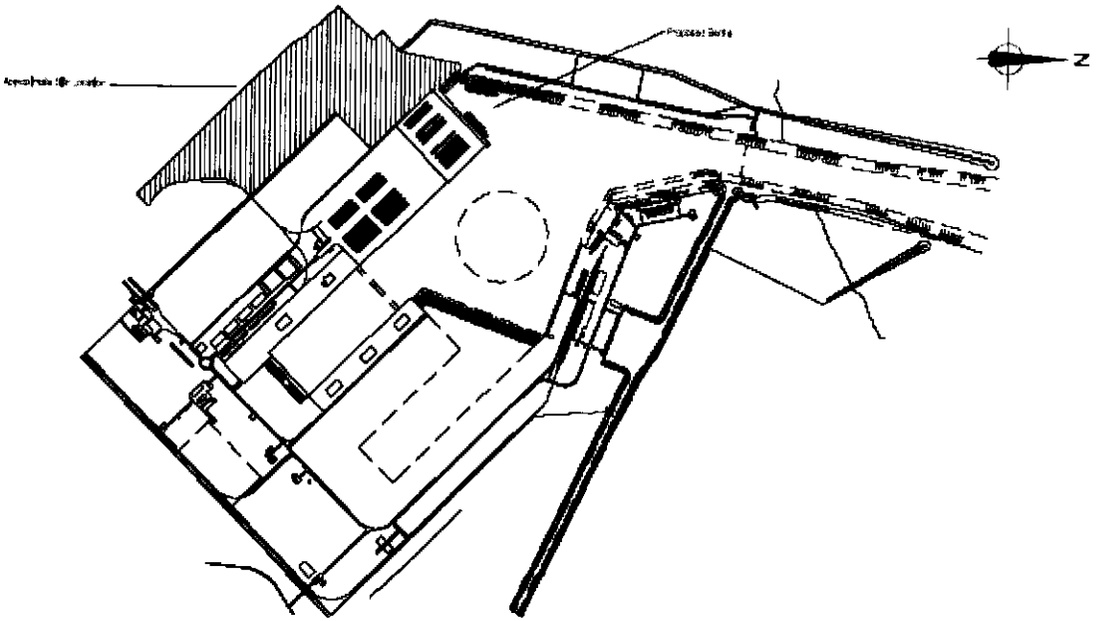
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PRELIMINARY
Halcrow
Agrium
DEVELOPMENT PROPOSAL
MARINE OPTION 4
DAMIETTA PORT
LOCATION PLAN
WD/AGRI/SK/400
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## EGYPT N2 MARINE COST ESTIMATES - ALL PHASES

### Halcrow Scoping Study - November 2004

| Cost Summary - All Phases | | Idku | Gamasah | Damietta Echem | Damietta Port |
|---|---|---|---|---|---|
| Item | Item Description | Amount | Amount | Amount | Amount |
| 1.0 | Berth | | | | |
| *1.1* | *Loading Platform & Dolphins* | 19,534,500 | 19,534,500 | 19,534,500 | 19,534,500 |
| *1.2* | *Jetty Approach Trestle* | 38,937,500 | 126,936,250 | 76,317,500 | 1,869,000 |
| *1.3* | *Berth Ancillaries* | 6,971,440 | 6,971,440 | 6,971,440 | 6,971,440 |
| 2.0 | Breakwaters/ Revetments | 31,250,000 | 23,692,500 | 22,572,000 | 3,090,000 |
| 3.0 | Tug Provision | 0 | 15,000,000 | 15,000,000 | 0 |
| 4.0 | Dredging Works | 7,674,624 | 15,984,450 | 25,557,631 | 6,490,100 |
| 5.0 | Excavation Works | 0 | 0 | 0 | 355,640 |
| 6.0 | Flood Protection Mound | 1,000,000 | 1,000,000 | 1,000,000 | 0 |
| 7.0 | Contractor's Preliminaries and General Items | 23,570,188 | 45,097,104 | 33,414,964 | 8,522,998 |
| TOTAL FOR MARINE WORKS | | 128,938,252 | 254,216,244 | 200,368,034 | 46,833,678 |

## EGYPT N2 MARINE COST ESTIMATES - PHASE 1

### Halcrow Scoping Study - November 2004

| Cost Summary - Phase 1 | | Idku | Gamasah | Damietta Echem | Damietta Port |
|---|---|---|---|---|---|
| Item | Item Description | Amount | Amount | Amount | Amount |
| 1.0 | Marine Works - Berth | | | | |
| 1.1 | Loading Platform & Dolphins | 19,534,500 | 19,534,500 | 19,534,500 | 11,475,000 |
| 1.2 | Jetty Approach Trestle | 38,937,500 | 126,936,250 | 76,317,500 | 934,500 |
| 1.3 | Berth Ancillaries | 6,971,440 | 6,971,440 | 6,971,440 | 6,971,440 |
| 2.0 | Marine Works - Breakwaters/ Revetments | 31,250,000 | 23,692,500 | 22,572,000 | 3,090,000 |
| 3.0 | Service Tugs | 0 | 15,000,000 | 15,000,000 | 0 |
| 4.0 | Dredging Works | 7,674,624 | 15,984,450 | 25,557,631 | 6,490,100 |
| 5.0 | Excavation Works | 0 | 0 | 0 | 355,640 |
| 6.0 | Flood Protection Mound | 1,000,000 | 1,000,000 | 1,000,000 | 0 |
| 7.0 | Contractor's Preliminaries and General Items | 23,570,188 | 45,097,104 | 33,414,964 | 6,274,498 |
| TOTAL FOR MARINE WORKS | | 128,938,252 | 254,216,244 | 200,366,034 | 35,591,178 |

# APPENDIX 3

## PROVISIONAL SITE PLANS, PLOT PLANS, AND OTHER TECHNICAL DIAGRAMS

Included in this Appendix are larger scale prints of the drawings developed during this study.

## Drawings Included

Task B – Process Technology / Licensor Selection

B.5.3.1/1 Preliminary Site Layout Including Piperack
B.5.3.1/2 Preliminary Site Drainage Layout
B.5.3.1/3 Preliminary Buried Pipeway Layout
B.5.3.1/4 Preliminary Paving and Road / Truck Loading Layout
B.5.3.1/5 Preliminary Fire Protection / Treatment Layout

B.2.3.1 – Primary Water Treatment System Utilities Flow Diagram (UFD)
B.2.3.2 – BFW Steam and Condensate UFD
B.2.3.3 – Cooling Water System UFD
B.2.3.4 – Power Generation UFD
B.2.3.5 – Fuel Gas System UFD
B.2.3.6 – Air System UFD
B.2.3.7 – Flare System UFD
B.2.3.8 – Waste Water Treatment UFD
B.2.3.9 – Methanol Storage and Loading UFD
B.2.3.10 – Ammonia Storage and Loading UFD

Task G – Project Implementation and Financing Strategy

Level 1 Summary Schedule:

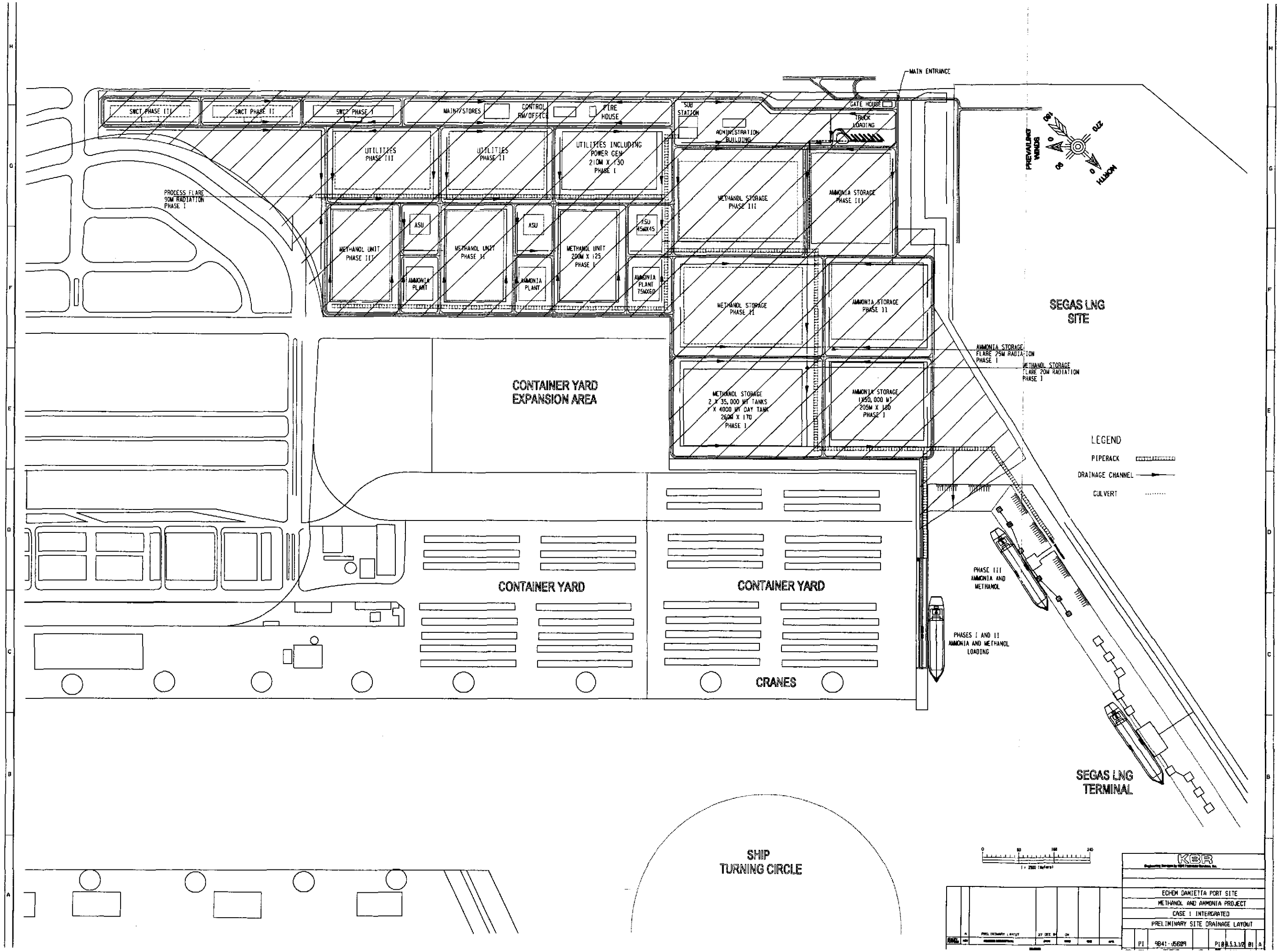
EPC Schedule

SWCT PHASE III
SWCT PHASE II
SWCT PHASE I
MAINT/STORES
CONTROL RM/OFFICE
FIRE HOUSE
SUB STATION
ADMINISTRATION BUILDING
GATE HOUSE
MAIN ENTRANCE
TRUCK LOADING
UTILITIES PHASE III
UTILITIES PHASE II
UTILITIES INCLUDING POWER GEN 2:0M X 130 PHASE I
PROCESS FLARE 50M RADIATION PHASE I
METHANOL UNIT PHASE III
ASU
METHANOL UNIT PHASE II
ASU
METHANOL UNIT 200M X 125 PHASE I
ASU 45MX45
AMMONIA PLANT
AMMONIA PLANT
AMMONIA PLANT 75MX60
METHANOL STORAGE PHASE III
AMMONIA STORAGE PHASE III
METHANOL STORAGE PHASE II
AMMONIA STORAGE PHASE II
METHANOL STORAGE 2 X 35,000 MT TANKS 1 X 4000 MT DAY TANK 260M X 170 PHASE I
AMMONIA STORAGE 1X50,000 MT 205M X 180 PHASE I
PREVAILING WINDS
180
090
270
NORTH
SEGAS LNG SITE
AMMONIA STORAGE FLARE 25M RADIATION PHASE I
METHANOL STORAGE FLARE 20M RADIATION PHASE I
CONTAINER YARD EXPANSION AREA
CONTAINER YARD
CONTAINER YARD
CRANES
LEGEND
PIPERACK
PHASE III AMMONIA AND METHANOL
PHASES I AND II AMMONIA AND METHANOL LOADING
SEGAS LNG TERMINAL
SHIP TURNING CIRCLE

KBR

ECHEM DAMIETTA PORT SITE
METHANOL AND AMMONIA PROJECT
CASE 1 INTERGRATED
PRELIMINARY SITE LAYOUT INCLUDING PIPERACK

P1 | 9841-J5609 | P10 B.5.3.1/1 | B1 | A


MAIN ENTRANCE
SWCT PHASE III
SWCT PHASE II
SWCT PHASE I
MAINT/STORES
CONTROL RM/OFFICE
FIRE HOUSE
SUB STATION
ADMINISTRATION BUILDING
GATE HOUSE
TRUCK LOADING
UTILITIES PHASE III
UTILITIES PHASE II
UTILITIES INCLUDING POWER GEN 210M X 130 PHASE I
PROCESS FLARE 90M RADIATION PHASE I
METHANOL STORAGE PHASE III
AMMONIA STORAGE PHASE III
ASU
METHANOL UNIT PHASE III
METHANOL UNIT PHASE II
METHANOL UNIT 200M X 125 PHASE I
FSU 45MX45
AMMONIA PLANT
AMMONIA PLANT 75MX60
METHANOL STORAGE PHASE II
AMMONIA STORAGE PHASE II
SEGAS LNG SITE
AMMONIA STORAGE FLARE 25M RADIATION PHASE I
METHANOL STORAGE FLARE 20M RADIATION PHASE I
CONTAINER YARD EXPANSION AREA
METHANOL STORAGE 2 X 35,000 MT TANKS 1 X 4000 MT DAY TANK 260M X 170 PHASE I
AMMONIA STORAGE 1X50,000 MT 205M X 180 PHASE I
LEGEND
PIPERACK
DRAINAGE CHANNEL
CULVERT
CONTAINER YARD
CONTAINER YARD
PHASE III AMMONIA AND METHANOL
PHASES I AND II AMMONIA AND METHANOL LOADING
CRANES
SEGAS LNG TERMINAL
SHIP TURNING CIRCLE
PREVAILING WINDS
NORTH
KBR
ECHEM DAMIETTA PORT SITE
METHANOL AND AMMONIA PROJECT
CASE 1 INTERGRATED
PRELIMINARY SITE DRAINAGE LAYOUT
PI 9841-05609 P10 8.5.3.1/2 01 A

SWCT PHASE III
SWCT PHASE II
SWCT PHASE I
MAINT/STORES
CONTROL RM/OFFICE
FIRE HOUSE
SUB STATION
ADMINISTRATION BUILDING
GATE HOUSE
TRUCK LOADING
MAIN ENTRANCE
UTILITIES PHASE III
UTILITIES PHASE II
UTILITIES INCLUDING POWER GEN 210M X 130 PHASE I
PROCESS FLARE 90M RADIATION PHASE I
METHANOL UNIT PHASE III
ASU
METHANOL UNIT PHASE II
ASU
METHANOL UNIT 200M X 125 PHASE I
ASU 45MX45
AMMONIA PLANT
AMMONIA PLANT
AMMONIA PLANT 75MX60
METHANOL STORAGE PHASE III
AMMONIA STORAGE PHASE III
METHANOL STORAGE PHASE II
AMMONIA STORAGE PHASE II
METHANOL STORAGE 2 X 35,000 MT TANKS 1 X 4000 MT DAY TANK 260M X 170 PHASE I
AMMONIA STORAGE 1X50,000 MT 205M X 180 PHASE I
PREVAILING WINDS
NORTH
SEGAS LNG SITE
AMMONIA STORAGE FLARE 25M RADIATION PHASE I
METHANOL STORAGE FLARE 20M RADIATION PHASE I
FROM FIREWATER SUPPLY
CONTAINER YARD EXPANSION AREA
CONTAINER YARD
CONTAINER YARD
CRANES
PHASE III AMMONIA AND METHANOL
PHASES I AND II AMMONIA AND METHANOL LOADING
SEGAS LNG TERMINAL
SHIP TURNING CIRCLE

LEGEND
PIPERACK
FIREWATER
SEAWATER (SUPPLY)
SEAWATER (RETURN)

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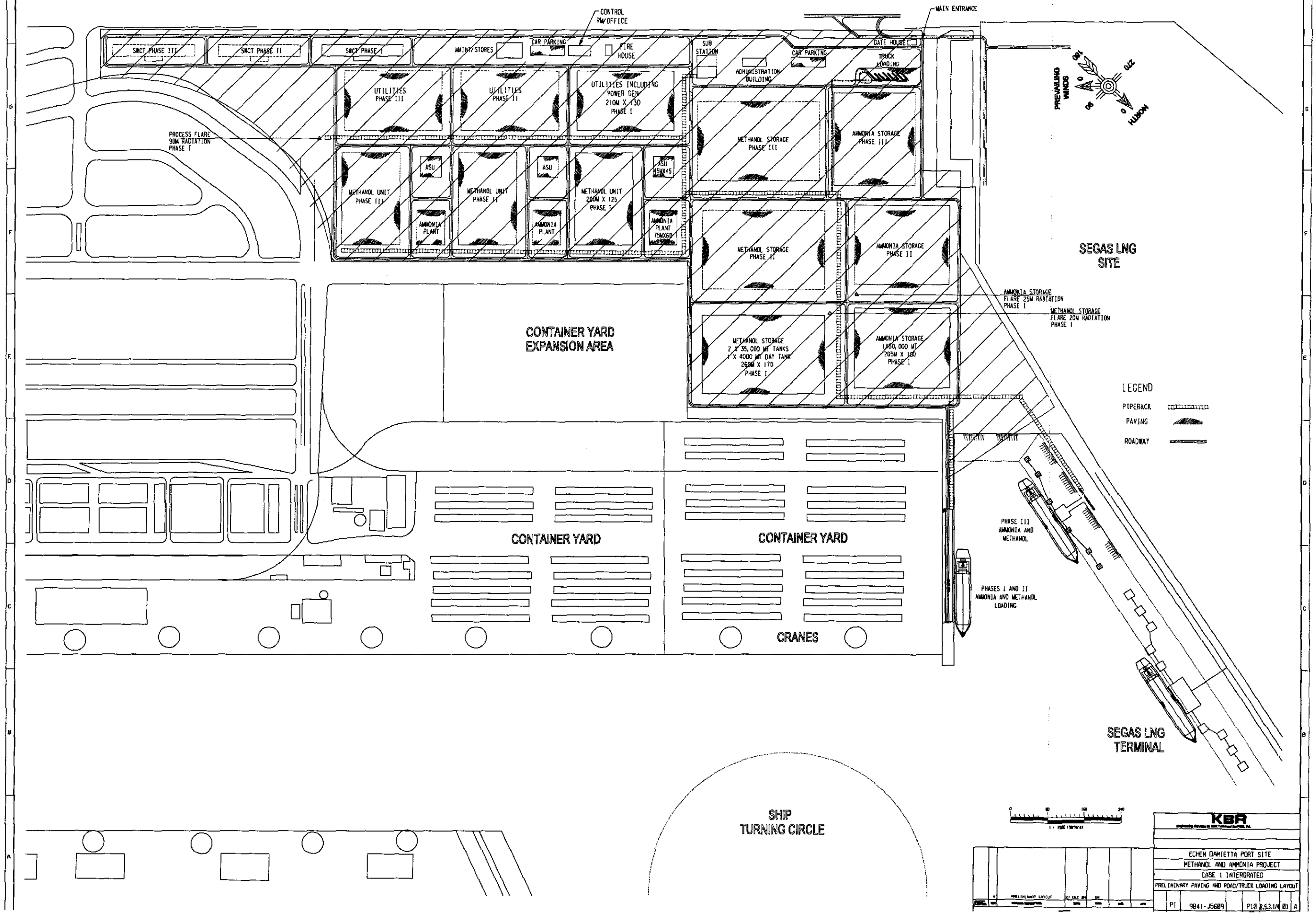
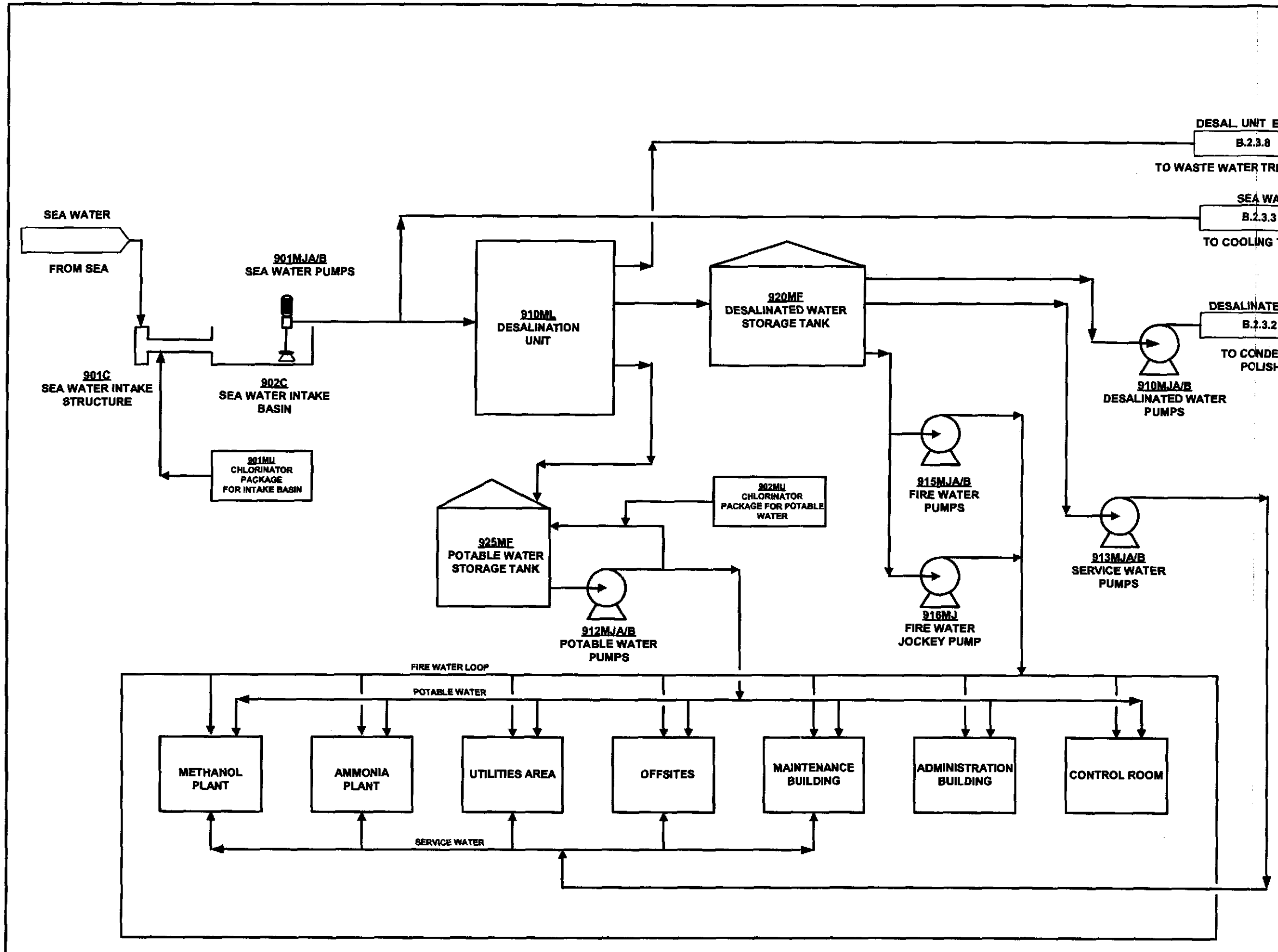
ECHEM DAMIETTA PORT SITE
METHANOL AND AMMONIA PROJECT
CASE I INTEGRATED
PRELIMINARY BURIED PIPEWAY LAYOUT
PI 9841-J5689


CONTROL RM/OFFICE
MAIN ENTRANCE
SMCT PHASE III
SMCT PHASE II
SMCT PHASE I
MAINT/STORES
CAR PARKING
FIRE HOUSE
SUB STATION
CAR PARKING
GATE HOUSE
TRUCK LOADING
ADMINISTRATION BUILDING
UTILITIES PHASE III
UTILITIES PHASE II
UTILITIES INCLUDING POWER GEN 210M X 130 PHASE I
PROCESS FLARE 90M RADIATION PHASE I
METHANOL UNIT PHASE III
ASU
METHANOL UNIT PHASE II
ASU
METHANOL UNIT 200M X 125 PHASE I
ASU 45MX45
AMMONIA PLANT
AMMONIA PLANT
AMMONIA PLANT 75MX60
METHANOL STORAGE PHASE III
AMMONIA STORAGE PHASE III
METHANOL STORAGE PHASE II
AMMONIA STORAGE PHASE II
METHANOL STORAGE 2 X 35,000 MT TANKS 1 X 4000 MT DAY TANK 260M X 170 PHASE I
AMMONIA STORAGE 1X50, 000 MT 205M X 180 PHASE I
CONTAINER YARD EXPANSION AREA
CONTAINER YARD
CONTAINER YARD
CRANES
SHIP TURNING CIRCLE
PREVAILING WINDS
NORTH
SEGAS LNG SITE
AMMONIA STORAGE FLARE 25M RADIATION PHASE I
METHANOL STORAGE FLARE 20M RADIATION PHASE I
LEGEND
PIPERACK
PAVING
ROADWAY
PHASE III AMMONIA AND METHANOL
PHASES I AND II AMMONIA AND METHANOL LOADING
SEGAS LNG TERMINAL
KBR
ECHEN DAMIETTA PORT SITE
METHANOL AND AMMONIA PROJECT
CASE 1 INTERGRATED
PRELIMINARY PAVING AND ROAD/TRUCK LOADING LAYOUT
PI 9841-J5609 P10 2.5.3.1/4 01 A

SWCT PHASE III
SWCT PHASE II
SWCT PHASE I
MAIN STORES
CONTROL RM/OFFICE
FIRE HOUSE
SUB STATION
ADMINISTRATION BUILDING
GATE HOUSE
MAIN ENTRANCE
TRUCK LOADING
UTILITIES PHASE III
UTILITIES PHASE II
UTILITIES INCLUDING POWER GEN 210M X 130 PHASE I
PROCESS FLARE 90M RADIATION PHASE I
METHANOL STORAGE PHASE III
AMMONIA STORAGE PHASE III
ASU
ASU 45MX45
METHANOL UNIT PHASE III
METHANOL UNIT PHASE II
METHANOL UNIT 200M X 125 PHASE I
AMMONIA PLANT
AMMONIA PLANT 75MX60
METHANOL STORAGE PHASE II
AMMONIA STORAGE PHASE II
AMMONIA STORAGE FLARE 25M RADIATION PHASE I
METHANOL STORAGE FLARE 20M RADIATION PHASE I
METHANOL STORAGE 2 X 35,000 MT TANKS 1 X 4000 MT DAY TANK 260M X 170 PHASE I
AMMONIA STORAGE 1X50,000 MT 205M X 130 PHASE I
CONTAINER YARD EXPANSION AREA
CONTAINER YARD
CONTAINER YARD
CRANES
SEGAS LNG SITE
PREVAILING WINDS
NORTH
LEGEND
PIPERACK
FIREWATER HYDRANT
FIREWATER MONITOR
HYDRANT/MONITOR
PHASE III AMMONIA AND METHANOL
PHASES I AND II AMMONIA AND METHANOL LOADING
SEGAS LNG TERMINAL
SHIP TURNING CIRCLE
1 : 1500 (Metres)
KBR
ECHEM DAMIETTA PORT SITE
METHANOL AND AMMONIA PROJECT
CASE 1 INTERGRATED
PRELIMINARY FIRE PROTECTION/TREATMENT LAYOUT
PI 9841-J5609 PI08.5.3.1/5 B1 A

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REVISIONS

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|---|---|---|
| DRAWN: | REVISED: | DATED: |

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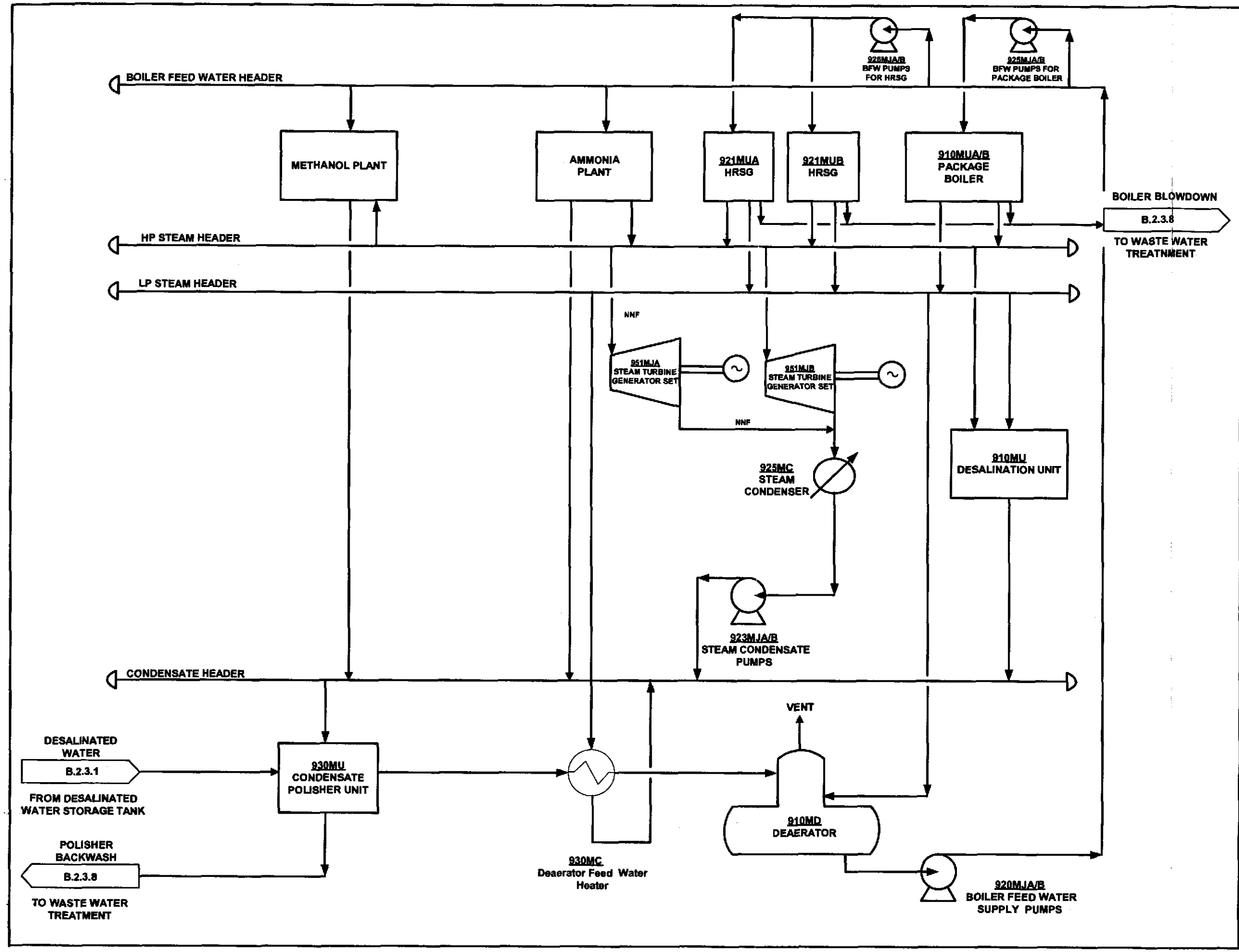
**ECHEM FEASIBILITY STUDY**

**METHANOL AND AMMONIA PROJECT**
**UTILITY FLOW DIAGRAM**

**PRIMARY WATER TREATMENT SYSTEM**

| MANAGER OFFICE | CLIENT | CLIENT | |
|---|---|---|---|
| ENGINEERING OFFICE | | B.2.3.1 | 0 |
| | JOB NUMBER | DRAWING NUMBER | REV. |

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REVISIONS

| ENGINEERED: | CHECKED: | APPROVED: |
|---|---|---|
| DRAWN: | REVISED: | DATED: |

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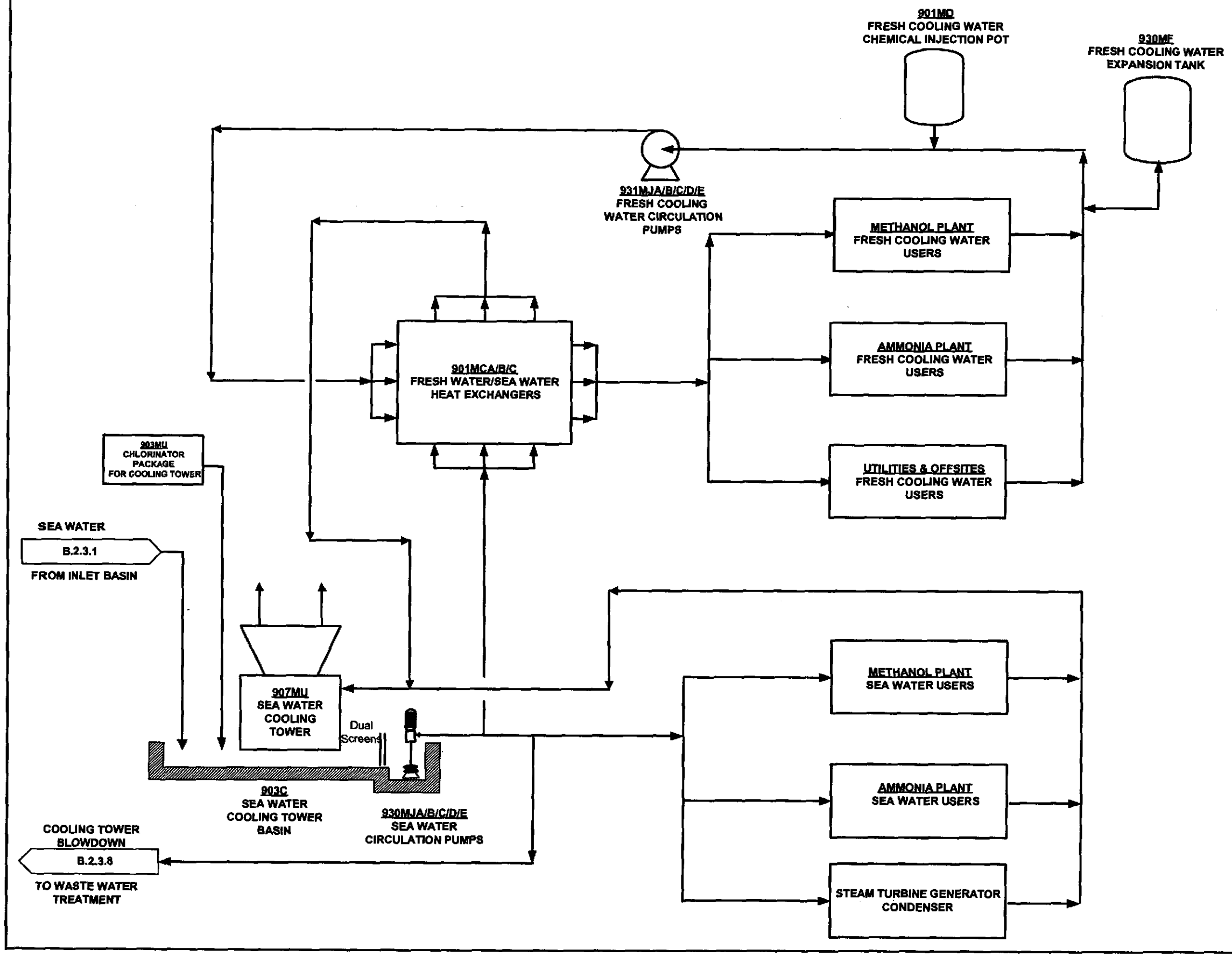
# ECHEM FEASIBILITY STUDY

## METHANOL AND AMMONIA PROJECT
## UTILITY FLOW DIAGRAM

## BFW, STEAM AND CONDENSATE

| MANAGER OFFICE | CLIENT | CLIENT | |
|---|---|---|---|
| ENGINEERING OFFICE | | B.2.3.2 | 0 |
| | JOB NUMBER | DRAWING NUMBER | REV. |

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| REV. | DESCRIPTION | DATE | BY | CHK. | REV. | APP. |
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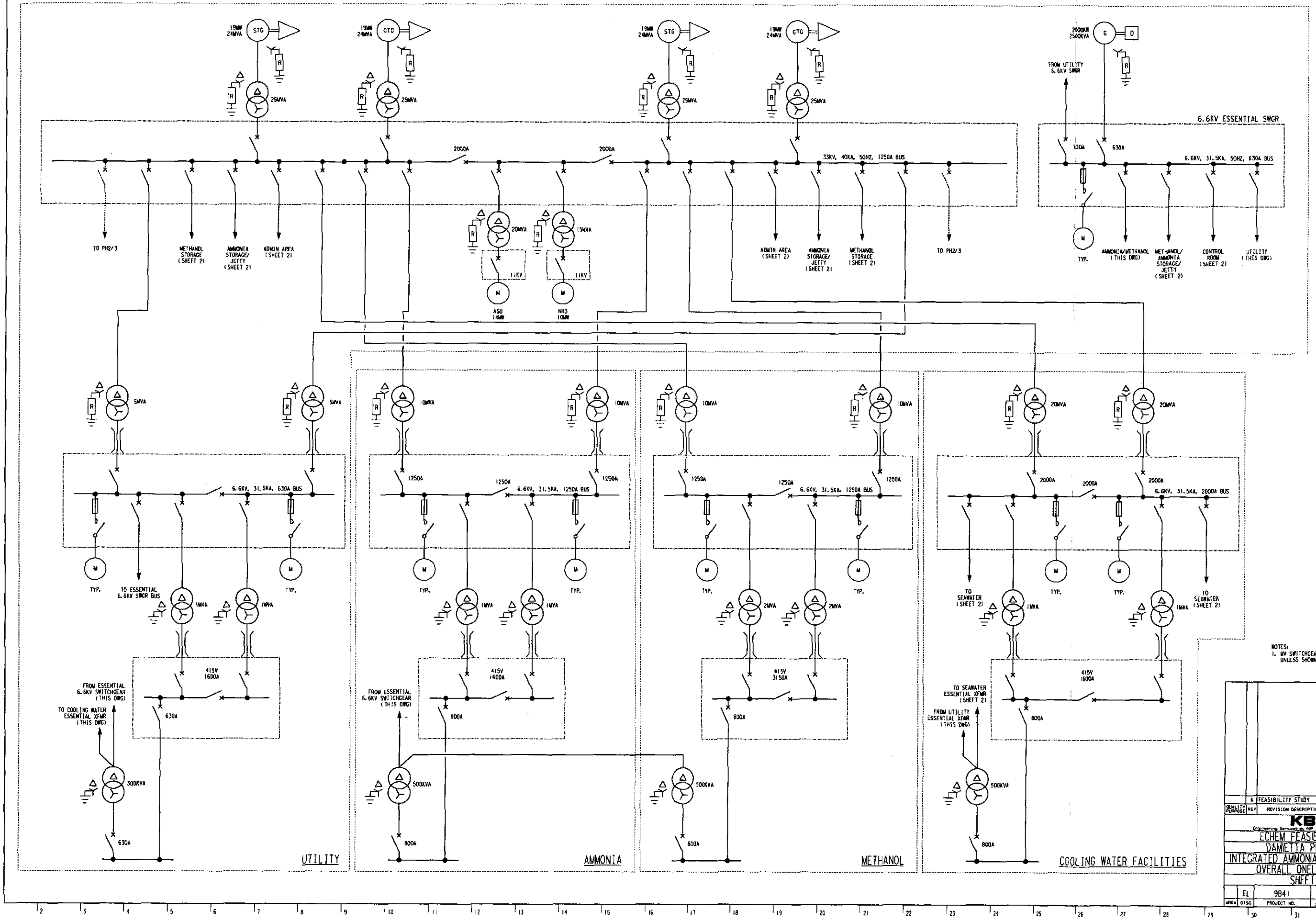
**ECHEM FEASIBILITY STUDY**

**METHANOL AND AMMONIA PROJECT**
**UTILITY FLOW DIAGRAM**

**COOLING WATER SYSTEM**

| MANAGER OFFICE | CLIENT | CLIENT | |
|---|---|---|---|
| ENGINEERING OFFICE | | B.2.3.3 | 0 |
| | JOB NUMBER | DRAWING NUMBER | REV. |




NOTES:
1. MV SWITCHGEAR BREAKERS ARE RATED 630A UNLESS SHOWN OTHERWISE.

| QUALITY PURPOSE | REV | REVISION DESCRIPTION | DATE | ORIG | CHK | APR |
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| | A | FEASIBILITY STUDY | 06DEC04 | DK | KM | BW |

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ECHEM FEASIBILITY STUDY
DAMIETTA PORT, EGYPT
INTEGRATED AMMONIA/METHANOL PLANT
OVERALL ONELINE DIAGRAM
SHEET 1OF 2

| AREA | DISC | PROJECT NO. | SUB TYPE | IDENTIFIER | SHEET | REV |
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| EL | | 9841 | 10 | 703-D100 | 01 | A |

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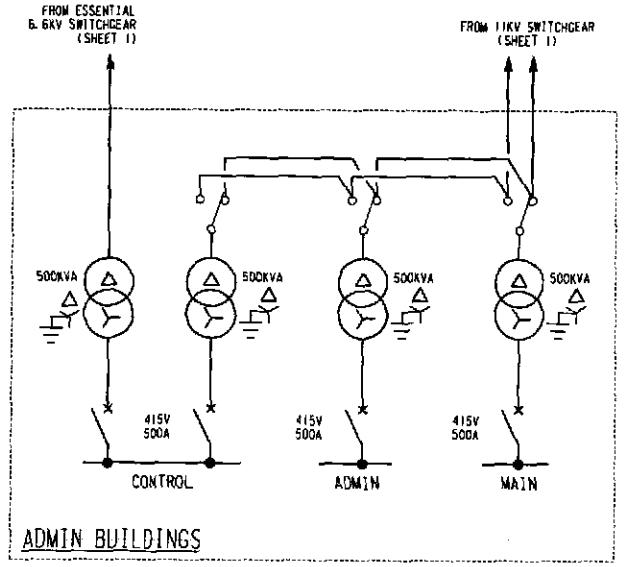


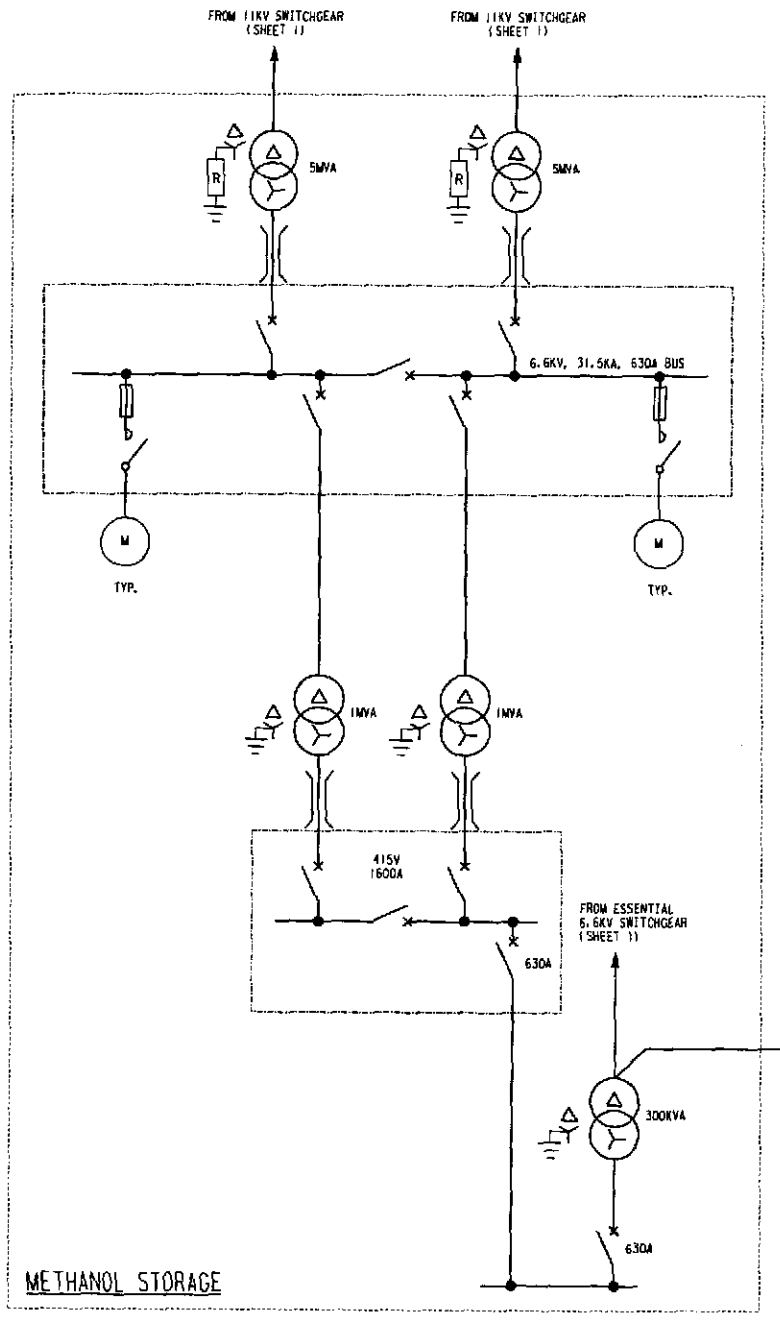


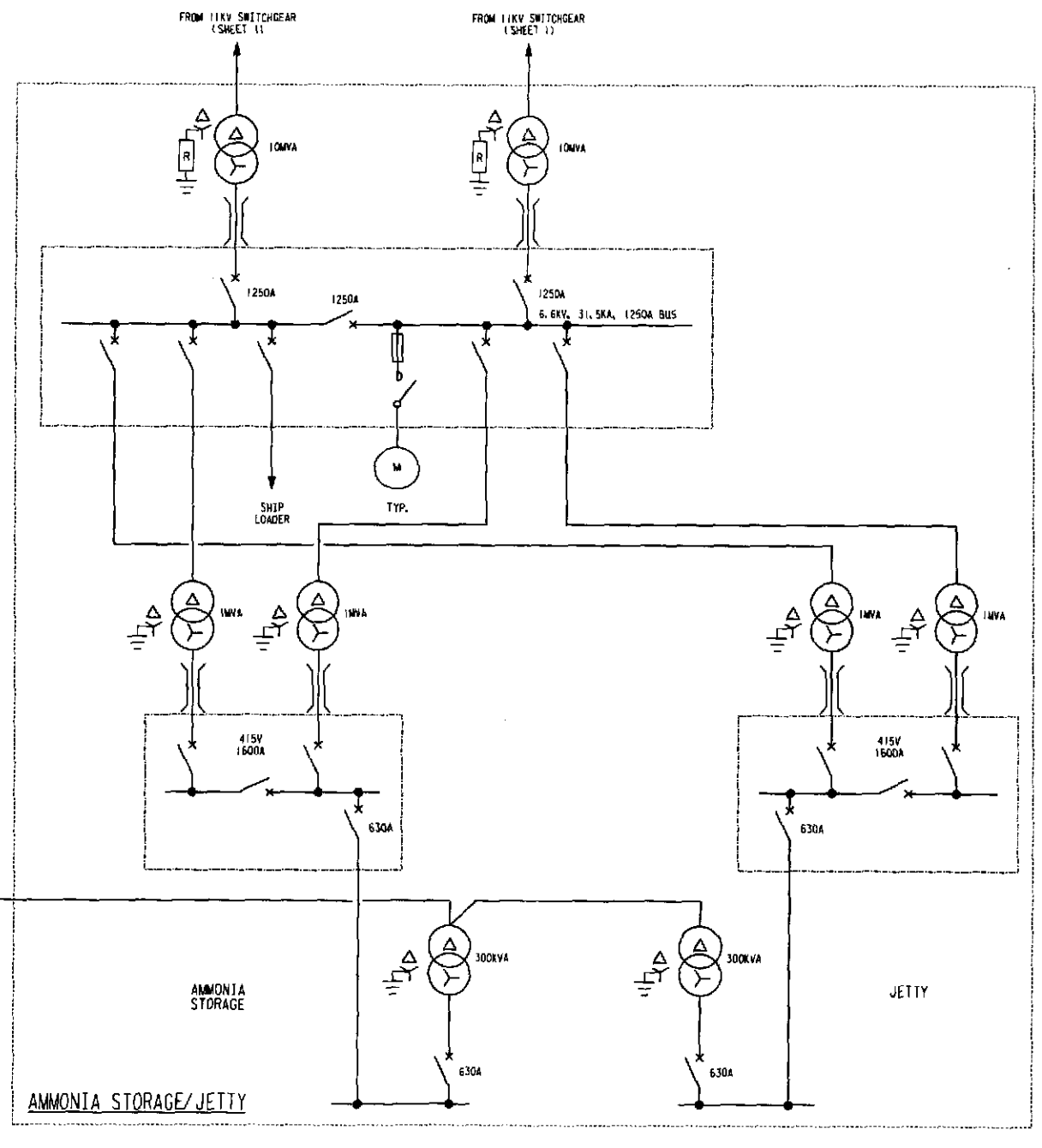


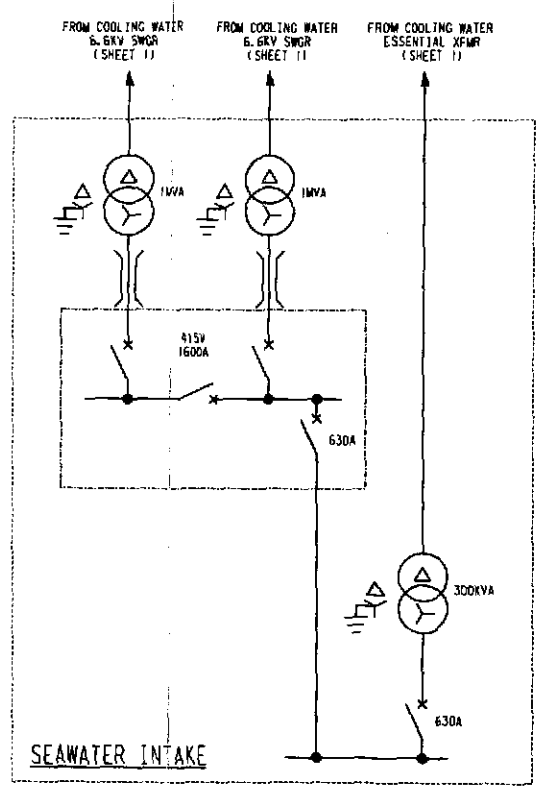


NOTES:
1. MV SWITCHGEAR BREAKERS ARE RATED 630A UNLESS SHOWN OTHERWISE.

| QUALITY PURPOSE | REV | REVISION DESCRIPTION | DATE | ORIG | CHK | APR |
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| | A | FEASIBILITY STUDY | 06DEC04 | DK | KM | BW |

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ECHEM FEASIBILITY STUDY
DAMIETTA PORT, EGYPT
INTEGRATED AMMONIA/METHANOL PLANT
OVERALL ONELINE DIAGRAM
SHEET 2 OF 2

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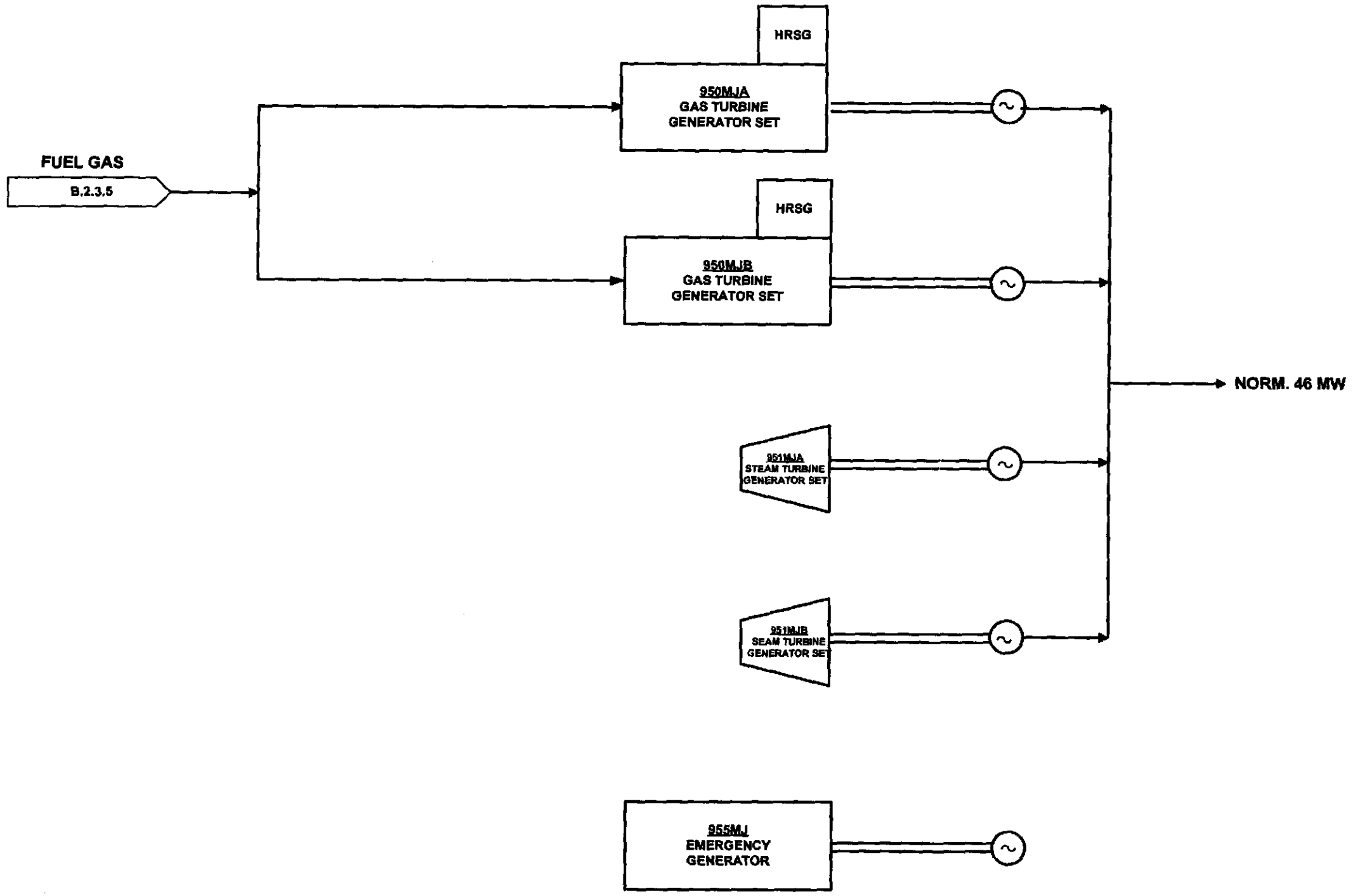


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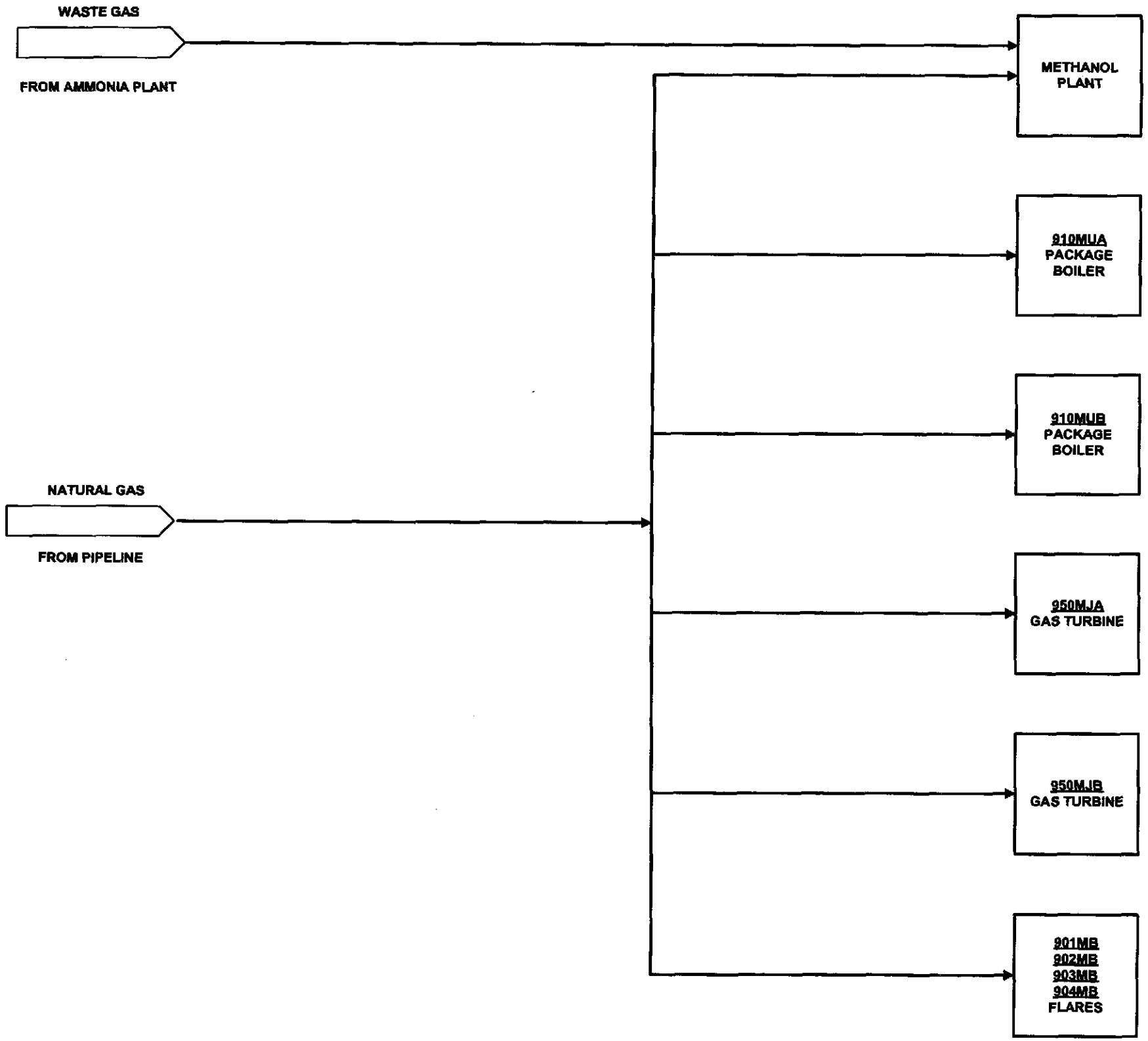
**ECHEM FEASIBILITY STUDY**

**METHANOL AND AMMONIA PROJECT**
**UTILITY FLOW DIAGRAM**

**POWER GENERATION**

| MANAGER OFFICE | CLIENT | CLIENT | |
|---|---|---|---|
| ENGINEERING OFFICE | | B.2.3.4 | 0 |
| | JOB NUMBER | DRAWING NUMBER | REV. |

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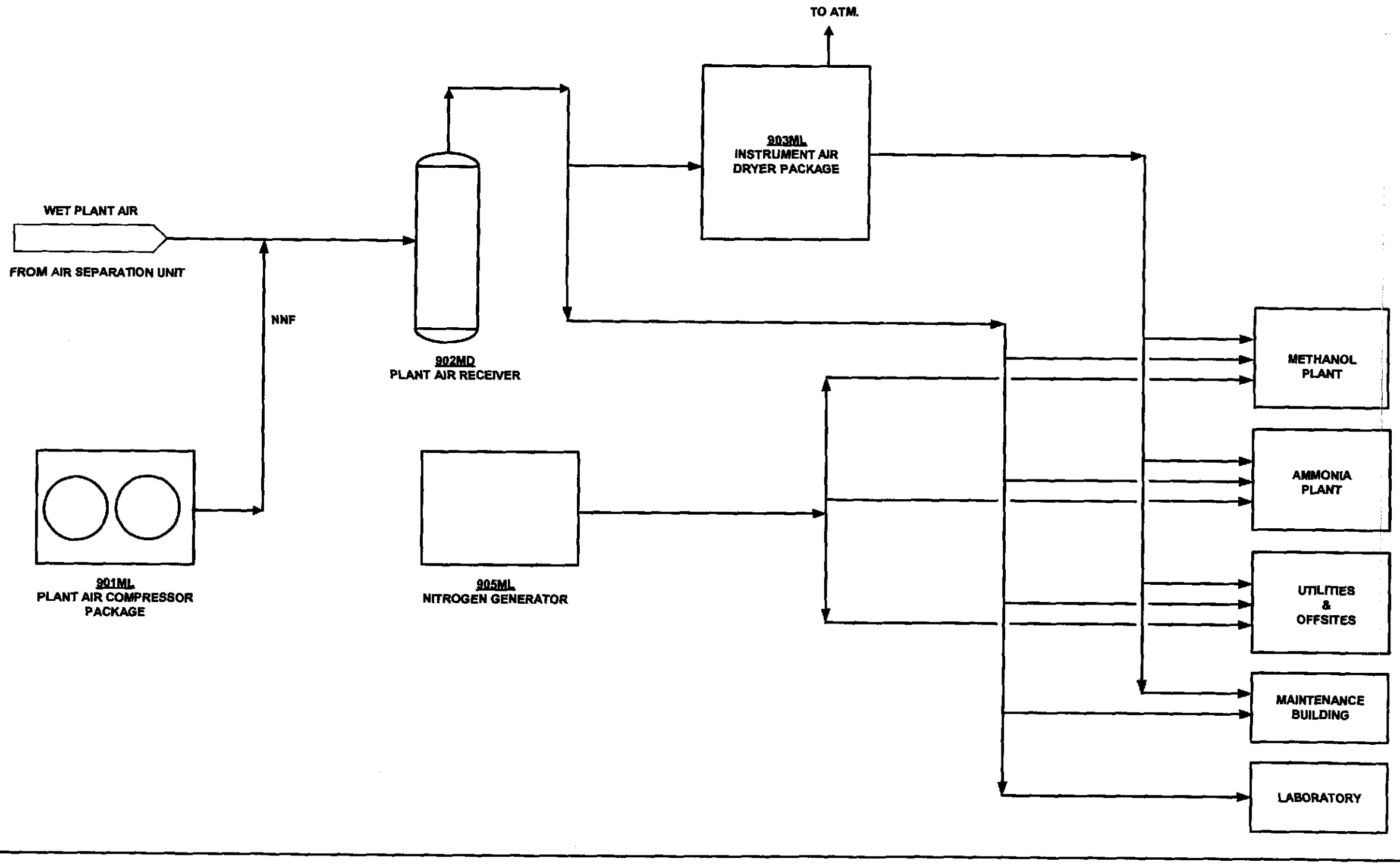
**ECHEM FEASIBILITY STUDY**

**METHANOL AND AMMONIA PROJECT**
**UTILITY FLOW DIAGRAM**

**FUEL GAS SYSTEM**

| MANAGER OFFICE | CLIENT | CLIENT | |
|---|---|---|---|
| ENGINEERING OFFICE | | B.2.3.5 | 0 |
| | JOB NUMBER | DRAWING NUMBER | REV. |




NOTES:

1. AIR SEPARATION UNIT PROVIDES AIR FOR NORMAL OPERATION. AIR COMPRESSOR IS FOR STARTUP AND EMERGENCY SHUT DOWN.

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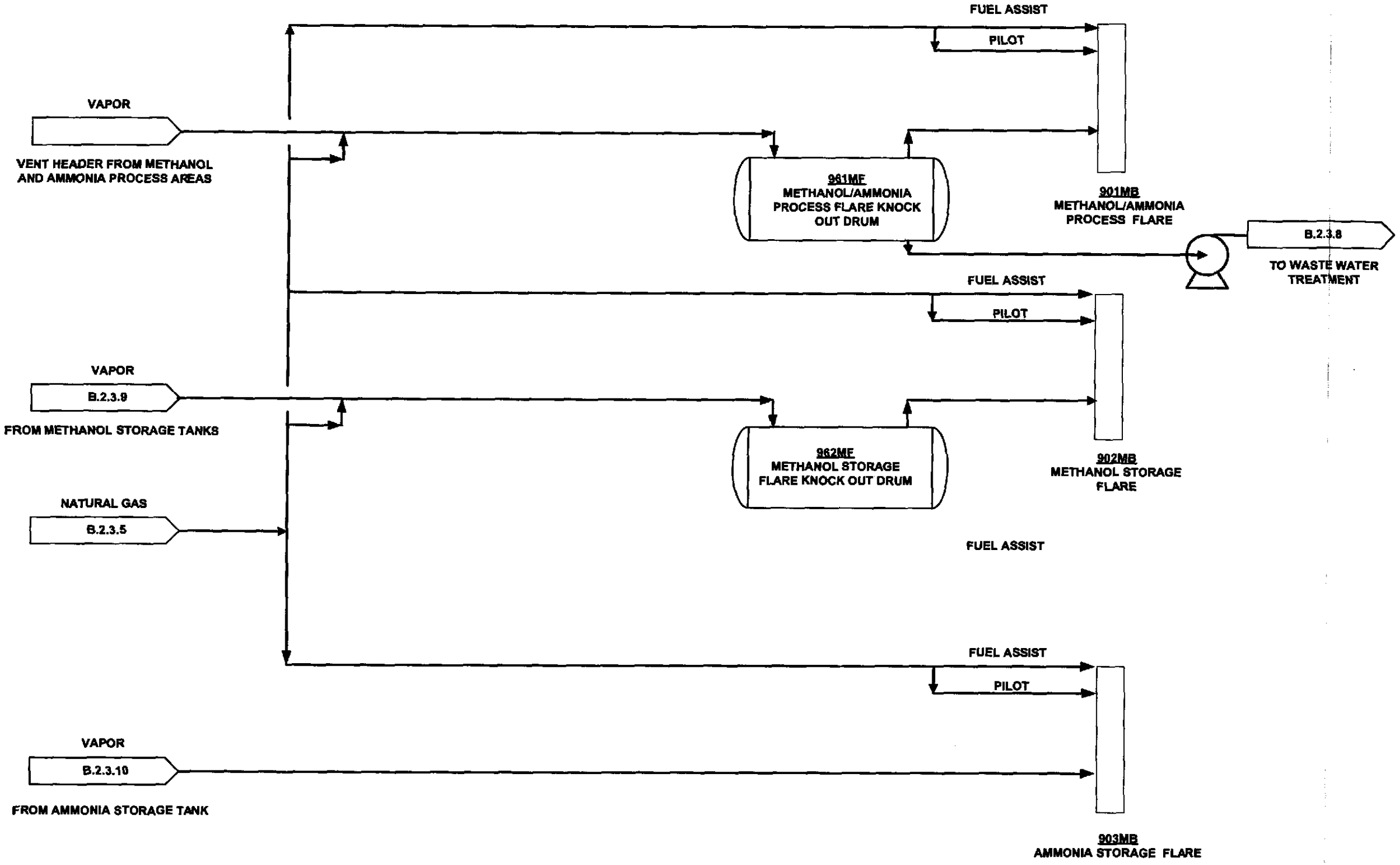
**ECHEM FEASIBILITY STUDY**

**METHANOL AND AMMONIA PROJECT**
**UTILITY FLOW DIAGRAM**

**AIR SYSTEM**

| MANAGER OFFICE | CLIENT | CLIENT | |
|---|---|---|---|
| ENGINEERING OFFICE | | B.2.3.6 | 0 |
| | JOB NUMBER | DRAWING NUMBER | REV. |

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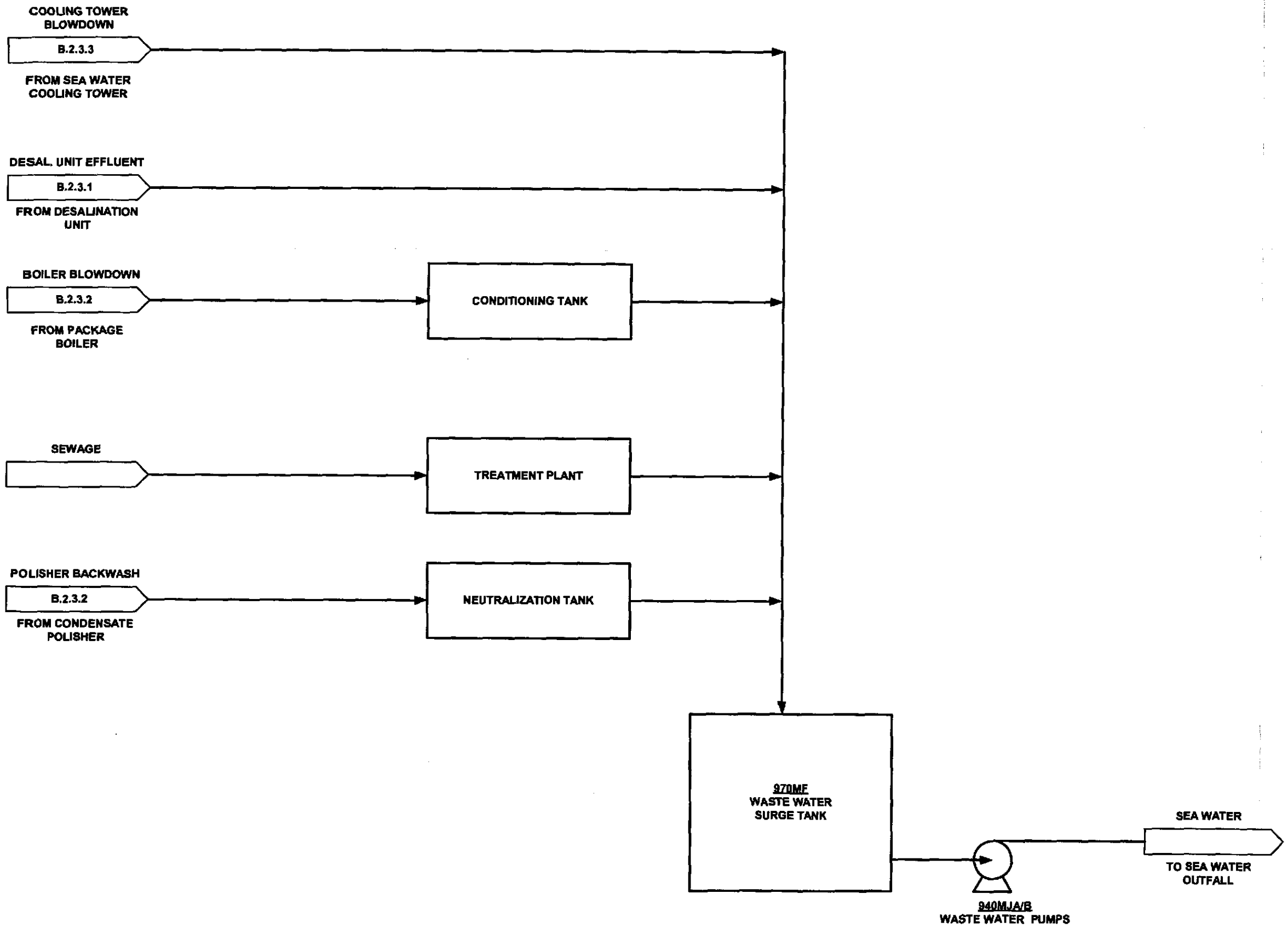
**ECHEM FEASIBILITY STUDY**

**METHANOL AND AMMONIA PROJECT**
**UTILITY FLOW DIAGRAM**

**FLARE SYSTEM**

| MANAGER OFFICE | CLIENT | CLIENT | |
|---|---|---|---|
| ENGINEERING OFFICE | | B.2.3.7 | 0 |
| | JOB NUMBER | DRAWING NUMBER | REV. |

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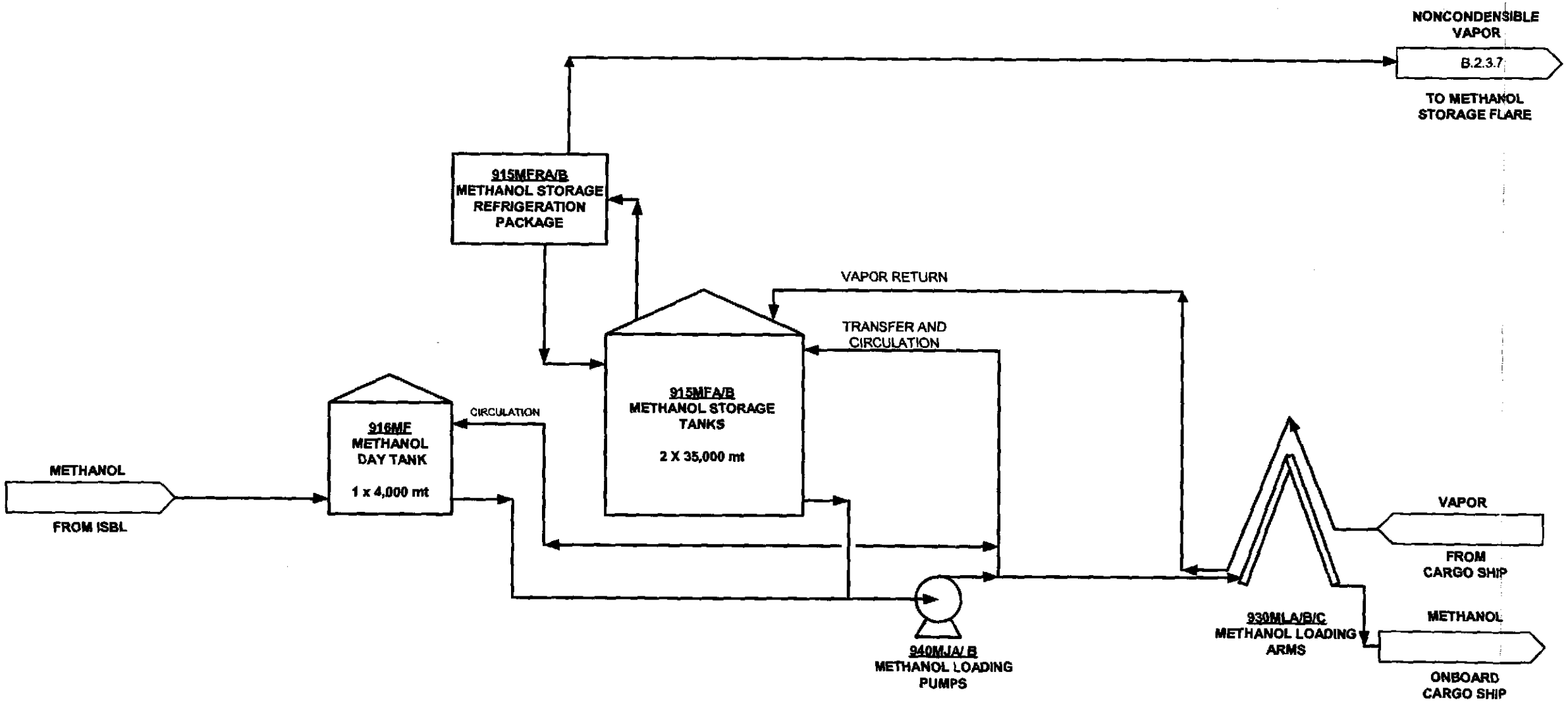
**ECHEM FEASIBILITY STUDY**

**METHANOL AND AMMONIA PROJECT**
**UTILITY FLOW DIAGRAM**

**WASTE WATER TREATMENT**

| MANAGER OFFICE | CLIENT | CLIENT | |
|---|---|---|---|
| ENGINEERING OFFICE | | B.2.3.8 | 0 |
| | JOB NUMBER | DRAWING NUMBER | REV. |

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**ECHEM FEASIBILITY STUDY**

**METHANOL AND AMMONIA PROJECT**
**UTILITY FLOW DIAGRAM**

**METHANOL STORAGE AND LOADING**

| MANAGER OFFICE | CLIENT | CLIENT | |
|---|---|---|---|
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| | JOB NUMBER | DRAWING NUMBER | REV. |

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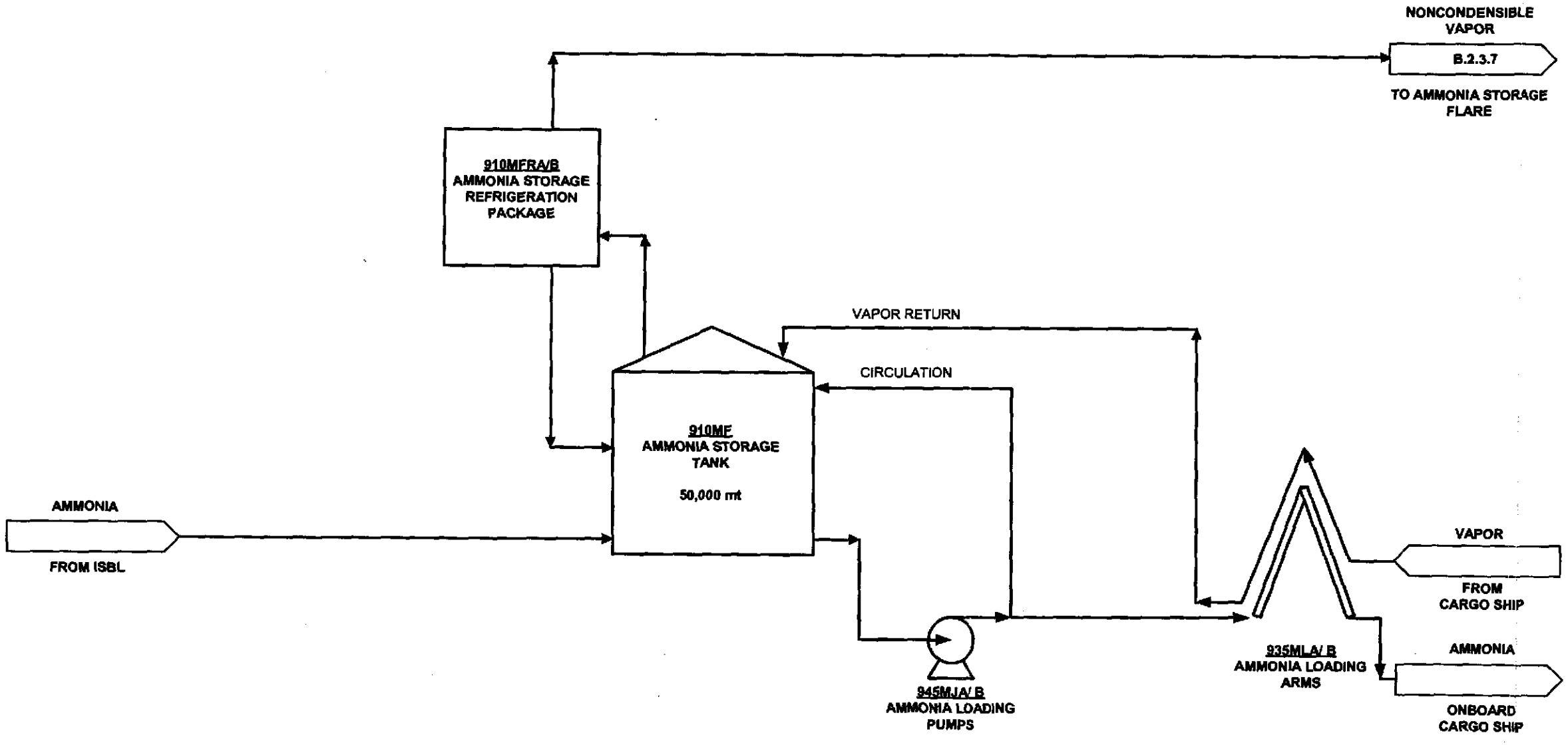


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**ECHEM FEASIBILITY STUDY**

**METHANOL AND AMMONIA PROJECT**
**UTILITY FLOW DIAGRAM**

**AMMONIA STORAGE AND LOADING**

| MANAGER OFFICE | CLIENT | CLIENT | |
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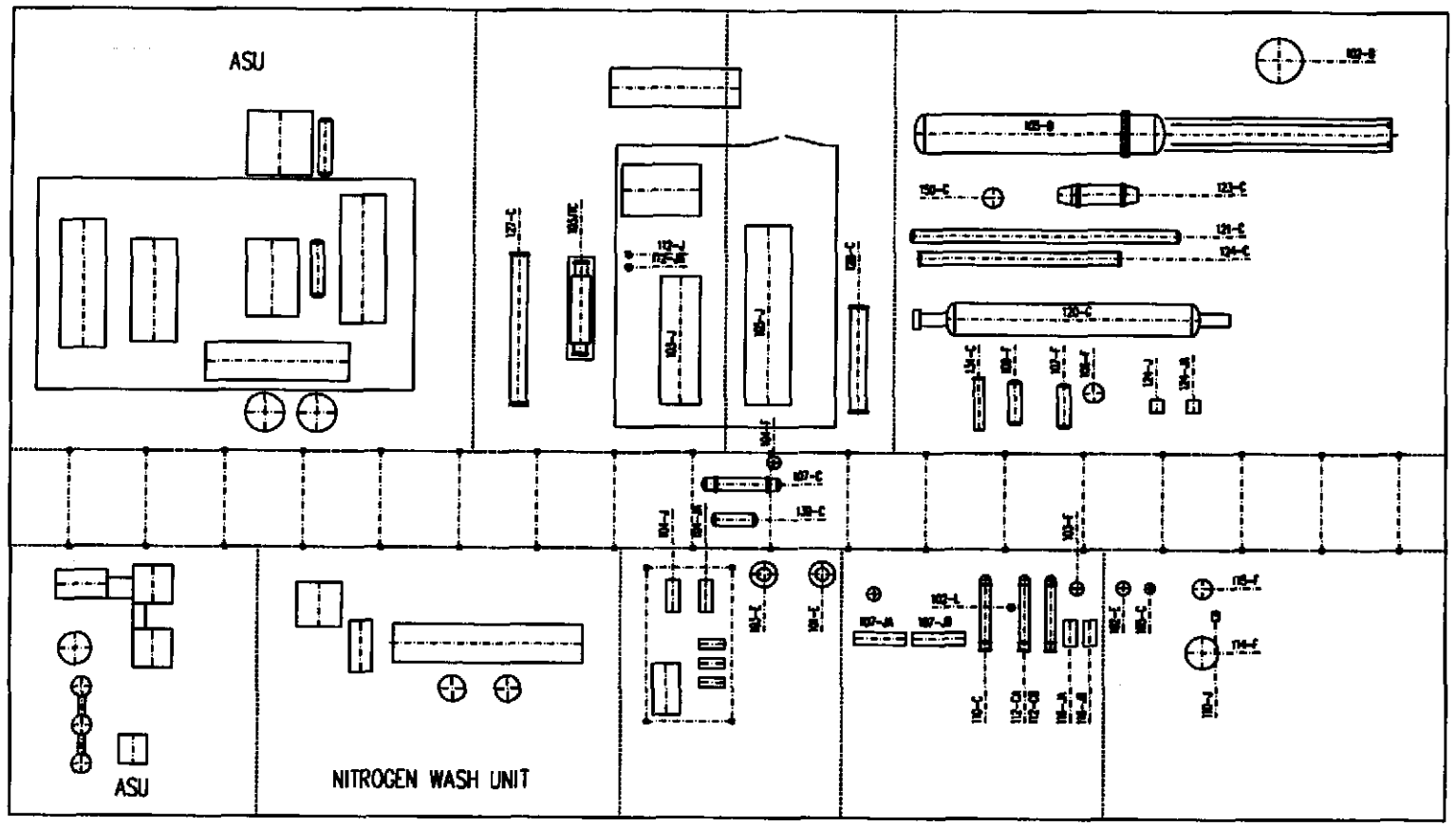
| ENGINEERING OFFICE | | B.2.3.10 | 0 |
| | JOB NUMBER | DRAWING NUMBER | REV. |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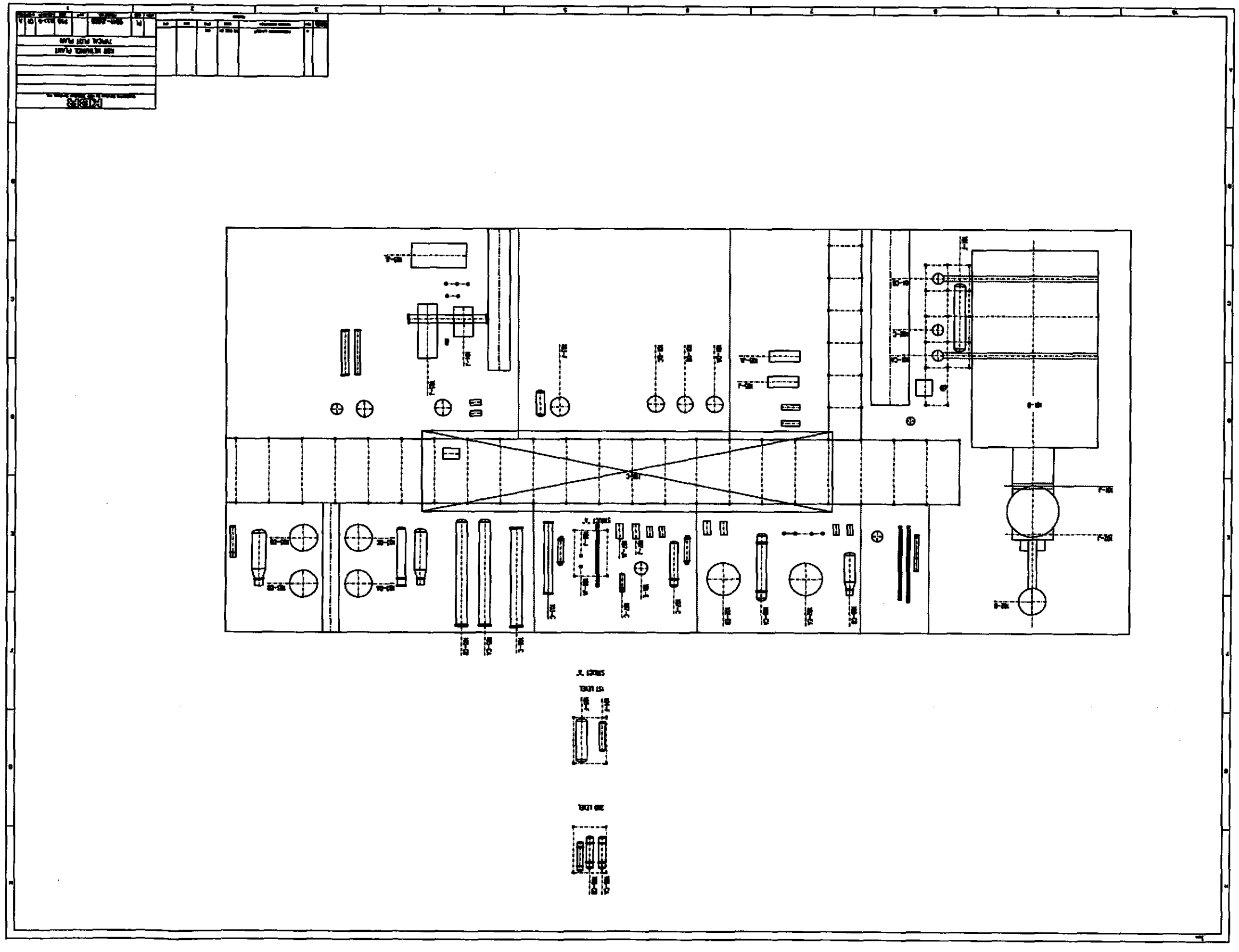
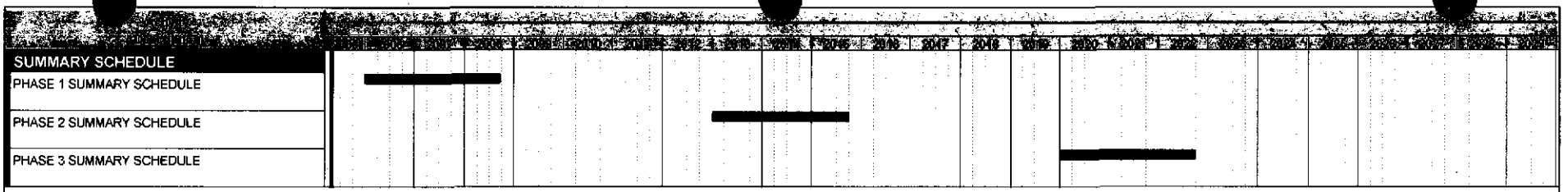
NITROGEN WASH UNIT



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| Start Date | 09DEC04 |
| Finish Date | 30SEP22 |
| Data Date | 25APR05 |
| Run Date | 19JAN05 09:26 |

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Early Bar
Progress Bar
Critical Activity

ECC1

Sheet 1 of 1

ECHEM

ECHEM METHANOL/AMMONIA PROJECT
CASE 1/PHASE 1,2 &3
SUMMARY SCHEDULE

| Date | Revision | Checked | Approved |
|---|---|---|---|
| 10DEC04 | Prelim. Review | | |
| 18JAN05 | PROPOSAL ISSUE | F.Budd | |
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CASE 1

| | |
|---|---|
| FINANCIAL/PERMITTING ACTIVITIVE START PHASE 1 | |
| FINALIZE INFORMATION MEMO & FINANCIAL MODEL | |
| PERMITTING ACTIVITIES | PREREQUISIT: FEASIBILITY STUDY |
| PRESENTATIONS TO LOAN ARRANGERS&EQUITY INVESTORS | |
| APPOINT LEAD ARRANGER FOR DEBT FINANCING | PREREQUISIT: LETTERS OF INTENT FROM POTENTIAL LENDERS AND INVESTESTORS |
| FINALIZE EQUITY PARTICIPATION | PREREQUISIT: LETTERS OF INTENT FROM POTENTIAL LENDERS AND INVESTESTORS |
| CONDUCT DUE DILLIGENCE & RECEIVE DRAFT TERM SHT | PREREQUISIT: FINALIZE ARRANGEMENTS FOR: EPC, FUEL SUPPLY AND OFFTAKE. |
| OBTAIN BINDING COMMITMENTS FRM LENDERS/INVESTORS | PREREQUISIT: NEGOTIATED AND AGREED TERM SHEET. |
| FINALIZE FINANCING DOCUMENTS (FINANCING CLOSING) | |
| FIRST DISBURSMENT | SATISFACTION OF CONDITIONS PRECEDENT TO DISBURSMENT |
| METHANOL PHASE 1 AWARD EPC | |
| METHANOL PHASE 1 ENGINEERING | |
| METHANOL PHASE 1 PROCUREMENT | |
| METHANOL PLANT PHASE 1 SITE PREP/EXCAVATION/FDNS | |
| METHANOL PLANT PHASE 1 UG PIPE/ELEC INSTALLATION | |
| METHANOL PLANT PHASE 1 FURNACE ERECTION | |
| METHANOL PLANT PHASE 1 STEEL ERECTION | |
| METHANOL PLANT PHASE 1 AG PIPE ERECTION | |

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| Start Date | 09DEC04 |
| Finish Date | 30SEP22 |
| Data Date | 25APR05 |
| Run Date | 19JAN05 09:24 |

Early Bar
Progress Bar
Critical Activity

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ECC1 Sheet 1 of 3

ECHEM

ECHEM METHANOL/AMMONIA PROJECT
CASE 1/PHASE 1
EPC SCHEDULE

| Date | Revision | Checked | Approved |
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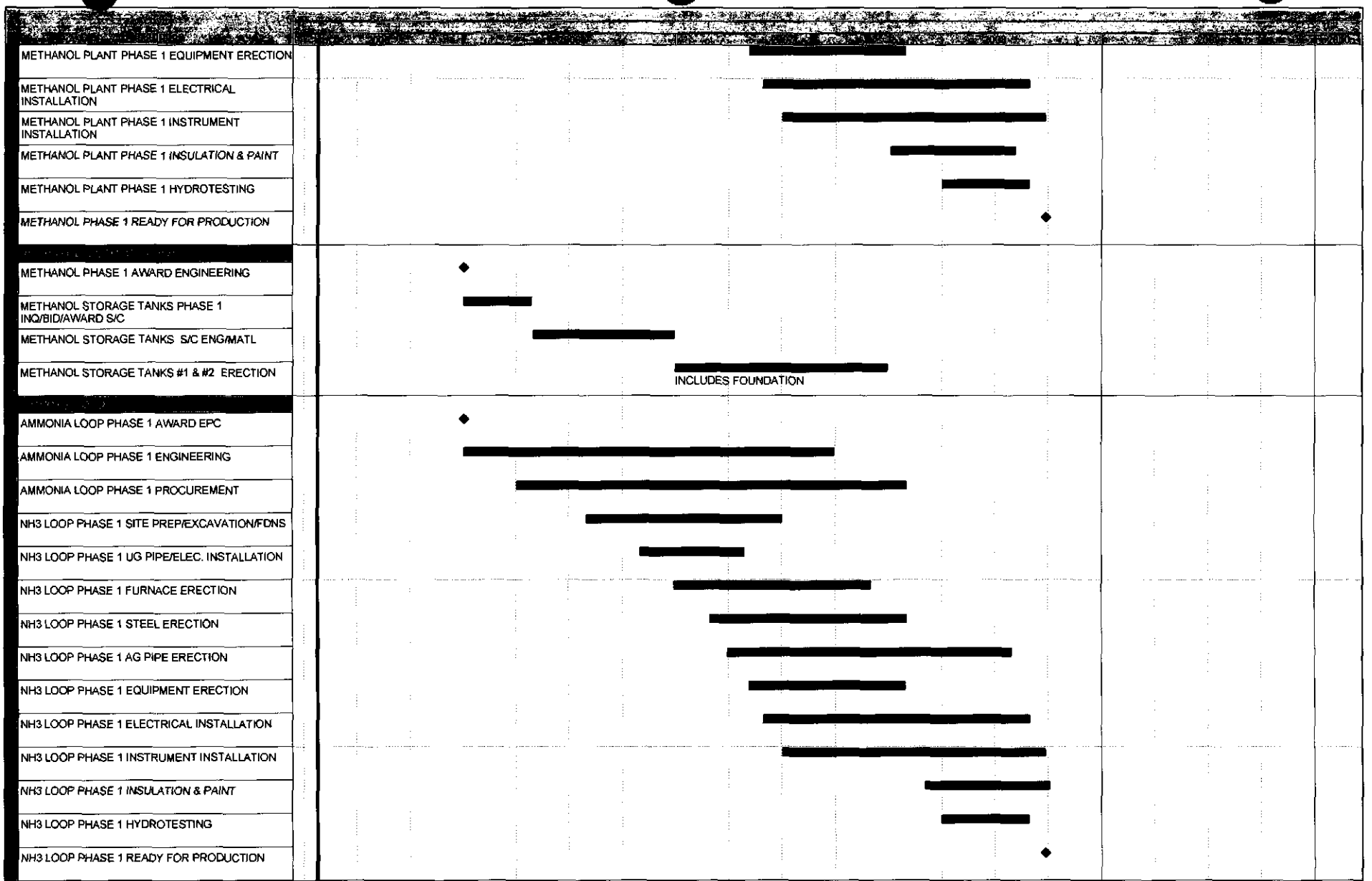
| 10DEC04 | Prelim. Review | | |
| 19JAN05 | PROPOSAL ISSUE | F.Budd | |

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| Data Date | 25APR05 |
| Run Date | 19JAN05 09:24 |

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Early Bar
Progress Bar
Critical Activity

ECC1

Sheet 2 of 3

ECHEM

ECHEM METHANOL/AMMONIA PROJECT
CASE 1/PHASE 1
EPC SCHEDULE

| Date | Revision | Checked | Approved |
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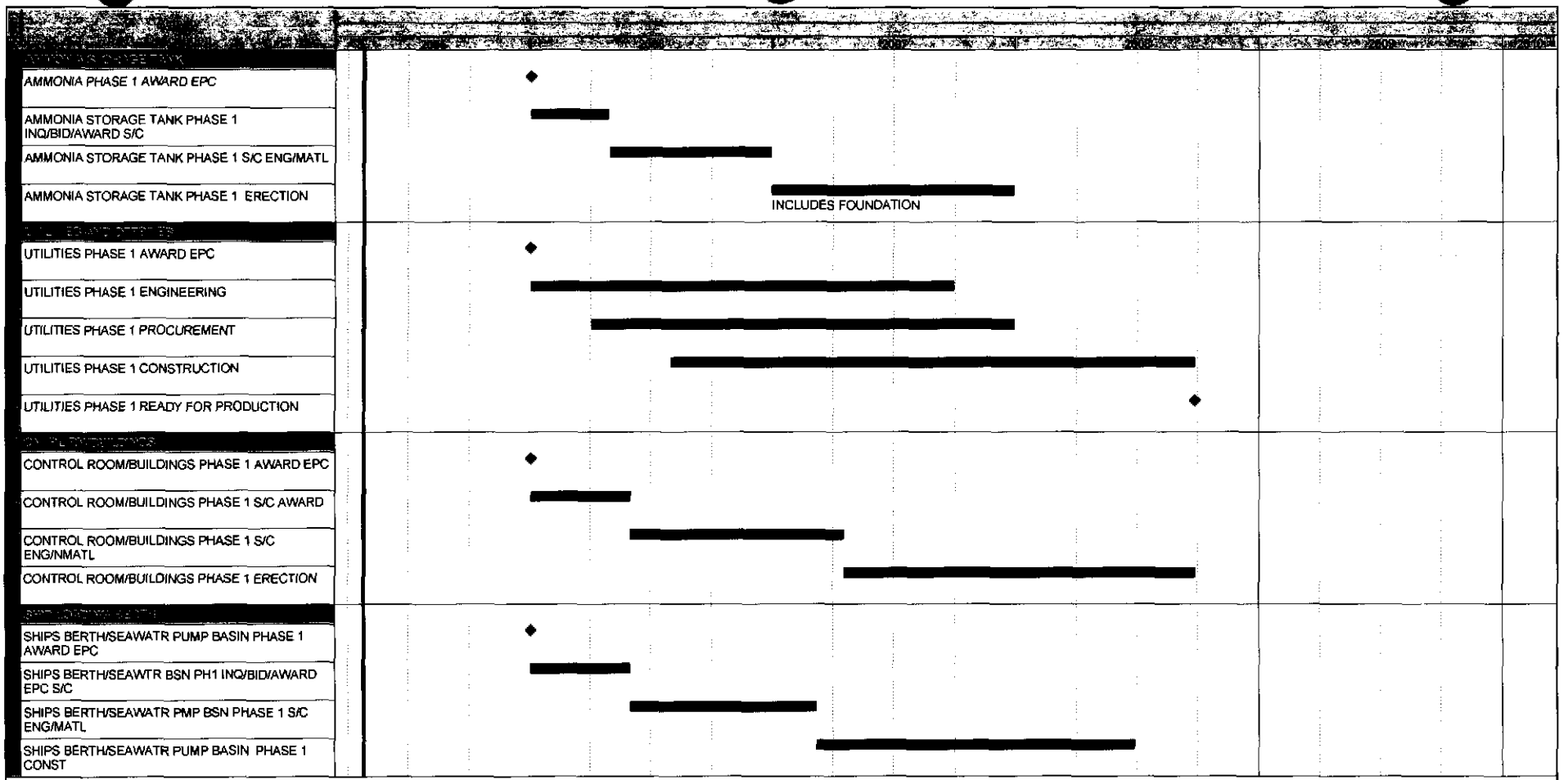
| 10DEC04 | Prelim. Review | | |
| 19JAN05 | PROPOSAL ISSUE | F.Budd | |

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| Start Date | 09DEC04 |
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Early Bar
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Critical Activity

ECC1 *Sheet 3 of 3*

ECHEM

ECHEM METHANOL/AMMONIA PROJECT
CASE 1/PHASE 1
EPC SCHEDULE

| Date | Revision | Checked | Approved |
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| 10DEC04 | Prelim. Review | | |
| 19JAN05 | PROPOSAL ISSUE | F.Budd | |

# APPENDIX 4

## Financial Model

The document in this Appendix is the Financial Model prepared by Delphos International, a global financial advisory firm. Delphos was subcontracted by Granherne to evaluate the financial aspects of this project.

Consistent with the Case 1 assumption that the project will be an integrated methanol ammonia plant, the financial calculations have been combined.

A description of the financial analysis along with the conclusions is included in Task E of this Report.

CHEMI

***Project Summary***

***Integrated Methanol/Ammonia Plant***

| *Project Summary* | *Per Phase* | *Total* |
|---|---|---|
| Methanol Capacity (MTD) | 3,000 | 3,000 |
| Ammonia Capacity (MTD) | 1,200 | 1,200 |
| | | |
| Construction Period (Months) | | 33 |
| Phase 1 Production Starts | Year | 2.75 |
| Phase 2 Construction Starts | Year | 8.00 |
| Phase 2 Production Starts | Year | 10.75 |
| Phase 3 Construction Starts | Year | 15.25 |
| Phase 3 Production Starts | Year | 18.00 |
| | | |
| Total Project Cost - Phase 1 | US$M | 916,925 |
| Total Project Cost - Phase 2 | US$M | - |
| Total Project Cost - Phase 3 | US$M | - |

* Note: Project cost increases are due to inflation

| *Key Statistics* | |
|---|---|
| Project IRR | 12.99% |
| Project NPV (in $000s) | $ 355,377 |
| Average DSCR | 1.53 |
| Minimum DSCR | 1.23 |

| *All Currencies in 000s of USD* | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 | Year 6 | Year 7 | Year 8 | Year 9 | Year 10 | Year 11 | Year 12 | Year 13 | Year 14 | Year 15 | Year 16 | Year 17 | Year 18 | Year 19 | Year 20 | Year 21 | Year 22 | Year 23 | Year 24 | Year 25 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Cash Flow Summary*** | | | | | | | | | | | | | | | | | | | | | | | | | |
| TOTAL REVENUE | - | - | 52,999 | 228,454 | 229,634 | 229,460 | 202,560 | 229,794 | 239,993 | 250,590 | 226,773 | 266,335 | 273,030 | 280,947 | 254,245 | 297,479 | 306,105 | 314,983 | 285,045 | 333,516 | 343,188 | 353,141 | 319,577 | 373,920 | 384,764 |
| Cost of Goods Sold | - | - | 14,973 | 65,066 | 66,941 | 68,882 | 62,338 | 72,938 | 75,051 | 77,227 | 69,887 | 81,771 | 84,143 | 86,583 | 78,354 | 91,677 | 94,336 | 97,072 | 87,846 | 102,784 | 105,784 | 108,831 | 98,488 | 115,235 | 118,577 |
| Gross Profit | - | - | 38,026 | 163,400 | 162,693 | 160,578 | 140,248 | 156,856 | 164,942 | 173,363 | 156,886 | 183,564 | 188,887 | 194,365 | 175,891 | 205,801 | 211,769 | 217,911 | 197,200 | 230,733 | 237,424 | 244,309 | 221,089 | 258,685 | 266,187 |
| Operating Expense Before Depreciation | - | - | 10,456 | 45,038 | 46,071 | 47,066 | 43,042 | 49,177 | 50,780 | 52,434 | 48,239 | 55,520 | 57,130 | 58,786 | 54,063 | 62,245 | 64,051 | 65,908 | 60,835 | 69,786 | 71,810 | 73,892 | 67,981 | 78,240 | 80,509 |
| **EBITDA** | - | - | 27,571 | 118,362 | 116,621 | 113,512 | 97,202 | 107,681 | 114,162 | 120,928 | 108,646 | 128,044 | 131,757 | 135,578 | 121,828 | 143,556 | 147,719 | 152,003 | 136,365 | 160,947 | 165,614 | 170,417 | 153,109 | 180,445 | 185,677 |
| Changes in Working Capital (Less Financed Portion) | - | - | - | (1,282) | (71) | 41 | 2,120 | (2,092) | (809) | (841) | 1,857 | (3,007) | (600) | (617) | 2,082 | (3,371) | (673) | (692) | 2,334 | (3,779) | (754) | (776) | 2,617 | (4,237) | (845) |
| Income taxes | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Cash Flow Before Debt Service | - | - | 27,571 | 117,080 | 116,550 | 113,553 | 99,322 | 105,590 | 113,353 | 120,087 | 110,503 | 125,037 | 131,157 | 134,961 | 123,890 | 140,185 | 147,046 | 151,311 | 138,699 | 157,167 | 164,860 | 169,641 | 155,726 | 176,207 | 184,832 |
| Debt Service | - | - | (22,006) | (85,962) | (62,661) | (79,360) | (76,059) | (72,758) | (69,457) | (66,156) | (62,855) | (59,554) | (42,499) | - | - | - | - | - | - | - | - | - | - | - | - |
| Cash Flow After Debt Service | - | - | 5,564 | 31,119 | 33,889 | 34,193 | 23,263 | 32,832 | 43,896 | 53,931 | 47,648 | 65,483 | 88,658 | 134,961 | 123,890 | 140,185 | 147,046 | 151,311 | 138,699 | 157,167 | 164,860 | 169,641 | 155,726 | 176,207 | 184,832 |
| Debt Service Coverage Ratio | n/a | n/a | 1.23 | 1.34 | 1.39 | 1.41 | 1.28 | 1.43 | 1.61 | 1.79 | 1.73 | 2.07 | 3.04 | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a |
| ***Balance Sheet Summary*** | | | | | | | | | | | | | | | | | | | | | | | | | |
| Total Current Assets | - | - | 63,045 | 62,890 | 61,358 | 59,778 | 55,737 | 56,614 | 55,860 | 55,140 | 51,331 | 46,298 | 42,704 | 73,354 | 103,585 | 134,862 | 165,321 | 195,983 | 226,154 | 257,317 | 287,989 | 318,685 | 348,789 | 380,027 | 410,714 |
| Total Long-Term Assets | 343,683 | 649,179 | 756,103 | 725,553 | 695,003 | 664,454 | 633,904 | 603,355 | 572,805 | 542,255 | 511,706 | 481,156 | 450,607 | 420,057 | 389,507 | 358,958 | 328,408 | 297,858 | 267,309 | 236,759 | 206,210 | 175,660 | 145,111 | 114,561 | 84,011 |
| Total Assets | 380,515 | 717,339 | 910,409 | 870,343 | 828,932 | 787,410 | 743,462 | 704,429 | 663,765 | 623,135 | 579,417 | 534,475 | 493,310 | 493,411 | 493,073 | 493,820 | 493,729 | 493,842 | 493,463 | 494,076 | 494,199 | 494,325 | 493,900 | 494,588 | 494,726 |
| Total Current Liabilities | - | 13,764 | 57,477 | 57,689 | 57,757 | 57,846 | 57,877 | 58,013 | 58,100 | 58,189 | 57,888 | 44,822 | 3,458 | 3,558 | 3,220 | 3,788 | 3,877 | 3,989 | 3,810 | 4,224 | 4,346 | 4,473 | 4,047 | 4,736 | 4,873 |
| Long-Term Debt | 228,309 | 416,649 | 481,386 | 426,370 | 371,355 | 316,339 | 261,324 | 206,308 | 151,293 | 96,277 | 41,262 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Liabilities | 228,309 | 430,403 | 538,863 | 484,059 | 429,121 | 374,185 | 319,201 | 264,321 | 209,392 | 154,466 | 99,149 | 44,822 | 3,458 | 3,558 | 3,220 | 3,788 | 3,877 | 3,989 | 3,810 | 4,224 | 4,346 | 4,473 | 4,047 | 4,736 | 4,873 |
| Total Shareholders' Equity | 152,206 | 286,936 | 371,547 | 386,284 | 399,810 | 413,225 | 424,561 | 440,108 | 454,372 | 468,669 | 480,267 | 489,653 | 489,853 | 489,853 | 489,853 | 489,853 | 489,853 | 489,853 | 489,853 | 489,853 | 489,853 | 489,853 | 489,853 | 489,853 | 489,853 |
| Total Liabilities & Shareholders' Equity | 380,515 | 717,339 | 910,409 | 870,343 | 828,932 | 787,410 | 743,462 | 704,429 | 663,765 | 623,135 | 579,417 | 534,475 | 493,310 | 493,411 | 493,073 | 493,620 | 493,729 | 493,842 | 493,463 | 494,076 | 494,199 | 494,325 | 493,900 | 494,588 | 494,726 |
| Current Ratio | n/a | - | 1.10 | 1.09 | 1.06 | 1.03 | 0.97 | 0.98 | 0.96 | 0.95 | 0.89 | 1.04 | 12.35 | 20.62 | 32.16 | 35.74 | 42.64 | 49.13 | 62.64 | 60.92 | 66.26 | 71.25 | 86.18 | 80.25 | 84.26 |
| Debt to Equity | 1.50 | 1.50 | 1.45 | 1.25 | 1.07 | 0.91 | 0.75 | 0.60 | 0.46 | 0.33 | 0.21 | 0.09 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |

| *Sources & Uses Summary* | *Phase 1* | | *Phase 2* | | *Phase 3* | |
|---|---|---|---|---|---|---|
| *SOURCES OF FUNDS* | | | | | | |
| Debt | 550,155 | 60.0% | - | 0.0% | - | 0.0% |
| Equity | 366,770 | 40.0% | - | 0.0% | - | 0.0% |
| Total Sources of Funds | 916,925 | 100.0% | - | 0.0% | - | 0.0% |
| *USES OF FUNDS* | | | | | | |
| ISBL & OSBL | 680,149 | 74.2% | - | 0.0% | - | 0.0% |
| Owner's Hard Costs | 12,000 | 1.3% | - | 0.0% | - | 0.0% |
| Shipping Terminal | 71,591 | 7.8% | - | 0.0% | - | 0.0% |
| Total Hard Costs | 763,740 | 83.3% | - | 0.0% | - | 0.0% |
| Working Capital | 16,604 | 1.8% | - | 0.0% | - | 0.0% |
| Land Rental During Construction | 7,700 | 0.8% | - | 0.0% | - | 0.0% |
| Owner's Soft Costs | 27,600 | 3.0% | - | 0.0% | - | 0.0% |
| Interest During Construction | 48,596 | 5.1% | - | 0.0% | - | 0.0% |
| Financing & Transaction Fees | 11,705 | 1.3% | - | 0.0% | - | 0.0% |
| Debt Service Reserve Account | 42,981 | 4.7% | - | 0.0% | - | 0.0% |
| Total Soft Costs | 153,185 | 16.7% | - | 0.0% | - | 0.0% |
| Total Uses of Funds | 916,925 | 100.0% | - | 0.0% | - | 0.0% |

**ECHEM**
**Project Summary**
**Integrated Methanol/Ammonia Plant**
Plant uses natural gas as feedstock to produce methanol and excess hydrogen to produce ammonia
***USD '000s***

OK

| Construction Summary | |
|---|---|
| EPC Contract Award | 1Q2006 |
| Construction Period (mos) | 33.00 |
| (Possible Values: 24-36) | |
| Production Phase 1 Starts | 2.75 |
| Construction Phase 2 Begins* | 8.00 |
| Production Phase 2 Starts* | 10.75 |
| Construction Phase 3 Begins* | 15.25 |
| Production Phase 3 Starts* | 18.00 |
| Plant Type | |
| | |
| Project Hard Costs | **USD** |
| ISBL & OSBL | 680,149 |
| Owner's Hard Costs | 12,000 |
| Shipping Terminal | 71,591 |
| **Total Hard Costs** | **763,740** |
| | |
| Project Soft Costs | |
| Working Capital | 16,604 |
| Land Rental During Construction | 7,700 |
| Owner's Soft Costs | 27,600 |
| Interest During Construction | 46,596 |
| Financing & Transaction Fees | 11,705 |
| Debt Service Reserve Account | 42,981 |
| **Total Soft Costs** | **153,185** |
| | |
| **Total Costs** | **916,925** |

* Fractional year for production start = part of next year

| Construction Curve | |
|---|---|
| Qtr 1 | 15% |
| Qtr 2 | 5% |
| Qtr 3 | 10% |
| Qtr 4 | 15% |
| Qtr 5 | 10% |
| Qtr 6 | 10% |
| Qtr 7 | 10% |
| Qtr 8 | 10% |
| Qtr 9 | 5% |
| Qtr 10 | 5% |
| Qtr 11 | 5% |
| Qtr 12 | 0% |

| Construction Cost Assumptions | |
|---|---|
| Cost | 0% |
| | USD |
| ISBL & OSBL | 680,149 |
| Marine Loading Terminal * | 71,591 |
| Total Hard Costs | 751,740 |
| Working Capital | 16,604 |
| Land Rental During Constr. | 7,700 |

* Marine Loading Terminal Cost for Phase 1 Only

| Site Preparation, Marine Loading Terminal & Sea Water Intake Basin Cost | |
|---|---|
| **Cost per Phase** | **USD** |
| Phase 1 | 71,591 |
| Phase 2 | - |
| Phase 3 | 15,000 |

| Owner's Cost | |
|---|---|
| Plant Set-up Costs | 10,000 |
| Cairo Office Costs | 2,000 |
| **Owner's Hard Costs** | 12,000 |
| | |
| Project Development | 15,000 |
| Project Management Team | 10,000 |
| Customs Clearance | 400 |
| Commercial Relations | 500 |
| Safety Incentive | 200 |
| Ind. Engineer | 2,000 |
| **Owner's Soft Costs** | 28,100 |
| | |
| **Total Owners' Cost** | 40,100 |

| Timing of Construction Assumptions | |
|---|---|
| **Construction Start Date (Year)** | |
| Phase 2 (Yes = 1, No = 0)* | 0 |
| Phase 3 (Yes = 1, No = 0)* | 0 |

* Construction start years must not be zeroed out if No = 0 is selected

| Production Assumptions | | |
|---|---|---|
| Methanol Capacity (MTD) | 3,000 | |
| Ammonia Capacity (MTD) | 1,200 | |
| | | |
| Capacity Factor - 1st Year of Operations | 90% | |
| Capacity Factor - Thereafter | 95% | |
| Potential Operating days | 365 | |
| Planned Outage Days | 44 | |
| Planned Outage Days Every | 4 | years |

| Annual COGS & Operating Expense Assumptions | | |
|---|---|---|
| **COGS** | | |
| Methanol Feed and Utility Costs ($ / MT) | | 41.54 |
| Ammonia Feed and Utility Costs ($ / MT) | | 36.28 |
| **Operating Expenses** | | |
| Methanol Fixed Costs ($ / MT) | | 15.04 |
| Ammonia Fixed Costs ($ / MT) | | 23.27 |
| Land Rental | $ | 2,800 |
| Selling, General & Administrative | $ | 1,500 |
| Quarterly Review * | $ | 500 |

| Currency and Inflation Assumptions | | | | |
|---|---|---|---|---|
| | Const. Start | Year 1 | Year 2 | Thereafter |
| Inflation Rate p.a. (US) | 2.50% | 2.60% | 2.70% | 2.90% |

| Fuel Gas Cap Sensitivity Tool |
|---|
| 1.00 |

| Sales Price Assumptions (Current USD) | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 | Year 6 | Year 7 | Year 8 | Year 9 | Year 10 | Year 13 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Methanol Sa | 103 | 108 | 114 | 119 | 121 | 122 | 124 | 125 | 127 | 129 | 135 |
| Ammonia Sa | 199 | 191 | 211 | 195 | 178 | 162 | 145 | 129 | 131 | 132 | 137 |

| Sales Price Sensitivity Tool |
|---|
| 1.00 |

| Senior Debt Financing Assumptions | |
|---|---|
| % Debt financing | 60% |
| Base Rate | 4.50% |
| Construction Risk Premium | 1.50% |
| Interest Rate During Construction | 6.00% |
| Post Construction Risk Premium | 1.50% |
| Post Construction Interest Rate | 6.00% |
| Debt Risk Premium | 0.00% |
| *All-in-Cost Debt* | *6.00%* |
| Cost of Equity | 11.20% |
| Equity Risk Premium | 1.80% |
| All-in-Cost Equity | 13.00% |
| Discount Rate (WACC) | 8.80% |
| Commitment Fee | 0.50% |
| Up-front Fee | 1.0% |
| Transaction Costs | 0.5% |
| Repayment Term (years) | 10 |
| Payment Style (Level = 0, Mortgage = 1) | 0 |
| Debt Service Reserve (months) | 6 |
| Debt Service Reserve Interest Rate | 3.0% |

| Working Capital & Other | |
|---|---|
| Days Receivable | 30 |
| Days Payable | 15 |
| Inventories | 10 |
| Tax Rate | 0% |
| Dividend Payout (% of NI) | 100% |
| Minimum Cash Balance | 1,000 |

| Depreciation Assumptions | |
|---|---|
| **Asset** | **Life** |
| Buildings | 25 |
| Capitalized Financing Costs | 10 |
| Remaining Life | 10 |
| Terminal Value Year | 25 |

**Echem**

***Construction Cost & Drawdown Schedule***

***Integrated Methanol/Ammonia Plant***

| | | Month>> | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *USD Inflation Factor* | | | 1.002 | 1.004 | 1.006 | 1.008 | 1.010 | 1.013 | 1.015 | 1.017 | 1.019 | 1.021 | 1.023 | 1.025 | 1.028 | 1.030 | 1.032 | 1.034 | 1.036 | 1.039 | 1.041 | 1.043 | 1.045 | 1.048 | 1.050 | 1.052 | 1.055 |
| *Construction Curve* | | | 5% | 5% | 5% | 2% | 2% | 2% | 3% | 3% | 3% | 5% | 5% | 5% | 3% | 3% | 3% | 3% | 3% | 3% | 3% | 3% | 3% | 3% | 3% | 3% | 2% |
| ***Phase 1 Construction Costs*** | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Project Hard Costs | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ISBL & OSBL | | 680,149 | 34,007 | 34,007 | 34,007 | 11,336 | 11,336 | 11,338 | 22,672 | 22,672 | 22,672 | 34,007 | 34,007 | 34,007 | 22,672 | 22,672 | 22,672 | 22,672 | 22,672 | 22,672 | 22,672 | 22,672 | 22,672 | 22,672 | 22,672 | 22,672 | 11,338 |
| Owner's Hard Costs | | 12,000 | 600 | 600 | 600 | 200 | 200 | 200 | 400 | 400 | 400 | 600 | 600 | 600 | 400 | 400 | 400 | 400 | 400 | 400 | 400 | 400 | 400 | 400 | 400 | 400 | 200 |
| Marine Loading Terminal | | 71,591 | 3,580 | 3,580 | 3,580 | 1,193 | 1,193 | 1,193 | 2,386 | 2,386 | 2,386 | 3,580 | 3,580 | 3,580 | 2,386 | 2,386 | 2,386 | 2,386 | 2,386 | 2,386 | 2,386 | 2,386 | 2,386 | 2,386 | 2,386 | 2,386 | 1,193 |
| Total Hard Costs | | 763,740 | 38,187 | 38,187 | 38,187 | 12,729 | 12,729 | 12,729 | 25,458 | 25,458 | 25,458 | 38,187 | 38,187 | 38,187 | 25,458 | 25,458 | 25,458 | 25,458 | 25,458 | 25,458 | 25,458 | 25,458 | 25,458 | 25,458 | 25,458 | 25,458 | 12,729 |
| Project Soft Costs | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Working Capital | | 18,604 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Land | | 7,700 | 7,700 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Owner's Soft Costs | | 27,600 | 1,380 | 1,380 | 1,380 | 460 | 460 | 460 | 920 | 920 | 920 | 1,380 | 1,380 | 1,380 | 920 | 920 | 920 | 920 | 920 | 920 | 920 | 920 | 920 | 920 | 920 | 920 | 460 |
| Interest During Construction | | 46,596 | - | 167 | 287 | 407 | 449 | 490 | 532 | 613 | 694 | 776 | 898 | 1,019 | 1,142 | 1,224 | 1,308 | 1,391 | 1,475 | 1,559 | 1,643 | 1,727 | 1,811 | 1,896 | 1,981 | 2,067 | 2,152 |
| Commitment Fee | | 3,452 | 215 | 205 | 195 | 192 | 188 | 185 | 178 | 171 | 165 | 154 | 144 | 134 | 127 | 120 | 113 | 106 | 99 | 92 | 85 | 78 | 71 | 64 | 57 | 50 | 46 |
| Up-front financing fees | | 5,502 | 5,502 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Debt Service Reserve | | 42,981 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Transaction Costs | | 2,751 | 2,751 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Total Soft Costs | | 153,185 | 17,548 | 1,753 | 1,862 | 1,059 | 1,097 | 1,135 | 1,630 | 1,704 | 1,778 | 2,310 | 2,422 | 2,533 | 2,189 | 2,266 | 2,341 | 2,417 | 2,494 | 2,571 | 2,648 | 2,725 | 2,803 | 2,880 | 2,958 | 3,038 | 2,658 |
| **Total Uses of Funds** | | 916,925 | 55,735 | 39,940 | 40,049 | 13,788 | 13,826 | 13,864 | 27,088 | 27,162 | 27,237 | 40,497 | 40,609 | 40,720 | 27,647 | 27,723 | 27,799 | 27,875 | 27,952 | 28,029 | 28,106 | 28,183 | 28,261 | 28,338 | 28,416 | 28,494 | 15,387 |
| Sources of Funds | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Debt | | 550,155 | 33,441 | 23,964 | 24,030 | 8,273 | 8,296 | 8,318 | 16,253 | 16,297 | 16,342 | 24,298 | 24,365 | 24,432 | 16,588 | 16,634 | 16,679 | 16,725 | 16,771 | 16,817 | 16,864 | 16,910 | 16,956 | 17,003 | 17,050 | 17,097 | 9,232 |
| Equity | | 366,770 | 22,294 | 15,976 | 16,020 | 5,515 | 5,530 | 5,545 | 10,835 | 10,865 | 10,896 | 16,199 | 16,244 | 16,288 | 11,059 | 11,089 | 11,120 | 11,150 | 11,181 | 11,212 | 11,242 | 11,273 | 11,304 | 11,335 | 11,367 | 11,398 | 6,155 |
| **Total Sources of Funds** | | 916,925 | 55,735 | 39,940 | 40,049 | 13,788 | 13,826 | 13,864 | 27,088 | 27,162 | 27,237 | 40,497 | 40,609 | 40,720 | 27,647 | 27,723 | 27,799 | 27,875 | 27,952 | 28,029 | 28,106 | 28,183 | 28,261 | 28,338 | 28,416 | 28,494 | 15,387 |
| Construction Loan Schedule | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Beginning Balance | | | - | 33,441 | 57,404 | 81,434 | 89,707 | 98,002 | 106,321 | 122,573 | 138,871 | 155,213 | 179,511 | 203,877 | 228,309 | 244,897 | 261,531 | 278,210 | 294,935 | 311,707 | 328,524 | 345,387 | 362,297 | 379,254 | 396,257 | 413,307 | 430,403 |
| IDC | 6.0% | | - | 167 | 287 | 407 | 449 | 490 | 532 | 613 | 694 | 776 | 898 | 1,019 | 1,142 | 1,224 | 1,308 | 1,391 | 1,475 | 1,559 | 1,643 | 1,727 | 1,811 | 1,896 | 1,981 | 2,067 | 2,152 |
| Draw Downs | | | 33,441 | 23,964 | 24,030 | 8,273 | 8,296 | 8,318 | 16,253 | 16,297 | 16,342 | 24,298 | 24,365 | 24,432 | 16,588 | 16,634 | 16,679 | 16,725 | 16,771 | 16,817 | 16,864 | 16,910 | 16,956 | 17,003 | 17,050 | 17,097 | 9,232 |
| Ending Balance | | | 33,441 | 57,404 | 81,434 | 89,707 | 98,002 | 106,321 | 122,573 | 138,871 | 155,213 | 179,511 | 203,877 | 228,309 | 244,897 | 261,531 | 278,210 | 294,935 | 311,707 | 328,524 | 345,387 | 362,297 | 379,254 | 396,257 | 413,307 | 430,403 | 439,636 |
| Undrawn Loan Amount | | | 516,714 | 492,751 | 468,721 | 460,448 | 452,153 | 443,834 | 427,582 | 411,284 | 394,942 | 370,644 | 346,278 | 321,846 | 305,258 | 288,624 | 271,945 | 255,220 | 238,449 | 221,631 | 204,768 | 187,858 | 170,901 | 153,898 | 136,848 | 119,752 | 110,520 |
| ***Phase 2 Construction Costs*** | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Construction Phase 2 Begins** | *Year* | 8.00 | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Production Phase 2 Starts** | *Year* | 10.75 | | | | | | | | | | | | | | | | | | | | | | | | | |
| Project Hard Costs | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ISBL & OSBL | | - | | | | | | | | | | | | | | | | | | | | | | | | | |
| Marine Loading Terminal | | - | | | | | | | | | | | | | | | | | | | | | | | | | |
| Total Hard Costs | | - | | | | | | | | | | | | | | | | | | | | | | | | | |
| Project Soft Costs | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Working Capital | | - | | | | | | | | | | | | | | | | | | | | | | | | | |
| Land | | - | | | | | | | | | | | | | | | | | | | | | | | | | |
| Owner's Soft Costs | | - | | | | | | | | | | | | | | | | | | | | | | | | | |
| Interest During Construction | | - | | | | | | | | | | | | | | | | | | | | | | | | | |
| Commitment Fee | | - | | | | | | | | | | | | | | | | | | | | | | | | | |
| Up-front financing fees | | - | | | | | | | | | | | | | | | | | | | | | | | | | |
| Debt Service Reserve | | - | | | | | | | | | | | | | | | | | | | | | | | | | |
| Transaction Costs | | - | | | | | | | | | | | | | | | | | | | | | | | | | |
| Total Soft Costs | | - | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Total Uses of Funds** | | - | | | | | | | | | | | | | | | | | | | | | | | | | |
| Sources of Funds | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Debt | | - | | | | | | | | | | | | | | | | | | | | | | | | | |
| Equity | | - | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Total Sources of Funds** | | - | | | | | | | | | | | | | | | | | | | | | | | | | |
| Construction Loan Schedule | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Beginning Balance | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| IDC | 6.0% | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Draw Downs | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Ending Balance | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Undrawn Loan Amount | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ***Phase 3 Construction Costs*** | | | | | | | | | | | | | | | | | | | | | | | | | | | |

**Echem**
***Income Statement***
***Integrated Methanol/Ammonia Plant***
*USD Inflation Factor*

| | Year 1<br>1.03 | Year 2<br>1.05 | Year 3<br>1.08 | Year 4<br>1.12 | Year 5<br>1.15 | Year 6<br>1.18 | Year 7<br>1.22 | Year 8<br>1.25 | Year 9<br>1.29 | Year 10<br>1.32 | Year 11<br>1.36 | Year 12<br>1.40 | Year 13<br>1.44 | Year 14<br>1.48 | Year 15<br>1.53 | Year 16<br>1.57 | Year 17<br>1.62 | Year 18<br>1.66 | Year 19<br>1.71 | Year 20<br>1.76 | Year 21<br>1.81 | Year 22<br>1.87 | Year 23<br>1.92 | Year 24<br>1.98 | Year 25<br>2.03 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Revenue | | | | | | | | | | | | | | | | | | | | | | | | | |
| Methanol | - | - | 30,453 | 138,113 | 144,506 | 149,926 | 137,901 | 162,851 | 170,046 | 177,733 | 150,841 | 188,191 | 193,849 | 199,264 | 180,328 | 210,989 | 217,108 | 223,404 | 202,171 | 236,549 | 243,409 | 250,468 | 226,663 | 265,206 | 272,897 |
| Ammonia | - | - | 22,546 | 90,342 | 85,127 | 79,534 | 64,680 | 67,142 | 69,947 | 72,857 | 65,932 | 77,144 | 79,381 | 81,683 | 73,919 | 86,489 | 88,997 | 91,578 | 82,874 | 96,967 | 99,779 | 102,673 | 92,914 | 108,714 | 111,867 |
| **TOTAL REVENUE** | **-** | **-** | **52,999** | **228,454** | **229,634** | **229,460** | **203,580** | **229,784** | **239,993** | **250,590** | **226,773** | **265,335** | **273,030** | **280,947** | **254,245** | **297,479** | **306,105** | **314,983** | **285,045** | **333,516** | **343,188** | **353,141** | **319,577** | **373,920** | **384,764** |
| Cost of Goods Sold | - | - | 14,973 | 65,055 | 66,941 | 68,882 | 62,336 | 72,936 | 75,051 | 77,227 | 69,857 | 81,771 | 84,143 | 86,583 | 78,354 | 91,877 | 94,336 | 97,072 | 87,848 | 102,784 | 105,784 | 108,831 | 98,488 | 115,235 | 118,677 |
| Value Added Tax | - | - | 405 | 1,779 | 1,741 | 1,726 | 1,513 | 1,701 | 1,785 | 1,871 | 1,693 | 1,979 | 2,036 | 2,093 | 1,893 | 2,214 | 2,277 | 2,341 | 2,117 | 2,476 | 2,546 | 2,617 | 2,367 | 2,767 | 2,845 |
| Gross Profit | - | - | 37,621 | 161,621 | 160,951 | 158,852 | 139,732 | 155,157 | 163,157 | 171,491 | 155,193 | 181,584 | 186,851 | 192,271 | 173,998 | 203,587 | 209,493 | 215,570 | 195,082 | 228,257 | 234,879 | 241,682 | 218,722 | 255,918 | 263,341 |
| Operating Expenses | - | - | 10,456 | 45,038 | 46,071 | 47,066 | 43,042 | 49,177 | 50,780 | 52,434 | 46,239 | 55,520 | 57,130 | 58,786 | 54,083 | 62,245 | 64,051 | 65,908 | 60,636 | 69,786 | 71,810 | 73,892 | 67,981 | 78,240 | 80,509 |
| **EBITDA** | **-** | **-** | **27,166** | **116,583** | **114,880** | **111,786** | **96,689** | **105,980** | **112,378** | **119,057** | **106,954** | **126,065** | **129,722** | **133,486** | **119,915** | **141,342** | **145,442** | **149,662** | **134,447** | **158,471** | **163,069** | **167,800** | **150,742** | **177,677** | **182,832** |
| Depreciation & Amortization | - | - | 9,977 | 39,910 | 39,910 | 39,910 | 39,910 | 39,910 | 39,910 | 39,910 | 39,910 | 39,910 | 37,570 | 30,550 | 30,550 | 30,550 | 30,550 | 30,550 | 30,550 | 30,550 | 30,550 | 30,550 | 30,550 | 30,550 | 30,550 |
| Interest Expense | - | - | 8,252 | 30,948 | 27,645 | 24,344 | 21,043 | 17,743 | 14,442 | 11,141 | 7,840 | 4,539 | 1,238 | - | - | - | - | - | - | - | - | - | - | - | - |
| Earnings Before Income Taxes | - | - | 8,936 | 45,726 | 47,325 | 47,532 | 34,736 | 48,328 | 58,027 | 68,007 | 59,204 | 81,616 | 90,914 | 102,935 | 89,365 | 110,792 | 114,893 | 119,112 | 103,898 | 127,922 | 132,519 | 137,250 | 120,192 | 147,128 | 152,283 |
| Income taxes | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| **NET INCOME** | **-** | **-** | **8,936** | **45,726** | **47,325** | **47,532** | **34,736** | **48,328** | **58,027** | **68,007** | **59,204** | **81,616** | **90,914** | **102,935** | **89,365** | **110,792** | **114,893** | **119,112** | **103,898** | **127,922** | **132,519** | **137,250** | **120,192** | **147,128** | **152,283** |

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***Balance Sheet***
***Integrated Methanol/Ammonia Plant***

| | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 | Year 6 | Year 7 | Year 8 | Year 9 | Year 10 | Year 11 | Year 12 | Year 13 | Year 14 | Year 15 | Year 16 | Year 17 | Year 18 | Year 19 | Year 20 | Year 21 | Year 22 | Year 23 | Year 24 | Year 25 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **ASSETS** | | | | | | | | | | | | | | | | | | | | | | | | | |
| Current Assets | | | | | | | | | | | | | | | | | | | | | | | | | |
| Cash | - | - | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 | 17,958 | 47,890 | 80,522 | 107,700 | 137,577 | 167,435 | 200,318 | 227,089 | 256,884 | 286,658 | 319,824 | 346,137 | 375,841 |
| Restricted Cash -DSRA | - | - | 42,981 | 41,330 | 39,680 | 38,029 | 36,379 | 34,729 | 33,078 | 31,428 | 29,777 | 21,250 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Accounts Receivable | - | - | 17,424 | 18,777 | 18,874 | 18,860 | 18,850 | 18,887 | 19,725 | 20,596 | 18,639 | 21,808 | 22,441 | 23,092 | 20,897 | 24,450 | 25,159 | 25,889 | 23,428 | 27,412 | 28,207 | 29,025 | 26,267 | 30,733 | 31,624 |
| Inventory | - | - | 1,641 | 1,782 | 1,834 | 1,887 | 1,708 | 1,998 | 2,058 | 2,116 | 1,915 | 2,240 | 2,305 | 2,372 | 2,147 | 2,512 | 2,585 | 2,660 | 2,407 | 2,816 | 2,898 | 2,982 | 2,698 | 3,157 | 3,249 |
| Total Current Assets | - | - | 63,046 | 62,890 | 61,388 | 59,776 | 55,737 | 56,614 | 55,860 | 55,140 | 51,331 | 46,298 | 42,704 | 73,354 | 103,565 | 134,662 | 165,321 | 195,983 | 226,154 | 257,317 | 287,989 | 318,665 | 348,789 | 380,027 | 410,714 |
| Long-Term Assets | | | | | | | | | | | | | | | | | | | | | | | | | |
| Gross PP&E | 343,683 | 649,179 | 763,740 | 763,740 | 763,740 | 763,740 | 763,740 | 763,740 | 763,740 | 763,740 | 763,740 | 763,740 | 763,740 | 763,740 | 763,740 | 763,740 | 763,740 | 763,740 | 763,740 | 763,740 | 763,740 | 763,740 | 763,740 | 763,740 | 763,740 |
| Accumulated Depreciation | - | - | 7,637 | 38,187 | 68,737 | 99,286 | 129,836 | 160,385 | 190,935 | 221,485 | 252,034 | 282,584 | 313,133 | 343,683 | 374,233 | 404,782 | 435,332 | 465,881 | 496,431 | 526,981 | 557,530 | 588,080 | 618,629 | 649,179 | 679,729 |
| Total Long-Term Assets | 343,683 | 649,179 | 756,103 | 725,553 | 695,003 | 664,454 | 633,904 | 603,355 | 572,805 | 542,255 | 511,706 | 481,156 | 450,607 | 420,057 | 389,507 | 358,958 | 328,408 | 297,859 | 267,309 | 236,759 | 206,210 | 175,660 | 145,111 | 114,561 | 84,011 |
| Capitalized Soft Costs, Net | 36,832 | 68,160 | 91,260 | 81,900 | 72,540 | 63,180 | 53,820 | 44,460 | 35,100 | 25,740 | 16,380 | 7,020 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| **TOTAL ASSETS** | **380,515** | **717,339** | **910,409** | **870,343** | **828,932** | **787,410** | **743,462** | **704,429** | **663,765** | **623,135** | **579,417** | **534,475** | **493,310** | **493,411** | **493,073** | **493,620** | **493,729** | **493,842** | **493,463** | **494,076** | **494,199** | **494,325** | **493,900** | **494,588** | **494,726** |
| **LIABILITIES** | | | | | | | | | | | | | | | | | | | | | | | | | |
| Current Liabilities | | | | | | | | | | | | | | | | | | | | | | | | | |
| Accounts Payable | - | - | 2,461 | 2,673 | 2,751 | 2,831 | 2,562 | 2,997 | 3,084 | 3,174 | 2,672 | 3,360 | 3,458 | 3,558 | 3,220 | 3,768 | 3,877 | 3,989 | 3,610 | 4,224 | 4,346 | 4,473 | 4,047 | 4,736 | 4,873 |
| Current Portion of Long-Term Debt | - | 13,754 | 55,016 | 55,016 | 55,016 | 55,016 | 55,016 | 55,016 | 55,016 | 55,016 | 55,016 | 41,262 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Total Current Liabilities | - | 13,754 | 57,477 | 57,689 | 57,767 | 57,846 | 57,577 | 58,013 | 58,100 | 58,189 | 57,688 | 44,622 | 3,458 | 3,558 | 3,220 | 3,768 | 3,877 | 3,989 | 3,610 | 4,224 | 4,346 | 4,473 | 4,047 | 4,736 | 4,873 |
| Long-Term Debt | 226,309 | 416,649 | 481,386 | 426,370 | 371,355 | 316,339 | 261,324 | 206,308 | 151,293 | 96,277 | 41,262 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Liabilities | 226,309 | 430,403 | 538,863 | 484,059 | 429,121 | 374,185 | 318,901 | 264,321 | 209,392 | 154,466 | 98,149 | 44,622 | 3,458 | 3,558 | 3,220 | 3,768 | 3,877 | 3,989 | 3,610 | 4,224 | 4,346 | 4,473 | 4,047 | 4,736 | 4,873 |
| SHAREHOLDERS' EQUITY | | | | | | | | | | | | | | | | | | | | | | | | | |
| Paid-In Capital | 152,206 | 286,936 | 366,770 | 366,770 | 366,770 | 366,770 | 366,770 | 366,770 | 366,770 | 366,770 | 366,770 | 366,770 | 366,770 | 366,770 | 366,770 | 366,770 | 366,770 | 366,770 | 366,770 | 366,770 | 366,770 | 366,770 | 366,770 | 366,770 | 366,770 |
| Retained Earnings | - | - | 4,776 | 19,514 | 33,040 | 46,455 | 57,791 | 73,338 | 87,602 | 101,899 | 113,497 | 123,082 | 123,082 | 123,082 | 123,082 | 123,082 | 123,082 | 123,082 | 123,082 | 123,082 | 123,082 | 123,082 | 123,082 | 123,082 | 123,082 |
| Total Shareholders' Equity | 152,206 | 286,936 | 371,547 | 386,284 | 399,810 | 413,225 | 424,561 | 440,108 | 454,372 | 468,669 | 480,267 | 489,853 | 489,853 | 489,853 | 489,853 | 489,853 | 489,853 | 489,853 | 489,853 | 489,853 | 489,853 | 489,853 | 489,853 | 489,853 | 489,853 |
| **TOTAL LIABILITIES AND SHAREHOLDERS' EQUITY** | **380,515** | **717,339** | **910,409** | **870,343** | **828,932** | **787,410** | **743,462** | **704,429** | **663,765** | **623,135** | **579,417** | **534,475** | **493,310** | **493,411** | **493,073** | **493,620** | **493,729** | **493,842** | **493,463** | **494,076** | **494,199** | **494,325** | **493,900** | **494,588** | **494,726** |
| Debt/Equity Ratio | 1.50 | 1.50 | 1.45 | 1.25 | 1.07 | 0.91 | 0.75 | 0.60 | 0.46 | 0.33 | 0.21 | 0.09 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Overall Balance Check (See Below) | OK | OK | OK | OK | OK | OK | OK | OK | OK | OK | OK | OK | OK | OK | OK | OK | OK | OK | OK | OK | OK | OK | OK | OK | OK |

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**Echem**
***Project Cash Flow***
***Integrated Methanol/Ammonia Plant***

| | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 | Year 6 | Year 7 | Year 8 | Year 9 | Year 10 | Year 11 | Year 12 | Year 13 | Year 14 | Year 15 | Year 16 | Year 17 | Year 18 | Year 19 | Year 20 | Year 21 | Year 22 | Year 23 | Year 24 | Year 25 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***OPERATING ACTIVITIES*** | | | | | | | | | | | | | | | | | | | | | | | | | |
| Net Income | - | - | 8,936 | 45,728 | 47,325 | 47,532 | 34,738 | 46,328 | 58,027 | 68,007 | 59,204 | 81,616 | 90,914 | 102,935 | 89,365 | 110,792 | 114,893 | 119,112 | 103,898 | 127,922 | 132,519 | 137,250 | 120,192 | 147,128 | 152,283 |
| Depreciation & amortization | - | - | 9,977 | 39,910 | 39,910 | 39,910 | 39,910 | 39,910 | 39,910 | 39,910 | 39,910 | 39,910 | 37,570 | 30,550 | 30,550 | 30,550 | 30,550 | 30,550 | 30,550 | 30,550 | 30,550 | 30,550 | 30,550 | 30,550 | 30,550 |
| *Changes in Working Capital* | | | | | | | | | | | | | | | | | | | | | | | | | |
| (Increase)/Decrease Accounts receivable | - | - | (17,424) | (1,353) | (97) | 14 | 2,209 | (2,237) | (838) | (871) | 1,956 | (3,189) | (832) | (651) | 2,195 | (3,553) | (709) | (730) | 2,461 | (3,984) | (795) | (818) | 2,759 | (4,467) | (691) |
| (Increase)/Decrease Inventory | - | - | (1,641) | (141) | (52) | (53) | 179 | (290) | (58) | (60) | 201 | (328) | (65) | (67) | 225 | (365) | (73) | (75) | 253 | (409) | (82) | (84) | 283 | (459) | (92) |
| Increase/(Decrease) Accounts payable | - | - | 2,461 | 212 | 78 | 80 | (269) | 436 | 87 | 89 | (302) | 488 | 97 | 100 | (338) | 548 | 109 | 112 | (379) | 614 | 122 | 126 | (425) | 688 | 137 |
| Total Changes in Working Capital | - | - | (16,604) | (1,282) | (71) | 41 | 2,120 | (2,092) | (809) | (841) | 1,857 | (3,007) | (800) | (617) | 2,082 | (3,371) | (673) | (692) | 2,334 | (3,779) | (754) | (776) | 2,617 | (4,237) | (645) |
| **Total Cash Flow from Operations** | - | - | 2,309 | 84,355 | 87,163 | 87,483 | 76,765 | 86,146 | 97,127 | 107,075 | 100,971 | 118,519 | 127,884 | 132,867 | 121,997 | 137,971 | 144,770 | 148,969 | 136,782 | 154,692 | 162,315 | 167,024 | 153,359 | 173,440 | 181,987 |
| ***INVESTING ACTIVITIES*** | | | | | | | | | | | | | | | | | | | | | | | | | |
| Capital Expenditures | (343,683) | (305,496) | (114,561) | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Capitalized Soft Cost | (36,832) | (31,328) | (25,440) | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| **Total Cash from Investing Activities** | (380,515) | (336,824) | (140,001) | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| ***FINANCING ACTIVITIES*** | | | | | | | | | | | | | | | | | | | | | | | | | |
| Loan Proceeds | 228,309 | 202,094 | 119,752 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Principal Payments | - | - | (13,754) | (55,016) | (55,016) | (55,016) | (55,016) | (55,016) | (55,016) | (55,016) | (55,016) | (55,016) | (41,262) | - | - | - | - | - | - | - | - | - | - | - | - |
| DSRA Contribution | - | - | (42,981) | 1,650 | 1,650 | 1,650 | 1,650 | 1,650 | 1,650 | 1,650 | 1,650 | 8,527 | 21,250 | - | - | - | - | - | - | - | - | - | - | - | - |
| Equity Contribution | 152,206 | 134,729 | 79,835 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Dividend payments | - | - | (4,159) | (30,990) | (33,798) | (34,118) | (23,400) | (32,781) | (43,762) | (53,710) | (47,606) | (72,031) | (90,914) | (102,935) | (89,365) | (110,792) | (114,893) | (119,112) | (103,898) | (127,922) | (132,519) | (137,250) | (120,192) | (147,128) | (152,283) |
| **Total Cash from Financing Activities** | 380,515 | 336,824 | 138,692 | (84,355) | (87,163) | (87,483) | (76,765) | (86,146) | (97,127) | (107,075) | (100,971) | (118,519) | (110,926) | (102,935) | (89,365) | (110,792) | (114,893) | (119,112) | (103,898) | (127,922) | (132,519) | (137,250) | (120,192) | (147,128) | (152,283) |
| Beginning Cash Balance | - | - | - | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 | 17,958 | 47,890 | 80,522 | 107,700 | 137,577 | 167,435 | 200,318 | 227,089 | 256,884 | 286,658 | 319,824 | 346,137 |
| Increase (Decrease) in Cash | - | - | 1,000 | - | - | - | - | - | - | - | - | - | 16,958 | 29,932 | 32,632 | 27,179 | 29,877 | 29,857 | 32,884 | 26,770 | 29,795 | 29,774 | 33,167 | 26,312 | 29,704 |
| **Ending Cash Balance** | - | - | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 | 17,958 | 47,890 | 80,522 | 107,700 | 137,577 | 167,435 | 200,318 | 227,089 | 256,884 | 286,658 | 319,824 | 346,137 | 375,841 |
| ***Coverage & Dividend Calculations*** | | | | | | | | | | | | | | | | | | | | | | | | | |
| Operating Cash Flow | - | - | 2,309 | 84,355 | 87,163 | 87,483 | 76,765 | 86,146 | 97,127 | 107,075 | 100,971 | 118,519 | 127,884 | 132,867 | 121,997 | 137,971 | 144,770 | 148,969 | 136,782 | 154,692 | 162,315 | 167,024 | 153,359 | 173,440 | 181,987 |
| Add: Interest Expense | - | - | 8,252 | 30,946 | 27,645 | 24,344 | 21,043 | 17,743 | 14,442 | 11,141 | 7,840 | 4,539 | 1,236 | - | - | - | - | - | - | - | - | - | - | - | - |
| Working Capital Financed by Debt/Equity | - | - | 16,604 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Cash Flow Before Debt Service | - | - | 27,166 | 115,302 | 114,809 | 111,827 | 97,809 | 103,889 | 111,568 | 118,216 | 108,811 | 123,058 | 129,122 | 132,867 | 121,997 | 137,971 | 144,770 | 148,969 | 136,782 | 154,692 | 162,315 | 167,024 | 153,359 | 173,440 | 181,987 |
| Total Debt Service | - | - | (22,006) | (85,962) | (82,861) | (79,360) | (78,059) | (72,758) | (69,457) | (66,156) | (62,855) | (59,554) | (42,499) | - | - | - | - | - | - | - | - | - | - | - | - |
| Cash Flow Before Investing | - | - | 5,159 | 29,340 | 32,148 | 32,467 | 21,750 | 31,131 | 42,111 | 52,060 | 45,956 | 63,504 | 86,622 | 132,867 | 121,997 | 137,971 | 144,770 | 148,969 | 136,782 | 154,692 | 162,315 | 167,024 | 153,359 | 173,440 | 181,987 |
| Cash from Investing Activities | (380,515) | (336,824) | (140,001) | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Loan & Equity Proceeds (Less WC Portion) | 380,515 | 336,824 | 182,982 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| DSRA Funding | - | - | (42,981) | 1,650 | 1,650 | 1,650 | 1,650 | 1,650 | 1,650 | 1,650 | 1,650 | 8,527 | 21,250 | - | - | - | - | - | - | - | - | - | - | - | - |
| Cash Flow Before Dividends | - | - | 5,159 | 30,990 | 33,798 | 34,118 | 23,400 | 32,781 | 43,762 | 53,710 | 47,606 | 72,031 | 107,872 | 132,867 | 121,997 | 137,971 | 144,770 | 148,969 | 136,782 | 154,692 | 162,315 | 167,024 | 153,359 | 173,440 | 181,987 |
| Cash Balance Available for Distribution | (1,000) | (1,000) | (1,000) | - | - | - | - | - | - | - | - | - | - | 16,958 | 48,890 | 79,522 | 108,700 | 138,577 | 166,435 | 199,318 | 226,089 | 255,884 | 285,658 | 318,824 | 345,137 |
| Net Cash Available for Distribution | (1,000) | (1,000) | 4,159 | 30,990 | 33,798 | 34,118 | 23,400 | 32,781 | 43,762 | 53,710 | 47,606 | 72,031 | 107,872 | 149,825 | 168,887 | 217,493 | 251,470 | 285,547 | 303,216 | 354,010 | 388,403 | 422,908 | 439,017 | 492,265 | 527,124 |
| Dividend | - | - | (4,159) | (30,990) | (33,798) | (34,118) | (23,400) | (32,781) | (43,762) | (53,710) | (47,606) | (72,031) | (90,914) | (102,935) | (89,365) | (110,792) | (114,893) | (119,112) | (103,898) | (127,922) | (132,519) | (137,250) | (120,192) | (147,128) | (152,283) |
| Debt Service Coverage Ratio (DSCR) | n/a | n/a | 1.23 | 1.34 | 1.39 | 1.41 | 1.29 | 1.43 | 1.61 | 1.79 | 1.73 | 2.07 | 3.04 | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a |

**Echem**

***Production & Revenue Forecast***

| ***Integrated Methanol/Ammonia Plant*** | **Year 1** | **Year 2** | **Year 3** | **Year 4** | **Year 5** | **Year 6** | **Year 7** | **Year 8** | **Year 9** | **Year 10** | **Year 11** | **Year 12** | **Year 13** | **Year 14** | **Year 15** | **Year 16** | **Year 17** | **Year 18** | **Year 19** | **Year 20** | **Year 21** | **Year 22** | **Year 23** | **Year 24** | **Year 25** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *USD Inflation Factor* | 1.03 | 1.05 | 1.08 | 1.12 | 1.15 | 1.18 | 1.22 | 1.25 | 1.29 | 1.32 | 1.36 | 1.40 | 1.44 | 1.48 | 1.53 | 1.57 | 1.62 | 1.66 | 1.71 | 1.76 | 1.81 | 1.87 | 1.92 | 1.98 | 2.03 |
| ***Phase 1*** | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Total Potential Operating Days* | - | - | 91 | 365 | 365 | 365 | 365 | 365 | 365 | 365 | 365 | 365 | 365 | 365 | 365 | 365 | 365 | 365 | 365 | 365 | 365 | 365 | 365 | 365 | 365 |
| *Planned Outage Days* | - | - | - | - | - | - | 44 | - | - | - | 44 | - | - | - | 44 | - | - | - | 44 | - | - | - | 44 | - | - |
| *Net Operating Days* | - | - | 91 | 365 | 365 | 365 | 321 | 365 | 365 | 365 | 321 | 365 | 365 | 365 | 321 | 365 | 365 | 365 | 321 | 365 | 365 | 365 | 321 | 365 | 365 |
| *Capacity Factor* | 0% | 0% | 90% | 95% | 95% | 95% | 95% | 95% | 95% | 95% | 95% | 95% | 95% | 95% | 95% | 95% | 95% | 95% | 95% | 95% | 95% | 95% | 95% | 95% | 95% |
| ***Phase 2*** | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Total Potential Operating Days* | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE |
| *Planned Outage Days* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Net Operating Days* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Capacity Factor* | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 90% | 95% | 95% | 95% | 95% | 95% | 95% | 95% | 95% | 95% | 95% | 95% | 95% | 95% | 95% |
| ***Phase 3*** | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Total Potential Operating Days* | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | - | - | - | - | - | - | - |
| *Planned Outage Days* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Net Operating Days* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Capacity Factor* | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 90% | 95% | 95% | 95% | 95% | 95% | 95% | 95% |
| ***Total Revenue by Product*** | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Methanol** | | | | | | | | | | | | | | | | | | | | | | | | | |
| Phase 1 Production | - | - | 246,375 | 1,040,250 | 1,040,250 | 1,040,250 | 914,850 | 1,040,250 | 1,040,250 | 1,040,250 | 914,850 | 1,040,250 | 1,040,250 | 1,040,250 | 914,850 | 1,040,250 | 1,040,250 | 1,040,250 | 914,850 | 1,040,250 | 1,040,250 | 1,040,250 | 914,850 | 1,040,250 | 1,040,250 |
| Phase 2 Production | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Phase 3 Production | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Total Production (MT) | - | - | 246,375 | 1,040,250 | 1,040,250 | 1,040,250 | 914,850 | 1,040,250 | 1,040,250 | 1,040,250 | 914,850 | 1,040,250 | 1,040,250 | 1,040,250 | 914,850 | 1,040,250 | 1,040,250 | 1,040,250 | 914,850 | 1,040,250 | 1,040,250 | 1,040,250 | 914,850 | 1,040,250 | 1,040,250 |
| Price per MT, Escalated | 108 | 114 | 124 | 133 | 139 | 144 | 151 | 156 | 163 | 171 | 176 | 181 | 186 | 192 | 197 | 203 | 209 | 215 | 221 | 227 | 234 | 241 | 248 | 255 | 262 |
| **Total Revenue (USD 000)** | - | - | **30,483** | **138,113** | **144,506** | **149,926** | **137,901** | **162,651** | **170,048** | **177,733** | **160,841** | **188,191** | **193,649** | **199,264** | **180,326** | **210,989** | **217,108** | **223,404** | **202,171** | **236,549** | **243,409** | **250,468** | **226,863** | **265,206** | **272,897** |
| **Ammonia** | | | | | | | | | | | | | | | | | | | | | | | | | |
| Phase 1 Production | - | - | 98,550 | 416,100 | 416,100 | 416,100 | 365,940 | 416,100 | 416,100 | 416,100 | 365,940 | 416,100 | 416,100 | 416,100 | 365,940 | 416,100 | 416,100 | 416,100 | 365,940 | 416,100 | 416,100 | 416,100 | 365,940 | 416,100 | 416,100 |
| Phase 2 Production | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Phase 3 Production | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Total Production (MT) | - | - | 98,550 | 416,100 | 416,100 | 416,100 | 365,940 | 416,100 | 416,100 | 416,100 | 365,940 | 416,100 | 416,100 | 416,100 | 365,940 | 416,100 | 416,100 | 416,100 | 365,940 | 416,100 | 416,100 | 416,100 | 365,940 | 416,100 | 416,100 |
| Price per MT, Escalated | 204 | 201 | 229 | 217 | 205 | 191 | 177 | 161 | 168 | 175 | 180 | 185 | 191 | 196 | 202 | 208 | 214 | 220 | 226 | 233 | 240 | 247 | 254 | 261 | 269 |
| **Total Revenue (USD 000)** | - | - | **22,546** | **90,342** | **85,127** | **79,534** | **64,680** | **67,142** | **69,947** | **72,857** | **65,932** | **77,144** | **79,381** | **81,683** | **73,918** | **86,489** | **88,997** | **91,578** | **82,674** | **96,967** | **99,779** | **102,673** | **92,914** | **108,714** | **111,867** |
| ***Total Revenue by Phase*** | | | | | | | | | | | | | | | | | | | | | | | | | |
| Phase 1 Revenue | - | - | 52,999 | 228,454 | 229,634 | 229,460 | 202,580 | 229,794 | 239,993 | 250,590 | 226,773 | 265,335 | 273,030 | 280,947 | 254,245 | 297,479 | 306,105 | 314,983 | 285,045 | 333,516 | 343,188 | 353,141 | 319,577 | 373,920 | 384,764 |
| Phase 2 Revenue | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Phase 3 Revenue | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| **Total Revenue** | - | - | **52,999** | **228,454** | **229,634** | **229,460** | **202,580** | **229,794** | **239,993** | **250,590** | **226,773** | **265,335** | **273,030** | **280,947** | **254,245** | **297,479** | **306,105** | **314,983** | **285,045** | **333,516** | **343,188** | **353,141** | **319,577** | **373,920** | **384,764** |

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***Cost of Goods Sold***

| ***Integrated Methanol/Ammonia Plant*** | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 | Year 6 | Year 7 | Year 8 | Year 9 | Year 10 | Year 11 | Year 12 | Year 13 | Year 14 | Year 15 | Year 16 | Year 17 | Year 18 | Year 19 | Year 20 | Year 21 | Year 22 | Year 23 | Year 24 | Year 25 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *USD Inflation Factor* | 1.026 | 1.054 | 1.084 | 1.116 | 1.145 | 1.181 | 1.216 | 1.251 | 1.287 | 1.324 | 1.363 | 1.402 | 1.443 | 1.485 | 1.528 | 1.572 | 1.618 | 1.665 | 1.713 | 1.763 | 1.814 | 1.866 | 1.921 | 1.976 | 2.034 |
| Methanol Feed & Utility Cost ($/MT) | 42.62 | 43.77 | 45.04 | 46.35 | 47.69 | 49.07 | 50.50 | 51.96 | 53.47 | 55.02 | 56.61 | 58.25 | 59.94 | 61.68 | 63.47 | 65.31 | 67.21 | 69.15 | 71.16 | 73.22 | 75.35 | 77.53 | 79.78 | 82.09 | 84.48 |
| Ammonia Feed & Utility Cost ($/MT) | 37.23 | 38.23 | 39.34 | 40.48 | 41.65 | 42.86 | 44.11 | 45.38 | 46.70 | 48.05 | 49.45 | 50.88 | 52.36 | 53.88 | 55.44 | 57.05 | 58.70 | 60.40 | 62.15 | 63.96 | 65.81 | 67.72 | 69.68 | 71.71 | 73.78 |
| ***Total COGS By Product*** | | | | | | | | | | | | | | | | | | | | | | | | | |
| Methanol | - | - | 11,097 | 46,211 | 49,609 | 51,047 | 46,198 | 54,051 | 56,619 | 57,232 | 51,792 | 60,599 | 62,357 | 64,165 | 58,066 | 67,940 | 69,911 | 71,938 | 65,101 | 78,171 | 78,380 | 80,653 | 72,987 | 85,399 | 87,876 |
| Ammonia | - | - | 3,877 | 18,844 | 17,332 | 17,835 | 16,140 | 18,884 | 19,432 | 19,996 | 18,095 | 21,172 | 21,796 | 22,418 | 20,287 | 23,737 | 24,425 | 25,134 | 22,745 | 26,813 | 27,384 | 28,179 | 25,500 | 29,837 | 30,702 |
| Total Cost of Goods Sold | - | - | 14,973 | 65,055 | 66,941 | 68,882 | 62,336 | 72,936 | 76,051 | 77,227 | 69,887 | 81,771 | 84,143 | 86,583 | 78,354 | 91,677 | 94,336 | 97,072 | 87,846 | 102,784 | 105,764 | 108,831 | 98,488 | 115,235 | 118,577 |
| ***Total COGS By Phase*** | | | | | | | | | | | | | | | | | | | | | | | | | |
| Phase 1 | - | - | 14,973 | 65,055 | 66,941 | 68,882 | 62,336 | 72,936 | 76,051 | 77,227 | 69,887 | 81,771 | 84,143 | 86,583 | 78,354 | 91,677 | 94,336 | 97,072 | 87,846 | 102,784 | 105,764 | 108,831 | 98,488 | 115,235 | 118,577 |
| Phase 2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Phase 3 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Total Cost of Goods Sold | - | - | 14,973 | 65,055 | 66,941 | 68,882 | 62,336 | 72,936 | 76,051 | 77,227 | 69,887 | 81,771 | 84,143 | 86,583 | 78,354 | 91,677 | 94,336 | 97,072 | 87,846 | 102,784 | 105,764 | 108,831 | 98,488 | 115,235 | 118,577 |
| ***Natural Gas Cost*** | | | | | | | | | | | | | | | | | | | | | | | | | |
| Methanol Natural Gas Cost | - | - | 11,641 | 39,036 | 52,043 | 53,552 | 46,462 | 56,703 | 58,348 | 60,040 | 54,333 | 63,573 | 65,416 | 67,313 | 60,916 | 71,274 | 73,341 | 75,458 | 68,295 | 79,908 | 82,226 | 84,510 | 76,569 | 89,589 | 92,187 |
| Ammonia Natural Gas Cost | - | - | 866 | 11,541 | 3,460 | 3,327 | 2,784 | 2,974 | 3,188 | 3,417 | 3,181 | 3,830 | 4,056 | 4,294 | 3,999 | 4,815 | 5,098 | 5,398 | 5,027 | 6,052 | 6,408 | 6,785 | 8,318 | 7,607 | 8,055 |
| Total Natural Gas Cost | - | - | 12,507 | 50,576 | 55,503 | 56,879 | 51,246 | 59,677 | 61,535 | 63,456 | 57,515 | 67,403 | 69,472 | 71,608 | 64,915 | 76,089 | 78,438 | 80,856 | 73,322 | 85,960 | 88,634 | 91,295 | 82,887 | 97,196 | 100,242 |

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***Operating Expenses***
***Integrated Methanol/Ammonia Plant***

| | | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 | Year 6 | Year 7 | Year 8 | Year 9 | Year 10 | Year 11 | Year 12 | Year 13 | Year 14 | Year 15 | Year 16 | Year 17 | Year 18 | Year 19 | Year 20 | Year 21 | Year 22 | Year 23 | Year 24 | Year 25 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *USD Inflation Factor* | | 1.026 | 1.054 | 1.084 | 1.116 | 1.148 | 1.181 | 1.216 | 1.251 | 1.287 | 1.324 | 1.363 | 1.402 | 1.443 | 1.485 | 1.528 | 1.572 | 1.618 | 1.665 | 1.713 | 1.763 | 1.814 | 1.866 | 1.921 | 1.976 | 2.034 |
| *Number of Phases in Operation* | | - | - | 0.3 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| **Operating Expenses** | *Amount** | | | | | | | | | | | | | | | | | | | | | | | | | |
| Land Rental | 2,800 | - | - | 759 | 3,124 | 3,215 | 3,308 | 3,404 | 3,502 | 3,604 | 3,709 | 3,816 | 3,927 | 4,041 | 4,158 | 4,278 | 4,402 | 4,530 | 4,661 | 4,797 | 4,936 | 5,079 | 5,226 | 5,376 | 5,534 | 5,694 |
| Selling, General & Administrative | 1,500 | - | - | 407 | 1,674 | 1,722 | 1,772 | 1,823 | 1,876 | 1,931 | 1,987 | 2,044 | 2,104 | 2,165 | 2,227 | 2,292 | 2,358 | 2,427 | 2,497 | 2,570 | 2,644 | 2,721 | 2,800 | 2,881 | 2,964 | 3,050 |
| Other Fixed Costs ($ / MT) | 38.31 | - | - | 6,504 | 26,260 | 29,079 | 29,922 | 27,078 | 31,683 | 32,602 | 33,547 | 30,356 | 35,521 | 36,551 | 37,611 | 34,037 | 39,824 | 40,979 | 42,166 | 38,160 | 44,849 | 45,944 | 47,278 | 42,783 | 50,058 | 51,510 |
| *Marketing Expenses* | *5.0%* | - | - | *2,650* | *11,423* | *11,482* | *11,473* | *10,129* | *11,490* | 12,000 | 12,529 | 11,339 | 13,267 | 13,651 | 14,047 | 12,712 | 14,874 | 15,305 | 15,749 | 14,252 | 16,678 | 17,159 | 17,657 | 15,979 | 18,696 | 19,238 |
| Quarterly Review | 500 | - | - | 136 | 556 | 574 | 591 | 608 | 625 | 644 | 662 | 681 | 701 | 722 | 742 | 764 | 788 | 809 | 832 | 857 | 881 | 907 | 933 | 960 | 988 | 1,017 |
| **Total Operating Expenses** | | - | - | 10,456 | 45,036 | 46,071 | 47,066 | 43,042 | 49,177 | 50,780 | 52,434 | 48,239 | 55,520 | 57,130 | 58,785 | 54,083 | 62,245 | 64,051 | 65,908 | 60,635 | 69,786 | 71,810 | 73,862 | 67,981 | 78,240 | 80,509 |

* Amount per phase except for land rental.

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***Debt Summary***

| ***Integrated Methanol/Ammonia Plant*** | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 | Year 6 | Year 7 | Year 8 | Year 9 | Year 10 | Year 11 | Year 12 | Year 13 | Year 14 | Year 15 | Year 16 | Year 17 | Year 18 | Year 19 | Year 20 | Year 21 | Year 22 | Year 23 | Year 24 | Year 25 | Year 26 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Phase 1*** | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Beginning Balance | - | 228,309 | 430,403 | 536,401 | 481,388 | 426,370 | 371,355 | 316,339 | 261,324 | 206,308 | 151,293 | 96,277 | 41,262 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| Draws | 228,309 | 202,094 | 119,752 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | |
| Interest Due | - | - | 8,252 | 30,946 | 27,845 | 24,344 | 21,043 | 17,743 | 14,442 | 11,141 | 7,840 | 4,539 | 1,238 | - | - | - | - | - | - | - | - | - | - | - | - | |
| Principal Payment | - | - | 13,754 | 55,016 | 55,016 | 55,016 | 55,016 | 55,016 | 55,016 | 55,016 | 55,016 | 55,016 | 41,262 | - | - | - | - | - | - | - | - | - | - | - | - | |
| Ending Balance | 228,309 | 430,403 | 536,401 | 481,388 | 426,370 | 371,355 | 316,339 | 261,324 | 206,308 | 151,293 | 96,277 | 41,262 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| Debt Service | - | - | 22,006 | 85,962 | 82,861 | 79,360 | 76,059 | 72,758 | 69,457 | 66,156 | 62,855 | 59,554 | 42,499 | - | - | - | | | | | | | | | | |
| DSRA | - | - | 42,981 | 41,330 | 39,680 | 38,029 | 36,379 | 34,729 | 33,078 | 31,428 | 29,777 | 21,250 | - | - | - | - | - | - | - | - | - | - | - | - | - | |
| ***Phase 2*** | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Beginning Balance | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | |
| Draws | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | |
| Interest Due | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | |
| Principal Payment | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | |
| Ending Balance | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | |
| Debt Service | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | |
| DSRA | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | |
| ***Phase 3*** | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Beginning Balance | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Draws | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Interest Due | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Principal Payment | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Ending Balance | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Debt Service | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| DSRA | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Total Debt Service | - | - | 22,006 | 85,962 | 82,861 | 79,360 | 76,059 | 72,758 | 69,457 | 66,156 | 62,855 | 59,554 | 42,499 | - | - | - | - | - | - | - | - | - | - | - | - | |
| DSRA | - | - | 42,981 | 41,330 | 39,680 | 38,029 | 36,379 | 34,729 | 33,078 | 31,428 | 29,777 | 21,250 | - | - | - | - | - | - | - | - | - | - | - | - | - | |

***Monthly Debt Service Schedule***

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Interest rate | 6.00% | Phase 1 Loan Amount | $ 550,155 | Phase 2 Loan Amount | $ - | Phase 3 Loan Amount | $ - |
| Payments/yr | 4 | | | Construction Begin Month | 84 | Construction Begin Month | 171 |
| Term (yrs) | 10 | | | Grace Period (months) | 33 | Grace Period (mos) | 33 |
| Grace Period | 33 | | | Grace Period End Month | 117 | Grace Period End Month | 204 |

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***Asset Depreciation***

| ***Integrated Methanol/Ammonia Plant*** | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 | Year 6 | Year 7 | Year 8 | Year 9 | Year 10 | Year 11 | Year 12 | Year 13 | Year 14 | Year 15 | Year 16 | Year 17 | Year 18 | Year 19 | Year 20 | Year 21 | Year 22 | Year 23 | Year 24 | Year 25 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Total Fixed Assets*** | | | | | | | | | | | | | | | | | | | | | | | | | |
| Gross Fixed Assets | 380,515 | 717,339 | 857,340 | 857,340 | 857,340 | 857,340 | 857,340 | 857,340 | 857,340 | 857,340 | 857,340 | 857,340 | 857,340 | 857,340 | 857,340 | 857,340 | 857,340 | 857,340 | 857,340 | 857,340 | 857,340 | 857,340 | 857,340 | 857,340 | 857,340 |
| Total Depreciation and Amortization | - | - | 9,977 | 39,910 | 39,910 | 39,910 | 39,910 | 39,910 | 39,910 | 39,910 | 39,910 | 39,910 | 37,570 | 30,550 | 30,550 | 30,550 | 30,550 | 30,550 | 30,550 | 30,550 | 30,550 | 30,550 | 30,550 | 30,550 | 30,550 |
| Total Accumulated Depreciation | - | - | 9,977 | 49,887 | 89,797 | 129,706 | 169,616 | 209,526 | 249,435 | 289,345 | 329,254 | 369,164 | 406,734 | 437,283 | 467,833 | 496,382 | 526,932 | 559,482 | 590,031 | 620,581 | 651,130 | 681,680 | 712,230 | 742,779 | 773,329 |
| **Net Fixed Assets** | **380,515** | **717,339** | **847,363** | **807,453** | **767,544** | **727,634** | **687,724** | **647,815** | **607,905** | **567,995** | **528,086** | **488,175** | **450,607** | **420,057** | **389,507** | **358,958** | **328,408** | **297,859** | **267,309** | **236,759** | **206,210** | **175,660** | **145,111** | **114,561** | **84,011** |
| ***Property, Plant & Equipment*** | | | | | | | | | | | | | | | | | | | | | | | | | |
| Gross Fixed Assets - Phase 1 | 343,683 | 649,179 | 763,740 | 763,740 | 763,740 | 763,740 | 763,740 | 763,740 | 763,740 | 763,740 | 763,740 | 763,740 | 763,740 | 763,740 | 763,740 | 763,740 | 763,740 | 763,740 | 763,740 | 763,740 | 763,740 | 763,740 | 763,740 | 763,740 | 763,740 |
| Depreciation | - | - | 7,637 | 30,550 | 30,550 | 30,550 | 30,550 | 30,550 | 30,550 | 30,550 | 30,550 | 30,550 | 30,550 | 30,550 | 30,550 | 30,550 | 30,550 | 30,550 | 30,550 | 30,550 | 30,550 | 30,550 | 30,550 | 30,550 | 30,550 |
| Accumulated Depreciation | - | - | 7,637 | 38,187 | 68,737 | 99,286 | 129,836 | 160,385 | 190,936 | 221,486 | 252,034 | 282,584 | 313,133 | 343,683 | 374,233 | 404,782 | 435,332 | 465,881 | 496,431 | 526,981 | 557,530 | 588,080 | 618,629 | 649,179 | 679,729 |
| Sub-Total | 343,683 | 649,179 | 758,103 | 725,553 | 695,003 | 664,454 | 633,904 | 603,355 | 572,805 | 542,255 | 511,706 | 481,156 | 450,607 | 420,057 | 389,507 | 358,958 | 328,408 | 297,859 | 267,309 | 236,759 | 206,210 | 175,660 | 145,111 | 114,561 | 84,011 |
| Gross Fixed Assets - Phase 2 | | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Depreciation | | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Accumulated Depreciation | | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Sub-Total | | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Gross Fixed Assets - Phase 3 | | | | | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Depreciation | | | | | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Accumulated Depreciation | | | | | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Sub-Total | | | | | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| ***Capitalized Soft Costs*** | | | | | | | | | | | | | | | | | | | | | | | | | |
| Capitalized Soft Costs - Phase 1 | 36,832 | 68,160 | 93,600 | 93,600 | 93,600 | 93,600 | 93,600 | 93,600 | 93,600 | 93,600 | 93,600 | 93,600 | 93,600 | 93,600 | 93,600 | 93,600 | 93,600 | 93,600 | 93,600 | 93,600 | 93,600 | 93,600 | 93,600 | 93,600 | 93,600 |
| Amortization | - | - | 2,340 | 9,360 | 9,360 | 9,360 | 9,360 | 9,360 | 9,360 | 9,360 | 9,360 | 9,360 | 7,020 | - | - | - | - | - | - | - | - | - | - | - | - |
| Accumulated Amortization | - | - | 2,340 | 11,700 | 21,060 | 30,420 | 39,780 | 49,140 | 58,500 | 67,860 | 77,220 | 86,580 | 93,600 | 93,600 | 93,600 | 93,600 | 93,600 | 93,600 | 93,600 | 93,600 | 93,600 | 93,600 | 93,600 | 93,600 | 93,600 |
| Sub-Total | 36,832 | 68,160 | 91,260 | 81,900 | 72,540 | 63,180 | 53,820 | 44,460 | 35,100 | 25,740 | 16,380 | 7,020 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Capitalized Soft Costs - Phase 2 | | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Amortization | | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Accumulated Amortization | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Sub-Total | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Capitalized Soft Costs - Phase 3 | | | | | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Amortization | | | | | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Accumulated Amortization | | | | | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Sub-Total | | | | | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |

**Echem**

***Working Capital Summary***

***Integrated Methanol/Ammonia Plant***

| | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 | Year 6 | Year 7 | Year 8 | Year 9 | Year 10 | Year 11 | Year 12 | Year 13 | Year 14 | Year 15 | Year 16 | Year 17 | Year 18 | Year 19 | Year 20 | Year 21 | Year 22 | Year 23 | Year 24 | Year 25 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Phase 1 Working Capital*** | | | | | | | | | | | | | | | | | | | | | | | | | |
| Gross Revenue | - | - | 52,999 | 229,454 | 229,634 | 229,460 | 202,580 | 229,794 | 239,993 | 250,590 | 226,773 | 285,335 | 273,030 | 280,947 | 254,245 | 297,479 | 308,105 | 314,983 | 285,045 | 333,516 | 343,188 | 353,141 | 319,577 | 373,920 | 384,764 |
| Operating Days (Gross) | - | - | 91 | 365 | 365 | 365 | 365 | 365 | 365 | 365 | 365 | 365 | 365 | 365 | 365 | 365 | 365 | 365 | 365 | 365 | 365 | 365 | 365 | 365 | 365 |
| Average Daily Revenue | - | - | 581 | 629 | 629 | 629 | 555 | 630 | 658 | 687 | 621 | 727 | 748 | 770 | 697 | 815 | 839 | 863 | 781 | 914 | 940 | 968 | 876 | 1,024 | 1,054 |
| Average Receivables Days | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 |
| Average Receivables Balance | - | - | 17,424 | 18,777 | 18,874 | 18,860 | 16,650 | 18,887 | 19,725 | 20,596 | 18,639 | 21,808 | 22,441 | 23,092 | 20,897 | 24,450 | 25,159 | 25,889 | 23,428 | 27,412 | 28,207 | 29,025 | 26,267 | 30,733 | 31,624 |
| Total COGS | - | - | 14,973 | 65,055 | 66,941 | 66,882 | 62,336 | 72,936 | 75,051 | 77,227 | 69,887 | 81,771 | 84,143 | 86,583 | 78,354 | 91,677 | 94,336 | 97,072 | 87,846 | 102,784 | 105,764 | 108,831 | 98,488 | 115,235 | 118,577 |
| Operating Days | - | - | 91 | 365 | 365 | 365 | 365 | 365 | 365 | 365 | 365 | 365 | 365 | 365 | 365 | 365 | 365 | 365 | 365 | 365 | 365 | 365 | 365 | 365 | 365 |
| Average Daily COGS | - | - | 164 | 178 | 183 | 183 | 171 | 200 | 206 | 212 | 191 | 224 | 231 | 237 | 215 | 251 | 258 | 266 | 241 | 282 | 290 | 298 | 270 | 316 | 325 |
| Average Inventory Days | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| Average Inventory Balance | - | - | 1,641 | 1,782 | 1,834 | 1,887 | 1,708 | 1,998 | 2,056 | 2,116 | 1,915 | 2,240 | 2,305 | 2,372 | 2,147 | 2,512 | 2,585 | 2,660 | 2,407 | 2,816 | 2,898 | 2,982 | 2,698 | 3,157 | 3,249 |
| Total COGS | - | - | 14,973 | 65,055 | 66,941 | 66,882 | 62,336 | 72,936 | 75,051 | 77,227 | 69,887 | 81,771 | 84,143 | 86,583 | 78,354 | 91,677 | 94,336 | 97,072 | 87,846 | 102,784 | 105,764 | 108,831 | 98,488 | 115,235 | 118,577 |
| Operating Days | - | - | 91 | 365 | 365 | 365 | 365 | 365 | 365 | 365 | 365 | 365 | 365 | 365 | 365 | 365 | 365 | 365 | 365 | 365 | 365 | 365 | 365 | 365 | 365 |
| Average Daily Cost | - | - | 164 | 178 | 183 | 183 | 171 | 200 | 206 | 212 | 191 | 224 | 231 | 237 | 215 | 251 | 258 | 266 | 241 | 282 | 290 | 298 | 270 | 316 | 325 |
| Average Payable Days | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 |
| Average Payables Balance | - | - | 2,461 | 2,673 | 2,751 | 2,831 | 2,562 | 2,997 | 3,084 | 3,174 | 2,872 | 3,360 | 3,458 | 3,558 | 3,220 | 3,766 | 3,877 | 3,989 | 3,610 | 4,224 | 4,348 | 4,473 | 4,047 | 4,736 | 4,873 |
| Net Working Capital | - | - | 16,804 | 17,886 | 17,957 | 17,916 | 15,787 | 17,888 | 18,697 | 19,539 | 17,682 | 20,668 | 21,288 | 21,905 | 19,824 | 23,194 | 23,867 | 24,559 | 22,225 | 26,004 | 26,758 | 27,534 | 24,917 | 29,155 | 30,000 |
| ***Phase 2 Working Capital*** | | | | | | | | | | | | | | | | | | | | | | | | | |
| Gross Revenue | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Operating Days (Gross) | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE |
| Average Daily Revenue | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Average Receivables Days | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 |
| Average Receivables Balance | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Total COGS | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Operating Days | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE |
| Average Daily Cost | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Average Inventory Days | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| Average Inventory Balance | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Total COGS + Opex | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Operating Days | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE |
| Average Daily Cost | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Average Payable Days | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 |
| Average Payables Balance | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Net Working Capital | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| ***Phase 3 Working Capital*** | | | | | | | | | | | | | | | | | | | | | | | | | |
| Gross Revenue | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Operating Days (Gross) | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | - | - | - | - | - | - | - |
| Average Daily Revenue | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Average Receivables Days | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 |
| Average Receivables Balance | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Total COGS | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Operating Days | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | - | - | - | - | - | - | - |
| Average Daily Cost | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Average Inventory Days | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| Average Inventory Balance | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Total COGS | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Operating Days | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | - | - | - | - | - | - | - |
| Average Daily Cost | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Average Payable Days | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 |
| Average Payables Balance | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Net Working Capital | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| **Grand Totals** | | | | | | | | | | | | | | | | | | | | | | | | | |
| Accounts Receivable | | - | - | 17,424 | 18,777 | 18,874 | 18,860 | 16,650 | 18,887 | 19,725 | 20,596 | 18,639 | 21,808 | 22,441 | 23,092 | 20,897 | 24,450 | 25,159 | 25,889 | 23,428 | 27,412 | 28,207 | 29,025 | 26,267 | 30,733 | 31,624 |
| Inventory | | - | - | 1,641 | 1,782 | 1,834 | 1,887 | 1,708 | 1,998 | 2,056 | 2,116 | 1,915 | 2,240 | 2,305 | 2,372 | 2,147 | 2,512 | 2,585 | 2,660 | 2,407 | 2,816 | 2,898 | 2,982 | 2,698 | 3,157 | 3,249 |
| Accounts Payable | | - | - | 2,461 | 2,673 | 2,751 | 2,831 | 2,562 | 2,997 | 3,084 | 3,174 | 2,872 | 3,360 | 3,458 | 3,558 | 3,220 | 3,766 | 3,877 | 3,989 | 3,610 | 4,224 | 4,348 | 4,473 | 4,047 | 4,736 | 4,873 |
| **Working Capital included as Project Costs:** | | | | | | | | | | | | | | | | | | | | | | | | | |
| Phase 1 | 16,804 | - | - | 16,804 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Phase 2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Phase 3 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |

**Echem**

***Ratio Analysis and Profitability Indicators***

***Integrated Methanol/Ammonia Plant***

| | | | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 | Year 6 | Year 7 | Year 8 | Year 9 | Year 10 | Year 11 | Year 12 | Year 13 | Year 14 | Year 15 | Year 16 | Year 17 | Year 18 | Year 19 | Year 20 | Year 21 | Year 22 | Year 23 | Year 24 | Year 25 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| EBITDA Margin | | | n/a | n/a | 51.3% | 51.0% | 50.0% | 48.7% | 47.2% | 46.1% | 46.8% | 47.5% | 47.2% | 47.5% | 47.5% | 47.5% | 47.2% | 47.5% | 47.5% | 47.5% | 47.2% | 47.5% | 47.5% | 47.5% | 47.2% | 47.5% | 47.5% |
| Net Income Margin | | | n/a | n/a | 16.9% | 20.0% | 20.6% | 20.7% | 17.1% | 21.0% | 24.2% | 27.1% | 26.1% | 30.8% | 33.3% | 36.6% | 35.1% | 37.2% | 37.5% | 37.8% | 35.4% | 38.4% | 38.6% | 38.9% | 37.6% | 39.3% | 39.6% |
| Return on Assets | | | n/a | n/a | 1.0% | 5.3% | 5.7% | 6.0% | 4.7% | 6.9% | 8.7% | 10.9% | 10.2% | 15.3% | 18.4% | 20.9% | 18.1% | 22.4% | 23.3% | 24.1% | 21.1% | 25.9% | 26.8% | 27.8% | 24.3% | 29.7% | 30.6% |
| Return on Equity | | | n/a | n/a | 2.4% | 11.6% | 11.8% | 11.5% | 8.2% | 11.0% | 12.8% | 14.5% | 12.3% | 16.7% | 18.5% | 21.0% | 18.2% | 22.6% | 23.5% | 24.3% | 21.2% | 26.1% | 27.1% | 28.0% | 24.5% | 30.0% | 31.1% |
| Current Ratio | | | n/a | - | 1.10 | 1.09 | 1.08 | 1.03 | 0.97 | 0.98 | 0.96 | 0.95 | 0.89 | 1.04 | 12.35 | 20.62 | 32.16 | 35.74 | 42.64 | 49.13 | 62.64 | 60.92 | 66.26 | 71.25 | 86.18 | 80.25 | 84.28 |
| DSCR | Min 1.23 | Avg 1.53 | n/a | n/a | 1.23 | 1.34 | 1.39 | 1.41 | 1.29 | 1.43 | 1.61 | 1.79 | 1.73 | 2.07 | 3.04 | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a |
| Debt to Equity | Max 1.50 | Avg 0.84 | 1.50 | 1.50 | 1.45 | 1.25 | 1.07 | 0.91 | 0.75 | 0.60 | 0.46 | 0.33 | 0.21 | 0.09 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Discount Rate | | 8.80% | | | | | | | | | | | | | | | | | | | | | | | | | |
| ***FCF Project NPV*** | | **356,377** | | | | | | | | | | | | | | | | | | | | | | | | | |
| ***FCF Project IRR*** | | **13.0%** | | | | | | | | | | | | | | | | | | | | | | | | | |
| Operating Cash Flow | | | - | - | 2,309 | 84,355 | 87,163 | 87,483 | 76,765 | 86,148 | 97,127 | 107,076 | 100,971 | 118,519 | 127,884 | 132,867 | 121,997 | 137,971 | 144,770 | 148,969 | 136,782 | 154,692 | 162,315 | 167,024 | 153,359 | 173,440 | 181,987 |
| Add Back: Interest Expense | | | - | - | 6,252 | 30,946 | 27,645 | 24,344 | 21,043 | 17,743 | 14,442 | 11,141 | 7,840 | 4,539 | 1,238 | - | - | - | - | - | - | - | - | - | - | - | - |
| Less: Interest Savings from Interest Expense | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Investing Cash Flow | | | (343,683) | (305,496) | (114,561) | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Less: Equity Financing Soft Costs | | | (20,120) | (11,040) | (4,140) | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Terminal Value | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 987,504 |
| Project Free Cash Flow | | | (363,803) | (316,536) | (108,139) | 115,302 | 114,809 | 111,827 | 97,809 | 103,889 | 111,568 | 118,216 | 108,811 | 123,058 | 129,122 | 132,867 | 121,997 | 137,971 | 144,770 | 148,969 | 136,782 | 154,692 | 162,315 | 167,024 | 153,359 | 173,440 | 1,169,491 |

# APPENDIX 5

## CASE 1

## PRELIMINARY PROJECT DESIGN BASIS

The Project Design Basis includes the Project Design Data (PDD) register. The PDD is a "living" document that is updated as source data becomes available, or as data is generated during the project development phases.

The PDD included in this Appendix includes the data developed during the course of the Feasibility Study.

# PRELIMINARY

# PROJECT DESIGN BASIS FOR

# ECHEM STUDY

## USTDA FUNDED FEASIBILITY STUDY

## Integrated Ammonia/Methanol Production Facilities

## To be Constructed for Echem Egypt - Mediterranean Coast

| NUMBER | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|
| REASON for Update | Draft for Review and Comment | Added Shipping Data and Gas Analysis | | | | | |
| DATE: | 30 Sept 04 | 09 Dec 2004 | | | | | |
| Prepared By: | AW | AW | | | | | |
| Approved By: | Alun Waters | Alun Waters | | | | | |

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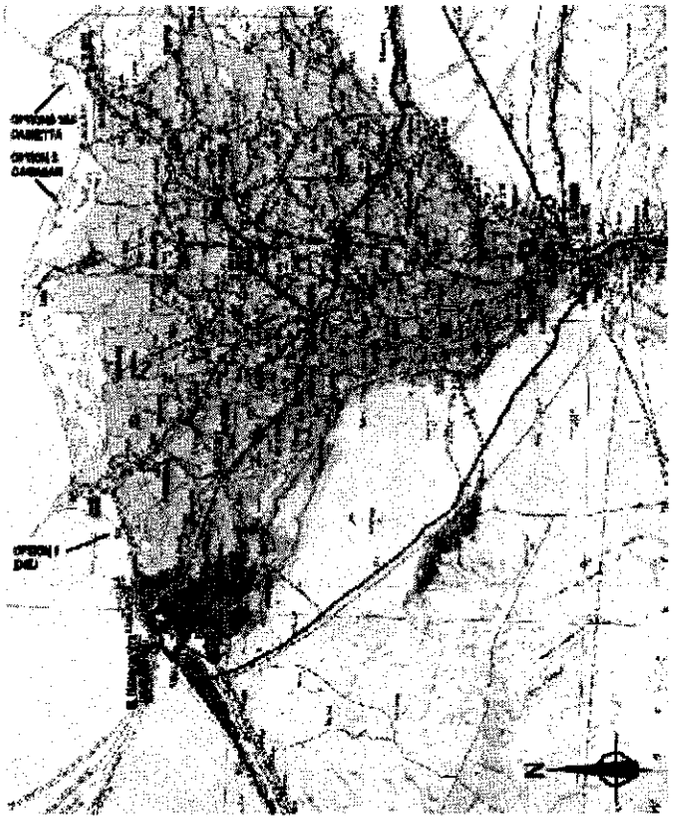
# 1.0 GENERAL

## 1.1 GENERAL SITE DATA

### 1.1.1 Plant Map – Four Proposed Sites:



SITE OPTIONS - GENERAL LOCATIONS

Idku Site (East of EGAS/Rash Petco Liquids Plants approx 45 kms east of Alexandria) N31°22' E30°20'

Gamasah Site (Approx 42 kms west of Port Damietta) N31°29' E31°24'

Damietta Port (Approx. 60 kms west of Port Said) N31°27' E31°44'

Damietta Echem Site (East of Port) – Approx 60 kms west of Port Said N31°28' E31°46'

1.1.2 **Topographical Map – drawing number** – None available. However Idku, Gamasah and Echem Damietta sites can be considered as relatively flat with low sand dunes (approx 3 meters) on the northern borders as the land approaches the beach frontage. Damietta Port Site is within the JIndustrial Port Zone and is also flat and level.

1.1.3 **Elevation above mean sea level** : All sites are approximately 2 meters above sea level.

1.1.4 **Clients Elevation** ___N/A_____ is considered as KBR reference elevation of ___0_____

1.1.5 **Coordinates of KBR battery limit reference**: Not available for this Study

1.1.6 **Angular relation between Client's or true north and KBR's descriptive north** - True North used as reference for this study.

1.1.7 **Nature of terrain**

Idku — Compacted sand, with some scrub, Irrigation waste water is being pumped onto the land and has formed a shallow lake on the west side of the plot. No rock.

Gamasah - Scrub covered sand, fairly level with some drain ditches crossing in a south north direction. A small marshy area parallel to the east border road. Outfall irrigation canal on the east of that road (source of water?) No rock.

Damietta Port - Part of the proposed land is covered with construction debris from SEGAS LNG Project. Surface is generally sand. There is a 200 – 300 meter frontage providing direct access to the inner port basin. Area was used to store dredged material from port.

Damietta Echem - Soil is rich alluvial deposit. Top soil has been removed from approximately 50% of the surface to a depth of about - 4 meters. No rock.

1.1.8 **Rivers:** The main Nile River delta branches of Rosetta (West branch) is about 20 kms east of Idku site. The eastern Damietta branch of the Nile River is about 5 kms to the east of Damietta Echem site.

The Navigation Channel that borders the east boundary of Damietta Port is a man made fresh water canal (5 meters deep) from the Damietta Nile branch and will be tested as a possible source of cooling water.

The irrigation outfall canal on the east border of Gamasah Site will be tested as a possible source of cooling water.

1.1.9 **Directions of prevailing wind in percentage of the total number of observations**: (Later)

Prevailing wind is from W-NW. Design wind speed is 12 meters/sec with max 39 meters/sec. The extreme high speed wind direction is shown in the table below.

**EXTEME HIGH SPEED WINDS**

| Wind Direction | Return Period (Years) | | |
|---|---|---|---|
| | 1 | 10 | 100 |
| NW | 42 | 48 | 53 |
| W | 44 | 50 | 56 |
| N | 27 | 42.5 | 47 |

1.1.10 **Design Snow Loading**
_0_Normal kg/m$^2$
_0_Maximum. kg/m$^2$

1.1.11 **Design Sand loading is:** Maximum_____LATER_____ kg/m$^2$
There is a potential for sand storms.

1.1.12 **Maximum rainfall in one hour** is __30__mm/hr
60 mm/hr max over 30 minutes - 10 year average
Runoff is ___Later_____% on paved areas and roof and _Later_____ % on unpaved areas..
The greatest amount of precipitation falls from November to March .

Distribution of precipitation in mm from month to month (Metering station Navoi):

| | I | II | III | IV | V | VI | VII | VIII | IX | X | XI | XII |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Avera | | | | | | | | | | | | |
| Maxi | 48 | 23 | 10 | 8 | 3 | 0 | 0 | 0 | 0 | 5 | 33 | 56 |

1.1.13 **Maximum rainfall** in one day is 55mm

1.1.14 **Average annual** rainfall 125 MM
Average annual snowfall __0__ MM

1.1.15 **Rainy season** from October to May

1.1.16 Indicate any **specific conditions of atmosphere** at site which causes corrosion and contamination such as:
- Saline air: Areas are close to beaches - Dry salt may form in the air and on surfaces.
- Dust: Air borne dust is a factor to consider for protecting rotating equipment. LATER mg/m$^3$ normal. Maximum LATER mg/m$^3$
- **Sand storms:** There is a potential for sand storms to take place from LATER . and LATER times per month and their duration could take up to LATER hours;
- **Temperature inversion:** LATER
- **Calms:** LATER
- **Fog:** LATER

1.1.17 **Remarks:**

## 1.2. METEOROLOGICAL DATA:

1.2.1 **Barometric pressure:**
Design barometric pressure: 1013 mbar
Maximum: 1032.5 mbar. Minimum: 992.9 mbar. (ENPPI Met. Design Criteria) .....)
Maximum rate of barometric pressure change **5 mbar** per hour.

1.2.2 **Ambient Temperature**
___Average maximum **29 °C** Absolute maximum **42.5 °C**
___Average minimum **18 °C** Absolute minimum is **2.5 °C**
___Average relative humidity: Summer 76% and 71% in Spring with max of 100%
___Five percentile dry bulb: Summer _____°C Winter _____°C
___Five percentile wet bulb: Summer _____°C Winter _____°C
___Five percentile relative humidity:

Summer _____°C Winter _____°C

1.2.3 **Design dry/wet bulb temperature for**
Cooling Towers: Dry bulb **29** °C Wet Bulb **24.4** °C
Relative Humidity 76 %
Air Coolers: Dry Bulb Winter ____°C Summer **X** °C
Compressors:
(Summer) Dry Bulb ____°C Wet Bulb ____°C
Relative Humidity ____°C
(Winter) Dry Bulb ____°C Wet Bulb ____°C
Relative Humidity ____°C
Barometric pressure for design _____mm Hg.

1.2.4 **Design conditions (outside)** for heating, ventilating and air conditioning.
Average dry bulb: Summer ___°C Winter ___°C
Average relative humidity: Summer ___°C Winter ___°C

1.2.5 **Wind Data**
Wind Pressure:

The standard basic reference for wind forces is called "THE EGYPTIAN CODE FOR LOAD AND FORCE COMPUTATION IN STRUCTURES AND BUILDINGS". Ministerial decree N° 45, 1993.

Whereby, Wind Force $F = Cf \times K \times q$

Where:

q = basic wind pressure = 0.8 kPa for Damietta site

K = elevation factor as given in the following table

| K | Height in meters |
|---|---|
| 1.0 | 0 to 10 |
| 1.1 | 10 to 20 |
| 1.3 | 20 to 30 |
| 1.5 | 30 to 50 |
| 1.7 | 50 to 80 |
| 1.9 | 80 to 120 |
| 2.1 | 120 to 160 |
| 2.3 | Above 160 |

Cf = shape factor

For building structures, Cf shall be determined from ASCE 7-98 such that Cf varies from 1.0 to 1.3 for rectangular buildings and 0.5 to 1.2 for circular buildings.

For piperacks and pressure vessels, Cf shall be determined with reference to "WIND LOADS ON PETROCHEMICAL FACILITIES" prepared by Task Committee on Wind Induced Forces and

published by ASCE, 1997. Cf will vary from 0.5 for smooth pressure vessels, 0.7 for pipes to between 1.6 and 2.0 for steelwork.

## 1.3 FOUNDATIONS AND STRUCTURES:

### 1.3.1 Geological and Geotechnical Conditions:

The Nile Delta has two main Nile River branches encompassing the area, the western Rosetta Branch and the eastern Damietta Branch. Three(3) of the four (4) sites considered are all located on the shoreline within the Delta Region while the Idku site is a few kilometres to the west of the Rosetta Branch. The soils are typical of a major delta area; consist of a sequence of soils varying from sands to clays.

On the coast line of the Nile delta, the general sequence comprises Recent coastal dune sands, overlying very soft Recent Alluvial Clays which are in turn is underlain by inter-bedded Deltaic Sands and Clays. Often the interfaces between these units vary and buried in filled channels can be common. The water table is generally just above sea level.

Port Damietta is situated in the Nile Delta on the coast. From ground investigations carried out in the environs of the Port the thickness of the different units are:

- upper sand is medium dense to dense around 10m thickness
- underlying clay is very soft to soft and its thickness varies between 10 to 20m
- underlying materials are inter-bedded dense to very dense sands and stiff to very stiff clays
- groundwater is around 0.75 m above sea level.

#### 1.3.1.2 Soil Description

The soil stratigraphy and properties as given in Annex 3 of the SOR "Soil Investigation at East Dock of Damietta Port (Extension Project of Existing Basin)" have been used for developing the civil foundation design. The soil parameters given in this soils report are summarized below.

The site consists of 12 to 14 metres of medium dense to dense fine sands overlying 15m of soft clays, which overlie very dense sands and stiff clays. The upper sands have reasonable bearing capacity. However where foundation pressures from large heavily loaded or closely spaced smaller foundations combine to transmit bearing pressures to the clays, this will lead to significant settlements in the long term by consolidation of the clays.

The dense sand below the clays at elevation –30m is suitable for end bearing piles. The thickness of the sand layer overlying stiff clays is important in determining the length of the piles.

#### 1.3.1.3 Site Fill

If the land in the site is raised to +2.5m to 3.0m as in other areas of the port this will lead to considerable consolidation of the clays, which would give long term settlements in the range 100-200mm Two options were considered for the adjacent Segas LNG site for ground treatment:-

a) Preloading with wick drains. This would enable most foundations to be constructed as spread footings and avoid the use of piles.

b) Using balanced cut and fill to reduce change in site levels to a minimum. This has the advantage of avoiding importing fill. Piling would be required where the surface loadings would lead to unacceptable differential settlements in areas with large diameter piping and heavy equipment, such as compressors casings, which are sensitive to any nozzle movements.

Option b) was selected because it is more economic and is not restricted by schedule.

#### 1.3.1.4 Pile Design

Preliminary pile design is based on precast driven piles with a working capacity of 600kN after allowing for negative skin friction. A lateral capacity of 30kn and a tension capacity where required of 180kN. These would be driven to founding level of approximate elevation of –32m in the first dense sand level below the clay. This sand layer is sufficiently thick to provide adequate end bearing without overloading the underlying stiff clay. If the final site investigation shows the elevation and thickness of the sand layers to be different, the length an type will be adjusted to ensure the necessary capacity.

The piling layout drawings can only be done at the time when the equipment is designed and the equipment manufacturers selected. The manufacturers will provide the necessary engineering data to enable the EPC contractor to design the foundations. A typical piling layout is shown in Figures 1 through Figure 4 attached to this section.

#### 1.3.1.5 Foundations

The maximum bearing pressure for spread foundations is 300 kPa, where settlement is not a criterion. Spread foundations will be used where overall settlements from long term consolidation of the soft clays is within allowable limits for the supported equipment.

The effect of this is that the methanol and ammonia/urea process trains and the Common Facilities areas will be piled. Other areas will not require piling.

A limiting differential settlement from consolidation of the clay, of 15mm over a length of 20m has been used for non piled structures.

#### 1.3.1.6 Topography

Ground elevations measured in the very similar Segas site next door varies from +2.368 m to +2.537 m (i.e. difference of 0.169 m in elevation) with an average of +2.38 m over the site. The ground surface at the site is thus almost plane.

#### 1.3.1.7 Ground Water

The Segas site ran several boreholes and found that the average groundwater level was 1.75 to 1.90 meters below the surface.

**1.3.2 Seismic Zone Classification:** The Seismic Risk Zone is considered to be class 2A based upon the Uniform Building Code 1997 (UBC 1997).

#### 1.3.3 Earthquake Design Criteria:

A Site Specific Response Spectrum has been defined in the URS Report "Seismic Hazard Analysis and Development of Seismic Parameters for LNG Project at Damietta Port in Egypt".

The design parameters given below shall be adopted for seismic analysis and design. Design procedures and detailing rules shall be based on Zone 1 of UBC-97.

With reference to Section 1630 of UBC-97, the following global parameters shall apply:

Importance Factor, I = 1.25
whereby, equation 30-4 of UBC-97 becomes:

$$V = 1.25\ C.W / R$$

where W is in kNs and C is defined below.

#### 1.3.3.1 Operational Basis Earthquake (OBE)

With reference to Section 1630 of UBC-97, the following site-specific parameters shall apply:

#### 1.3.3.2 Horizontal Component of OBE

Seismic Coefficient, $C_a = 0.07$
Seismic Coefficient, $C_v = 0.10$

For Fundamental Period, T (secs), the site specific acceleration coefficient, C, is given by:

$C = 0.07(1 + 13.12T)$ for $0.000 \le T < 0.114$ secs
$C = 0.175$ for $0.114 \le T < 0.571$ secs
$C = 0.10/T$ for $0.571 \le T < 4.000$ secs
$C = 0.40/T^2$ for $4.000 \le T$

#### 1.3.3.3 Vertical Component of OBE

Seismic Coefficient, $C_a = 0.045$
Seismic Coefficient, $C_v = 0.04$
For Fundamental Period, T (secs), the site specific acceleration coefficient, C, is given by:

$C = 0.045(1+24.44T)$ for $0.000 \le T < 0.050$ secs
$C = 0.10$ for $0.050 \le T < 0.400$ secs
$C = 0.04/T$ for $0.400 \le T < 4.000$ secs
$C = 0.16/T^2$ for $4.000 \le T$

#### 1.3.3.4 Safe Shutdown Earthquake (SSE)

With reference to Section 1630 of UBC-97, the following site-specific parameters shall apply:

#### 1.3.3.5 Horizontal Component of SSE

Seismic Coefficient, $C_a = 0.20$
Seismic Coefficient, $C_v = 0.30$
For Fundamental Period, T (secs), the site specific acceleration coefficient, C, is given by:

$C = 0.20(1 + 12.5T)$ for $0.000 \le T < 0.120$ secs
$C = 0.50$ for $0.120 \le T < 0.600$ secs
$C = 0.30/T$ for $0.600 \le T < 4.000$ secs
$C = 1.20/T^2$ for $4.000 \le T$

#### 1.3.3.6 Vertical Component of SSE

Seismic Coefficient, $C_a = 0.15$
Seismic Coefficient, $C_v = 0.12$

For Fundamental Period, T (secs), the site specific acceleration coefficient, C, is given by:

$C = 0.15(1 + 20T)$ for $0.000 \le T < 0.050$ secs
$C = 0.30$ for $0.050 \le T < 0.400$ secs
$C = 0.12/T$ for $0.400 \le T < 4.000$ secs
$C = 0.48/T^2$ for $4.000 \le T$

1.3.4 **Soil investigation report identification and data** See Attachment

1.3.5 **Soil or pile test results** As above

1.3.6 ***Design criteria for foundations** are the following engineering-geological conditions:*
Type of foundation
- Tanks Bored piling
- Major process equipment, pipe ways and structures Bored piling
- Minor buildings and equipment Pad Foundations

1.3.7 **Ground water elevation** 0.7 m above sea level
Average frost penetration Not Applicable

1.3.8 **Existing underground structures**, foundations, piping, electric cables
See Drawing No. LATER

1.3.9 **Aircraft warning requirements** Required

## 1.4 MARINE DATA

1.4.1.1 **Erosion:** Since the completion of the Aswan High Dam, sediment input into the Delta Area has fallen by approx 150 million tpa. As a result, considerable erosion is taking place with the 10 meter contour having moved 2 – 3 kms closer towards the shoreline.

1.4.1.2 **Tides:** Semi-Diurnal Tides with a small range of <0.9 m

1.4.1.3 **Currents:** Influenced by wind pattern but easterly currents dominating in summer and stronger westerly currents in winter. Mean values of 0.17 m/s near surface to 0.02 m/s in mid water.

1.4.1.4 **Waves:** Offshore waves are 0.5 – 1.5 m for 77% of time. Heights greater than 2m for 7% of the time. Offshore wave direction are from S-W to N-E direction while near shore waves are predominantly from the N-W.

1.4.1.5 **Breakwater:** Designed for 8 meter storm waves

1.4.1.6 **Sea Temperature:** Min 14°C Max 30°C. Stratification to a depth of 100 – 150 m

## 1.5 SHIPPING DATA

1.5.1 **Ship Sizes**

| | MTDWAT (Summer Salt Water) | Length (m) | Beam (m) | Draft (m) |
|---|---|---|---|---|
| **Methanol Bulk Carriers:** | | | | |
| | 48,000 | 186 | 32.2 | 12.22 |
| | 30,000 | 175 | 27.7 | 10.02 |
| **Ammonia Bulk Carriers:** | | | | |
| Hugo N | 43,350 (57,000 $m^3$) | 215.7 | 32.3 | 11.48 |

1.5.2 **Loading Rates:**

Methanol 2,750 mtph- (2 x 12" dia. lines) – Note manifold height approx 19 ft above sea level.

Ammonia 750mtph .

1.5.2 **Shipping Frequency:**

| | |
|---|---|
| Ammonia | 1 ship per month |
| Methanol | 3 – 4 shipments per month (Phase 1) |

## 1.6 ECONOMIC DESIGN CRITERIA

1.6.1 **Payout** (years) 5 years

1.6.2 **Cost of Capital**: Major consideration

1.6.3 **Economic Objective:**

1. Low capital cost – maintaining high reliability of operation.
2. Payout incremental capital cost 5 y

1.6.4 **Other miscellaneous factors** (List below): _____

# 2.0 UTILITIES

## 2.1 ELECTRIC POWER

Independent power supply using on site gas turbines with diesel generator sets for back up. Incoming National Electrical Grid supply as emergency standby only.

### 2.1.1 Voltage Levels

| | |
|---|---|
| Main distribution | 33 kV, 3 phase |
| HV motors and distribution | 6.6 kV, 3 phase |
| LV motors and consumers | 380 V, 3 phase |
| LV and UPS consumers | 220 V, 1 phase |
| Switchgear trip/close supply | 110 V, DC |

Note : LV motors = less than 150 kW (however, there may be some exceptions, for geographical reasons, of motors marginally greater than 150 kW which may be fed from LV distribution boards).

### 2.1.2 Frequency

| | |
|---|---|
| Alternating current frequency | 50 Hz |

### 2.1.3 *Design Conditions for Electrical Equipment*

| | |
|---|---|
| Normal ambient temperature | 20 °C |
| Maximum design temperature | 45°C |
| Relative humidity maximum | 100% |

### 2.1.4 Power, Communications and Alarms

| ITEM (LATER) | FURNISHED BY |
|---|---|
| - Incoming power supply voltage | N/A |
| - Stand alone power generation | 2 x 19Mw GTG plus 2 x 19MW HRSG |
| - Transformers: | Later |
| - Welding Machine Outlets: | 380V |
| - Emergency power system: | 2,000 kW |
| - Public telephone system: | Yes |
| - Sound-powered Telephone System: | Yes |
| - Radio system: | Yes |
| - Uninterruptible Power Supply: | Yes |
| - Instrument Power: | Yes |
| - Alarm System: | Yes |
| - Aircraft Warning Lights: | Yes |
| - TV Monitoring (Security): | Yes |
| - Cathodic Protection: | Yes |

### 2.1.5 Area Classification

Area classification to be in accordance with _ ___ Code. ____LATER_____

## 2.2 WATER

### 2.2.1 Water Analysis

#### 2.2.1.1 Sea Water and Fresh Water Analysis - Damietta

| Test | Identification | FRESH WATER Sample No. 1 (Water Supply) | SEA WATER Sample No. 2 (Inside Harbor) | SEA WATER Sample No. 3 (Navigation Channel) |
|---|---|---|---|---|
| 1 | PH-Value | 7.4 | 7.2 | 7.3 |
| 2 | Conductivity @ 200 C,S | 700 | 57000 | 58000 |
| 3 | B. O. D. 5, mg/l | 3.63 | - | - |
| 4 | Suspended Solids, mg/l | <1 | 43 | 12 |
| 5 | T.D.S. @ 1100 C, mg/l | 454 | 38779 | 39689 |
| 6 | Free CO2, mg/l | 2.5 | - | - |
| 7 | Sodium (Na), mg/l | 61 | 12045 | 12426 |
| 8 | Potassium (K), mg/l | 6 | 380 | 401 |
| 9 | Calcium (Ca), mg/l | 42 | 447 | 447 |
| 10 | Magnesium (Mg), mg/l | 14 | 1349 | 1333 |
| 11 | Chloride (Cl), mg/l | 67 | 21229 | 21899 |
| 12 | Hydroxyl (OH), mg/l | Nil | Nil | Nil |
| 13 | Carbonate (CO3), mg/l | Nil | Nil | Nil |
| 14 | Bicarbonate (HCO3), mg/l | 226 | 195 | 201 |
| 15 | Sulphate (SO4), mg/l | 22 | 3120 | 2966 |
| 16 | Phosphate (PO4), mg/l | 4.17 | 0.27 | 1.26 |
| 17 | Silica (SIO2), mg/l | 5.16 | 3.15 | 3.44 |
| 18 | Nitrites (NO2), mg/l | < 0.01 | 3.51 | 1.52 |
| 19 | Boron (B), mg/l | 0.008 | 5.68 | 4.57 |
| 20 | Ammonia-N, mg/l | < 0.01 | < 0.25 | < 0.01 |
| 21 | Alkalinity, mg/l | 226 | 195 | 201 |
| 22 | M-Alkalinity | 226 | 195 | 201 |
| 23 | Iron (Fe), total, mg/l | 0.14 | 0.16 | 1.03 |
| 24 | Manganese (Mn), mg/l | < 0.01 | < 0.01 | 0.62 |
| 25 | Aluminium (Al), mg/l | 0.46 | - | - |
| 26 | Total organic Carbon, mg/l | 2.89 | - | - |
| 27 | Redox Potential, mv | -9 | - | - |
| 28 | Escherichia Coli, count/ml(after 72 hrs) | Nil | - | - |
| 29 | Clostridium perfingens, count/ml (after 72 hrs) | 15e06 | - | - |

### 2.2.1.2 *Fresh Water Analysis - SEDPIC – (Idku Area)*

# Water Analysis Of Canal Near SEDPIC

| Date | 2002 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | pH | Cond. | Turbidity | T.Hardn. | Ca.Hardn. | P.Alka | M.Alka | Chlorides | Sulphate |
| January | 7.90 | 1085 | 6.05 | 263.3 | 133.9 | Nil | 177.6 | 155.5 | 158.0 |
| February | 8.07 | 636 | 3.81 | 201.4 | 108.1 | Nil | 163.5 | 98.0 | 104.3 |
| March | 8.02 | 714 | 8.23 | 192.4 | 111.7 | Nil | 162.0 | 106.6 | 135.2 |
| April | 7.70 | 652 | 9.92 | 194.2 | 93.0 | Nil | 129.1 | 89.9 | 85.7 |
| May | 7.61 | 592 | 8.67 | 180.7 | 90.4 | Nil | 129.9 | 90.0 | 80.0 |
| June | 7.18 | 569 | 9.31 | 178.7 | 92.0 | Nil | 127.2 | 87.4 | 88.3 |
| July | 7.99 | 691 | 8.65 | 168.6 | 98.3 | Nil | 142.3 | 89.0 | 98.9 |
| August | 7.56 | 671 | 8.33 | 196.4 | 105.7 | Nil | 132.6 | 112.5 | 106.2 |
| September | 7.56 | 559 | 6.02 | 177.9 | 97.1 | Nil | 139.7 | 82.5 | 78.4 |
| October | 7.93 | 621 | 8.50 | 187.2 | 102.3 | Nil | 160.0 | 90.0 | 96.8 |
| November | 7.73 | 659 | 5.62 | 213.2 | 111.2 | Nil | 163.9 | 104.6 | 96.7 |
| December | 7.90 | 701 | 3.57 | 215.4 | 116.4 | Nil | 178.4 | 110.5 | 116.7 |
| **AVG.** | **7.76** pH | **627** micro S/cm | **7.22** NTU | **197.5** ppm | **105.0** ppm | **Nil** ppm | **150.5** ppm | **101.4** ppm | **103.8** ppm |

| Date | 2003 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | pH | Cond. | Turbidity | T.Hardn. | Ca.Hardn. | P.Alka | M.Alka | Chlorides | Sulphate |
| January | 7.93 | 685 | 4.25 | 204.7 | 110.9 | Nil | 183.1 | 102.7 | 110.0 |
| February | 8.07 | 636 | 3.81 | 201.4 | 108.1 | Nil | 163.5 | 98.0 | 104.3 |
| March | 8.02 | 714 | 8.23 | 192.4 | 111.7 | Nil | 162.0 | 106.6 | 135.2 |
| April | 7.89 | 925 | 8.83 | 228.1 | 120.2 | Nil | 177.3 | 155.2 | 174.6 |
| May | 7.72 | 859 | 17.52 | 203.1 | 106.0 | Nil | 194.5 | 115.2 | 129.9 |
| June | 7.74 | 719 | 19.82 | 168.7 | 87.1 | Nil | 150.1 | 73.4 | 84.5 |
| July | 8.05 | 761 | 14.55 | 168.6 | 95.3 | Nil | 152.1 | 81.1 | 98.9 |
| August | 8.07 | 780 | 18.47 | 172.1 | 91.2 | Nil | 151.0 | 82.8 | 96.3 |
| September | 7.62 | 959 | 12.95 | 203.5 | 107.2 | Nil | 169.6 | 112.1 | 124.6 |
| October | 7.93 | 822 | 12.47 | 187.2 | 99.9 | Nil | 160.0 | 87.1 | 104.0 |
| November | 8.11 | 789 | 8.83 | 184.5 | 98.8 | Nil | 168.3 | 87.7 | 101.7 |
| December | 8.01 | 843 | 7.04 | 195.8 | 104.3 | Nil | 169.2 | 90.3 | 111.1 |
| **AVG.** | **7.93** pH | **791** micro S/cm | **11.40** NTU | **192.5** ppm | **103.4** ppm | **Nil** ppm | **166.7** ppm | **99.4** ppm | **114.6** ppm |

## 2.2.2 COOLING WATER RETURN – HYDRAULIC THERMAL CONDITIONS AT BATTERY LIMITS:

### 2.2.2.1 Sea Water Supply/Return:

Design Sea Water Supply temperature: 29 °C

Discharge of Sea Water into the ocean will not be greater than 10°C above ambient sea water temperature

| CONDITIONS | DESTINATION | COINCIDENT CONDITION TEMP °C | PRESSURE MPa | FLOWRATE $M^3/HR$ |
|---|---|---|---|---|
| Maximum | | | | |
| Minimum | | | | |

Maximum outlet temperature from individual items _____ °C.

### 2.2.3 MISCELLANEOUS WATER – HYDRAULIC THERMAL CONDITIONS

#### 2.2.3.1 Tempered Cooling Water

| | |
|---|---|
| Supply pressure | 5 barg minimum at farthest user |
| Design Supply temperature nominal | 32 °C |
| Supply temperature maximum | 55 °C (based on max. amb. of 45°C) |
| Mechanical design pressure & temperature | 10 barg 85 °C |
| Maximum DP | 1 bar |
| Maximum DT | 7 °C |
| Heat exchanger fouling resistance | < 65°C 0.00009 °C $m^2$ /W |
| | > 65°C 0.000176 °C $m^2$ /W |

Note : Temperatures quoted are bulk water (hot fluid) temperatures.

#### 2.2.3.2 Fire Water

| | |
|---|---|
| Supply pressure | 7.5 barg min. at any point in the system |
| Temperature | 24 °C or Ambient |
| Mechanical design pressure & temperature | 18 barg 85 °C |

#### 2.2.3.3 Demineralized Water

| | |
|---|---|
| Supply pressure | 3 barg min. at users |
| Temperature | Ambient |
| Mechanical design pressure & temperature | 10 barg 85 °C |

#### 2.2.3.4 Drinking Water

| | |
|---|---|
| Distribution supply pressure | 3.5 barg , 2 barg minimum at users |
| Temperature | 24 °C nominal on PFD |
| Mechanical design pressure & temperature | 10 barg 85 °C above ground |
| | 50 °C below ground |

### 2.3 Service Water

| | |
|---|---|
| Supply pressure | 3.5 barg min. at farthest users |

| | |
|---|---|
| Temperature | 24 °C |
| Mechanical design pressure & temperature | 10 barg 85 °C |

## 2.4 AIR AND INERT GAS

### 2.3.1 Instrument Air

| | |
|---|---|
| Normal pressure and temperature (in main distribution header at air receiver outlet) | 9 barg 40 °C |
| Mechanical design pressure & temperature | 14 barg 85 °C |
| Water dew point | -40 °C @ 10 barg |
| Minimum normal operating pressure | 7 barg at farthest user |

### 2.3.2 Tool Air

| | |
|---|---|
| Normal supply pressure | 9 barg |
| Normal temperature | 40 °C |
| Mechanical design pressure & temperature | 14 barg 85 °C |

### 2.3.3 Nitrogen

| | |
|---|---|
| Normal operating pressure | 6 barg at farthest user |
| Normal operating temperature | 15 °C |
| Mechanical design pressure & temperature | 14 barg 85 °C |

## 2.4 FUEL GAS ANALYSIS

See section 3.1 for Feed Gas analysis, pressure being not less than 35 Barg at battery limits.

## 3.0 FEED GAS

Natural gas supplied by EGAS from offshore gas fields.

### 3.1 FEED GAS DESIGN ANALYSIS: (Rev 1)

| Component | Units | Typical Gas | Lean Gas | Rich Gas |
|---|---|---|---|---|
| $CH_4$ | Mol % | 94.75 | 98.23 | 92.25 |
| $C_2H_6$ | | 03.75 | 01.07 | 04.10 |
| $C_3H_8$ | | 00.67 | 00.09 | 01.87 |
| Iso-butane | | 00.05 | 00.01 | 00.41 |
| N-butane | | 00.05 | 00.01 | 00.43 |
| Iso-pentane | | 00.00 | 00.00 | 00.15 |
| N-pentane | | 00.04 | 00.00 | 00.15 |
| N-hexane | | 00.03 | 00.00 | 00.09 |
| 2-methylpentane | | 00.00 | 00.00 | 00.00 |
| $N_2$ | | 00.55 | 00.43 | 00.00 |
| $CO_2$ | | 00.11 | 00.16 | 00.55 |
| HHV | BTU/scf | 1000 | 980 | 1180 |

Total sulfur: 8 ppm max
Water: 0% max
Specific Gravity Range 0.596 – 0.693 .

### 3.2 FEED STOCK – HYDRAULIC THERMAL DESIGN CONDITIONS AT BATTERY LIMITS

**See Section 3.1.** Not less than 35 Barg at a temperature of 38°C

# 4.0 PRODUCTS

## 4.1. PRODUCT DESIGN ANALYSIS:

### 4.1.1 Ammonia – Technical Specification

| Parameter | | | | |
|---|---|---|---|---|
| | NH3 2300 MTPD | | | |
| 1 Ammonia, wt.% | 99.9 | | | |
| | | | | |
| 2. Water Wt.% | 0.1 | | | |
| 3. Oil ppmw | 5 | | | |
| 4. | | | | |
| 5. | | | | |
| 6. | | | | |
| 7. | 100 | | | |

### 4.1.2 Methanol – Technical Specification

US-government specification for Methanol, grade AA

| Characteristic | Requirements | Test method |
|---|---|---|
| Acetone, wt-%, maximum | 0.002 | See note 1 |
| Acidity (as acetic acid), wt-%, maximum | 0.003 | ASTM E 346 |
| Appearance | Free of opalescence, suspended matter and sediment | See note 2 |
| Carbonizable impurities, color, Platinum-Cobalt (Pt-Co), maximum | No. 30 | ASTM E 346 |
| Color, Pt-Co, maximum | No. 5 | ASTM E 346 |
| Distillation range at 760 mm, maximum | 1.0°C (and shall include 64.6 +/- 0.1°C) | ASTM E 346 |
| Ethanol, wt-%, maximum | 0.001 | ASTM E 346 |
| Nonvolatile matter, mg/100 ml, maximum | 10 | ASTM D 1353 |
| Odor | Characteristic, non residual | ASTM D 1296 |
| Permanganate time | No discharge of color in 30 minutes | ASTM E 346 |
| Specific gravity at 20/20°C, maximum | 0.7928 | ASTM E 346 |
| Water, wt-%, maximum | 0.10 | ASTM E 346 |

Note 1: Determine the percent by weight acetone in the specimen in accordance with the procedures for acetone in ASTM E 346. Use 1.5 ml of sample and 3.5 ml of water instead of 1 ml of sample and 4 ml of water. Report the acetone content as less than or greater than 0.002 percent by weight.

Note 2: Dilute 15 ml of the specimen to 45 ml with water in a Nessler tube. Visually examine the solution for opalescence, suspended matter and sediment during 30 minutes of standing.

## 4.2. PRODUCT – HYDRAULIC THERMAL DESIGN CONDITIONS AT BATTERY LIMITS

### 4.2.1 Ammonia

| Service Conditions | Source | Coincident Conditions | | |
|---|---|---|---|---|
| | | Temp °C | Pressure bar-g | Flow rate mtph |
| Design | | -33 | 5 | 50.0 |
| Maximum | | | | |
| Minimum. | | | | |
| | | | | |

### 4.2.2 Methanol

| Service Conditions | Source | Coincident Conditions | | |
|---|---|---|---|---|
| | | Temp oC | Pressure bar-g | Flowrate mtph |
| Design | | | | 125 |
| Maximum | | | | |
| Minimum. | | | | |

# 5.0 EFFLUENT TREATMENT AND DISPOSAL

## 5.1. Biochemical Treatment Plant:

Liquid effluent is directed to a plant Biochemical Treatment Plant.

### 5.1.1. *Effluent quality requirements:*

| Parameter | Maximum Limits / Specifications (ppm unless otherwise indicated) |
|---|---|
| BOD | 20 |
| COD (Dichromate) | 40 |
| TSS | 20 |
| Oil and grease | 5 |
| Faecal coliform count | 100/100ml |
| Total dissolved salts | Up to 2000 |
| Sodium absorption rate (according to soil and plant types) | 20 |
| Chlorides | 300 |
| Boron | Up to 3 |
| Cadmium | 0.01 |
| Lead | 5 |
| Copper | 0.2 |
| Nickel | 0.2 |
| Zinc | 2 |
| Cyanide | 0.1 |
| Chromium | 0.1 |
| Molybdenum | 0.01 |
| Manganese | 0.2 |
| Iron | 5 |
| Cobalt | 0.05 |

Toxic: effluents should not contain substances with undetermined MAC (maximum allowable concentration) and it should not be toxic for microorganisms of activated sludge of the biochemical treatment unit.

**5.1.1 Others (Specify)** - Max. normal discharge temperature to drain - 45 °C

### 5.1.2 Out Fall Limits

| Parameter | Maximum Limits / Specifications (mg/l unless otherwise indicated) |
|---|---|
| Temperature | Not more than 3 °C above existing level 100m from outlet |
| pH | 6 – 9 |
| Colour | Free of coloured agents |
| Biological Oxygen Demand | 60 |
| Chemical Oxygen Demand (Dichromate) | 100 |
| Total Dissolved Solids | 2000 |
| Fixed (Ash of) Dissolved Solids | 1800 |
| Suspended Solids | 60 |
| Turbidity | NTU 50 |
| Sulphides | 1 |
| Oils and grease | 15 |
| Hydrocarbons, of oil origin | 0.5 |
| Phosphates | 5 |
| Nitrates | 40 |
| Phenols | 1 |
| Fluorides | 1 |
| Aluminium | 3 |
| Ammonia (Nitrogen) | 3 |
| Mercury | 0.005 |
| Lead | 0.5 |
| Cadmium | 0.05 |
| Arsenic | 0.05 |
| Chromium | 1 |
| Copper | 1.5 |
| Nickel | 0.1 |
| Iron | 1.5 |
| Manganese | 1 |
| Zinc | 5 |
| Silver | 0.1 |
| Barium | 2 |
| Cobalt | 2 |
| Pesticides | 0.2 |
| Cyanide | 0.1 |
| Faecal coliform count | 5000 / 100ml |

### 5.1.3 Air emissions

#### 5.1.3.1 Maximum allowable

Maximum allowable concentrations (MAC) in the air in mg/Nm$^3$:

| | |
|---|---|
| NOx in stack gases | 300 mg/Nm3 |
| SOx in gas turbine exhaust | 3000 mg/ Nm3 |
| Fugitive emissions, hydrocarbons | Minimise |
| Particulate in stack gases | 100 mg/Nm3 |

| Constituent | $MAC_{da}$ | $MAC_{mo}$ | $MAC_{wa}$ |
|---|---|---|---|
| $SO_x$ (sulphur oxides) | | | |
| $NO_x$ (nitrogen oxides) | | | |
| $NH_3$ (ammonia) | | | |
| CO (carbon monoxide) | | | |
| Particulates (dust) | | | |

Where:

$MAC_{da}$ - daily average concentration in atmosphere of populated localities;
$MAC_{mo}$ - maximum one-time concentration in atmosphere of populated localities;
$MAC_{wa}$ - allowable concentration in working area.

#### 5.1.3.2 Allowable concentration at a range of 1 km from a site

| | |
|---|---|
| $SO_2$ | mg/m$^3$ |
| $NO_x$ | mg/m$^3$ |
| CO | mg/m$^3$ |
| $NH_3$ | mg/m$^3$ |

## 5.2 EFFLUENT MANAGEMENT CONCEPT

### 5.2.1 Liquid Effluent:

Process wastewater and water polluted with lubricating oils as well as other waste waters containing organic contaminations are directed through the drainage system to the existing biochemical treatment unit. .Lubricating oils content should not exceed mg/liter.

- Clean storm water, boiler blow down water, reused water are directed to rainwater drainage system at the temperature no more than °C.
- Waste mineral acids and alkali liquors should pass neutralization and can be directed to rainwater drainage system with pH____ and suspended matter content not exceeding ___ mg/liter.
- Fat solvent should be directed to burning.
- Overpressure and intensity of flow in all streams are determined by design.

| Methanol Process Effluents | | | |
|---|---|---|---|
| Source | Flow Rate | Components and Temperature | Environmental Mitigation Strategy |
| Saturator Blow Down | 3.5 (kg/MT MeOH) | Water<br>pH: 10 – 12<br>BOD (mg/l): <210<br>COD (mg/l): < 375<br>Methanol (mg/l): <250<br>Carbon dioxide (mg/l): <150<br>Methane (mg/l): <10<br>TSS (mg/l): <30 | Meets Egyptian regulations covered by Law 4. Discharge to Outfall Sewer where diluted by Seawater |
| Steam System Blow Down | 44 (kg/MT MeOH) | Water<br>pH: 9 – 10<br>BOD (mg/l): <10<br>COD (mg/l): <10<br>TSS (mg/l): <10 | Meets Egyptian regulations covered by Law 4. Discharge to Cooling Tower |

| Ammonia Process Effluents | | | |
|---|---|---|---|
| Steam System Blow Down | 400 kg/hr | Water<br>COD (mg/l): < 10 | Meets Egyptian regulations covered by Law 4. Discharged to Cooling Tower |
| Process Air Compressor Condensate | 4100 kg/hr | Clean Water | Meets Egyptian regulations covered by Law 4. Discharged to Cooling Tower |
| **Utilities and Offsites Effluents** | | | |
| Sanitary System | 48700 kg/day (Approx 48.7 $m^3$/day) | Temperature (°C): Ambient | Sanitary Treatment System (settling of suspended solids, biological treatment, and chlorination) and discharged to Outfall Sewer |
| Cooling Tower Blowdown | 2360 t/hr | Water<br>(2 cycles of concentration) | Low Cycle of Concentration. Discharge to Outfall Sewer |
| Desalination Unit Reject | 1271 t/hr | Water | Low Cycle of Concentration. Discharge to Outfall Sewer |
| Boiler Blowdown | 0.6 t/h | Water | Meets Egyptian regulations covered by Law 4. Discharged to Cooling Tower |
| Demineralized Water Plant Effluent | 225 (kg/MT MeOH) | Water<br>Temperature: 45°F | Neutralized in Neutralization Tank and discharged to Outfall Sewer where diluted by Seawater |

### 5.2.2 Emissions

| Methanol Process Emissions | | | |
|---|---|---|---|
| ***Source*** | ***Flow rate*** | ***Components*** | **Environmental Mitigation Strategy** |
| Reformer Flue Gas | 4,465 $Nm^3$/MT MeOH | Temperature (°C): 180<br>$O_2$: 1.7 mol%<br>$N_2$: 70.1 mol%<br>$CO_2$: 8.5 mol%<br>$H_2O$: 19.7 mol%<br>[b] $SO_2$: 0.45 ppmw<br>[a] NOx: See Note | Sulfur level of natural gas to be less than 8 ppmv, resulting in $SO_2$ emissions of 0.5 ppmv, below the Egyptian limit of 1100 ppmv.<br><br>Conventional burners are capable of controlling $NO_x$ to 150 ppmv, below Egyptian limit of 155 ppmv. |
| Boiler Flue Gas | 390 $Nm^3$/MT MeOH | $O_2$: 1.7 mol%<br>$N_2$: 70.1 mol%<br>$CO_2$: 8.5 mol%<br>$H_2O$: 19.7 mol%<br>[b] $SO_2$: 0.45 ppmw<br>[a] NOx: See Note | Sulfur level of natural gas to be less than 8 ppmv, resulting in $SO_2$ emissions of 0.5 ppmv, below the Egyptian limit of 1100 ppmv.<br><br>Conventional burners are capable of controlling $NO_x$ to 150 ppmv, below Egyptian limit of 155 ppmv. |
| Deaerator Vent | 10 $Nm^3$/MT MeOH | Temperature (°C): 109°C Steam | None Required |
| Converter Catalyst Oxidation Vent | Occurs for a period of 24 – 36 hours at catalyst change | Temperature (°C): 50<br>$O_2$: 2.0 mol%<br>$N_2$: 98.0 mol% | No Pollutants |
| Tanks:<br>- Crude Methanol Tank<br>- Refined Methanol Shift Tank Vent<br>- Methanol Product Storage Vent | Subject to equipment size | $N_2$ with low methanol | Floating roof type product tanks to minimize vapor emissions. |
| Miscellaneous Emissions:<br>- Flare Gases<br>- Firewater Pump Diesel Driver<br>- Sample Point Vents<br>- Atmospheric Vents | Subject to equipment size | Combustion products of natural gas / diesel<br><br>Small intermittent flows of process gas<br><br>Releases due to upset | Emission levels low and / or intermittent. |
| **Ammonia Process Emissions** | | | |
| $CO_2$ | 4,100 $Nm^3$/hr | No Sulfur Compounds | High vent to disperse flow.<br><br>No Egyptian regulations which limit $CO_2$ emissions. |
| Oxygen Vent | 25,000 $Nm^3$/hr | $O_2$: 59 vol%<br>$N_2$ + Ar: 41 vol% | No Pollutants |
| Dryer Vent | 9,600 $Nm^3$/hr | No Pollutants | No Pollutants |

| Utilities and Offsites Emissions | | | |
|---|---|---|---|
| Gas Turbine Generator Exhaust | 326,349 $Nm^3/hr$ | Temperature (°C): 230<br>$O_2$: 12.3 mol%<br>$N_2$: 76.1 mol%<br>$CO_2$: 4.0 mol%<br>$H_2O$: 7.7 mol%<br>[a] NOx: See Note | Sulfur level of natural gas to be less than 8 ppmv, resulting in $SO_2$ emissions of ~0.5 ppmv, below the Egyptian limit of 1100 ppmv.<br><br>Conventional burners are capable of controlling $NO_x$ to 150 ppmv, below Egyptian limit of 155 ppmv. Provisions for water / steam injection. |
| Package Boiler | 37,806 $Nm^3/hr$ | Temperature (°C): 315<br>$O_2$: 2.5 mol%<br>$N_2$: 72.6 mol%<br>$CO_2$: 8.5 mol%<br>$H_2O$: 16.3 mol%<br>[b] $SO_2$: 0.45 ppmw<br>[a] NOx: See Note | Sulfur level of natural gas to be less than 8 ppmv, resulting in $SO_2$ emissions of 0.5 ppmv, below the Egyptian limit of 1100 ppmv.<br><br>Conventional burners are capable of controlling $NO_x$ to 150 ppmv, below Egyptian limit of 155 ppmv. Provisions for water / steam injection |
| | | | |

### 5.2.3 Solid Wastes

| ITEM | SOURCE | TYPE | Treatment By | Method of Control |
|---|---|---|---|---|
| 1 | Process Units | Catalysts | Recycle or Land Fill | Avoid early poisoning of catalysts. |
| 2 | Offsite Units | | | |
| 3 | Others | | | |

### 5.2.4 Relief, Vent and Flare Systems

| Material | Design Conditions | | | | Designation |
|---|---|---|---|---|---|
| | Temp. °C | Pressure MPa | Flow Rate Kgs/sec | | |
| Gas Relief | 35 | Atmos | 28.2 | | |
| Ammonia Storage | 0 | 1.5 kgs/sec | 1.5 | | |
| | | | | | |

# 6.0 REGULATIONS, CODES AND STANDARDS

Application of appropriate codes and standards should be separately agreed to by the parties.

## 6.1 SPECIFICATIONS AND STANDARDS

Approved International Design Standards shall be used for this Study. Procedures to obtain Project Specific approval from the Egyptian Codes and Regulations Authorities shall be developed:

## 6.2 INDUSTRY CODES:

Design and construction shall conform with the following codes. Where a proposal has been based on specified editions of codes, the proposal editions shall be used as the basis for the job unless otherwise authorized by the Project Manager.

| USA CODES: |
|---|
| ASME |
| API |
| TEMA |
| ACI |
| AISC |
| ANSI |
| ASTM |
| NFPA |
| Applicable Egyptian National Codes |

## 6.3 CODES BY CLASSIFICATION

| | |
|---|---|
| **American Concrete Institute (ACI)** | |
| ACI 308 | Standard Practice for Curing Concrete |
| ACI 506R | Guide to Shot-Crete |
| | |
| **American Society of Civil Engineers (ASCE)** | |
| ASCE | Design of Blast Resistant Buildings in Petrochemical Facilities, 1997 |
| ASCE 7-98 | Minimum Design Loads for Buildings and Other Structures |
| | |
| **Concrete Reinforcing Steel Institute (CRSI)** | |
| CRSI | Manual of Standard Practice |
| | |
| **American Institute of Steel Construction** | |
| AISC | Manual of Steel Construction, Allowable Stress Design |
| AISC | Specification of Structural Steel Buildings |
| AISC | Test Method to Determine the Slip Coefficient for Coatings Used in Bolted Joints |
| | |

| **American Society For Testing And Materials** | |
|---|---|
| ASTM A105/A105M | Carbon Steel Forgings for Piping Applications |
| ASTM A106/A106M | Seamless Carbon Steel Pipe for High-Temperature Service |
| ASTM A123 | Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products |
| ASTM A134 | Pipe, Steel, Electric-fusion (Arc)-Welded (Sizes NPS 16 and Over) |
| ASTM A139 | Electric-Fusion (Arc)-Welded Steel Pipe (NPS 4 and over) |
| ASTM A143 | Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedures for Detecting Embrittlement |
| ASTM A153/153M | Zinc Coating (Hot-Dip) on Iron and Steel Hardware |
| ASTM A161 | Seamless Low-Carbon and Carbon-Molybdenum Steel Still Tubes for Refinery Service |
| ASTM A167 | Stainless and Heat-Resisting Chromium-Nickel Plate, Sheet and Strip |
| ASTM A179/A179M | Seamless Cold-Drawn Low-Carbon Steel Heat-Exchanger and Condenser Tubes |
| ASTM A182/A182M | Forged of Rolled Alloy-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service |
| **American Society For Testing And Materials** | |
| | |
| ASTM A185 | Steel Wire Fabric, Plain, for Concrete Reinforcement |
| ASTM A193/193M | Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service |
| ASTM A194/194M | Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service |
| ASTM A200 | Seamless Intermediate Alloy-Steel Still Tubes for Refinery Service |
| ASTM A203/A203M | Pressure Vessel Plates, Alloy Steel, Nickel |
| ASTM A210/A210M | Seamless Medium-Carbon Steel Boiler and Superheater Tubes |
| ASTM A213/A213M | Seamless Ferritic and Austenitic Alloy-Steel Boiler, Superheater, and Heater-Exchanger Tubes |
| ASTM A214/214M | Electric-Resistance-Welded Carbon Steel Heat-Exchanger and Condenser Tubes |
| ASTM A216/A216M | Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service |
| ASTM A217 | Steel Castings, Martensitic Stainless Steel and Alloy, for Pressure-Containing Parts Suitable for High-Temperature Service |
| ASTM A234/234M | Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service |
| ASTM A240/A240M | Heat Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels |
| ASTM A249/A249M | Welded Austenitic Steel Boiler, Superheater, Heat-Exchange, and Condenser Tubes |
| ASTM A266 | Carbon Steel Forgings for Pressure Vessel Components |
| ASTM A271 | Seamless Austenitic Chromium-Nickel Steel Still Tubes for Refinery Service |
| ASTM A276 | Stainless Steel Bars and Shapes |
| ASTM A283/A283M | Low and Intermediate Tensile Strength Carbon Steel Plates |
| ASTM A285 | Pressure Vessel Plates, Carbon Steel, Low-and Intermediate-Tensile Strength |

| | |
|---|---|
| ASTM A297/A297M | Steel Castings, Iron-Chromium and Iron-Chromium-Nickel, Heat Resistant, for General Application |
| ASTM A307 | Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength |
| ASTM A312/A312M | Seamless and Welded Austenitic Stainless Steel Pipes |
| ASTM A319 | Gray Iron Castings for Elevated Temperatures for Non-Pressure Containing Parts |
| ASTM A320/320M | Alloy Steel Bolting Materials for Low-Temperature Service |
| ASTM A325 | Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength |
| ASTM A333/A333M | Seamless and Welded Steel Pipes for Low-Temperature Service |
| ASTM A334/A334M | Seamless and Welded Carbon and Alloy-Steel Tubes for Low-Temperature Service |
| ASTM A335 | Seamless Ferritic Alloy-Steel Pipe for High-Temperature Service |
| ASTM A336/A336M | Alloy Steel Forgings for Pressure and High Temperature Parts |
| ASTM A350/A350M | Carbon and Low-Alloy Steel Forgings, Requiring Notch Toughness Testing for Piping Components |
| ASTM A351/A351M | Castings, Austenitic, Austenitic-Ferritic (Duplex), for Pressure-Containing Parts |
| ASTM A352/A352M | Steel Castings, Ferritic and Martensitic, for Pressure Containing Parts, Suitable for Temperature Service |
| ASTM A353/A353M | Pressure Vessel Plates, Alloy Steel, 9 Percent Nickel, Double-Normalized and Tempered |
| ASTM A358/A358M | Electric-Fusion-Welded Austenitic Chromium-Nickel Alloy Steel Pipe for High-Temperature Service |
| ASTM A36/A36M | Carbon Structural Steel |
| ASTM A385 | Providing High-Quality Zinc Coatings (Hot Dip) |
| ASTM A387/A387M | Pressure Vessel Plates, alloy Steel, Chromium-Molybdenum |
| ASTM A403/A403M | Wrought Austenitic Stainless Steel Piping Fittings |
| ASTM A420/A420M | Piping Fittings of Wrought Carbon Steel and Alloy Steel for Low-Temperature Service |
| ASTM A463/A463M | Steel Sheet, Aluminum-Coated by the Hot-Dip Process |
| ASTM A475 | Zinc-Coated Steel Wire Strand |
| ASTM A48 | Gray Iron Castings |
| ASTM A488/488M | Standard Practice for Steel Castings, Welding, Qualifications of Procedures and Personnel |
| ASTM A516/A516M | Pressure Vessel Plates, Carbon Steel, for Moderate-and Lower-Temperature Service |
| ASTM A519 | Seamless Carbon and Allow Steel Mechanical Tubing |
| ASTM A522/A522M | Forged or Rolled 8 and 9% Nickel Alloy Steel Flanges, Fittings, Valves, and Parts for Low-Temperature Service |
| ASTM A53/A53M | Pipe, Steel, Black and Hot-Dipped, Zinc-coated, Welded and Seamless |
| ASTM A536 | Ductile Iron Castings |
| ASTM A537/A537M | Pressure Vessel Plates, Heat Treated, Carbon-Manganese-Silicon Steel |
| ASTM A541/A541M | Quenched and Tempered Carbon Treated Carbon and Alloy Steel Forgings, for Pressure Vessel Components |
| ASTM A553 | Pressure Vessel Plates, Alloy Steel, Quenched and Tempered 8 and 9% Nickel |

| | |
|---|---|
| ASTM A563 | Carbon and Alloy Steel Nuts |
| ASTM A572/A572M | High Strength Low Alloy columbium-Vanadium Structural Steel |
| ASTM A573/A573M | Structural Carbon Steel Plates of Improved Toughness |
| ASTM A6 | General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling |
| ASTM A633/A633M | Normalized High-Strength Low-Alloy Structural Steel Plates |
| ASTM A671 | Electric-Fusion -Welded Steel Pipe for Atmospheric and Lower Temperatures |
| ASTM A672 | Electric-Fusion -Welded Steel Pipe for High-Pressure Service at Moderate Temperatures |
| ASTM A673/A673M | Sampling Procedure for Impact Testing of Structural Steel |
| ASTM A691 | Carbon and Alloy-Steel Pipe, Electric-Fusion-Welded for High-Pressure Service at High Temperatures |
| ASTM A743/A743M | Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion-Resistant, for General Application |
| ASTM A744/A744M | Castings, Iron-Chromium, Corrosion Resistant for Severe Services |
| ASTM A765/A765M | Carbon Steel and Low Alloy Steel Pressure-Vessel Component Forgings with Mandatory Toughness Requirements |
| ASTM A780 | Repair of Damaged and Uncoated Areas Hot-Dip Galvanized Coatings |
| ASTM A792/A792M | Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot Dip Process |
| ASTM A992 | Steel for Structural Shapes for Use in Building Framing |
| ASTM B209 | Aluminum and Aluminum Alloy Sheet and Plate |
| ASTM B695 | Coatings of Zinc Mechanically Deposited on Iron and Steel |
| ASTM C1086 | Glass Fiber Felt Thermal Insulation |
| ASTM C1335 | Measuring Non-Fibrous Content of Man-Made Rock and Slag Mineral Fiber Insulation |
| ASTM C150 | Portland Cement |
| ASTM C33 | Concrete Aggregates |
| ASTM C518 | Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus |
| ASTM C533 | Calcium Silicate Block and Pipe Thermal Insulation |
| ASTM C547 | Mineral Fiber Pipe Insulation |
| ASTM C552 | Cellular Glass Thermal Insulation |
| ASTM C591 | Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation |
| ASTM C592 | Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type) |
| ASTM C610 | Molded Expanded Perlite Block and Pipe Thermal Insulation |
| ASTM C612 | Mineral Fiber Block and Board Thermal Insulation |
| ASTM D4285 | Indicating Oil or Water in Compressed Air |
| ASTM D4417 | Field Measurement of Surface Profile of Blast Cleaned Steel |
| ASTM D56 | Test Method for Flash Point by Tag Closed Tester |
| ASTM D93 | Test Methods for Flash Point by Pensky-Martens Closed Cup Tester |
| ASTM E112 | Determining Average Grain Size |
| ASTM E165 | Liquid Penetrant Examination |
| ASTM E741 | Method for Determining Air Changes in a Single Zone By Means of a Tracer Gas Dilution |

| | |
|---|---|
| ASTM E90 | Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements |
| ASTM F436 | Hardened Steel Washers |
| | |
| **American Society of Mechanical Engineers** | |
| ASME A17.1 | Safety Code for Elevators and Escalators |
| ASME B1.20.1 | Pipe Threads, General Purpose |
| ASME B16.11 | Forged Fittings, Socket-Welding and Threaded |
| ASME B16.20 | Metallic Gaskets for Pipe Flanges - Ring-Joint, Spiral-Wound, and Jacketed |
| ASME B16.21 | Nonmetallic Flat Gaskets for Pipe Flanges |
| ASME B16.47 | Large Diameter Steel Flanges NPS 26 Through NPS 60 |
| ASME B16.5 | Pipe Flanges and Flanged Fittings NPS 1/2 through NPS 24 |
| ASME B18.2.2 | Square and Hex Nuts |

| | |
|---|---|
| **American Society of Mechanical Engineers** | |
| | |
| ASME B18.2.22.1 | Plain Washers |
| ASME B31.1 | Power Piping |
| ASME B31.3 | Process Piping |
| ASME B46.1 | Surface Texture (Surface Roughness, Waviness and Lay) |
| ASME Section I | Power Boilers |
| ASME Section II | Material Specifications |
| ASME Section II Part A | Ferrous Materials |
| ASME Section II Part B | Nonferrous Materials |
| ASME Section II Part C | Welding Rods, Electrodes and Filler Metals |
| ASME Section II Part D | Material Properties |
| ASME Section IX | Welding and Brazing Qualifications |
| ASME Section V | Nondestructive Examination |
| ASME Section VIII | Boiler and Pressure Vessel Code |
| ASME Section VIII Division 1 | Pressure Vessels |
| ASME Section VIII Division 2 | Alternate Rules |
| | |
| **Welding Research Council (WRC)** | |
| Bulletin Number 107-79 | Local Stresses in Spherical and Cylindrical Shells Due to External Loadings |
| Bulletin Number 297-84 | Local Stresses in Cylindrical Shells Due to External Loadings on Nozzles |
| **American Welding Society (AWS)** | |
| AWS A4.2/A4.2M | Calibrating Magnetic Instruments to Measure the Delta Ferrite Content of Austenitic And Duplex Austenitic-Ferritic Stainless Steel Weld Metal |
| | |

| | |
|---|---|
| **American Petroleum Institute** | |
| API 2000 | Venting Atmospheric and Low-Pressure Storage Tanks (Nonrefrigerated and Refrigerated) |
| API 526 | Flanged Steel Pressure Relief Valves |
| API 527 | Seat Tightness of Pressure Relief Valves |
| API 5L | Line Pipe |
| API 617 | Centrifugal Compressors for Petroleum, Chemical and Gas Service Industries |
| API 620 | Design and Construction of Large, Welded, Low-Pressure Storage Tanks |
| API 650 | Welded Steel Tanks for Oil Storage |
| API MPMS Ch. 2.2A | Measurement and Calibration of Upright Cylindrical Tanks by the Manual Strapping Method |
| API RP 520 | Sizing, Selection, and Installation of Pressure-Relieving Devices in Refineries |
| API RP 520 Part I | Sizing and Selection |
| API RP 520 Part II | Installation |
| API RP 521 | Guide for Pressure Relieving and Depressuring Systems |
| **American Petroleum Institute** | |
| | |
| API STD 530 | Calculation of Heater-Tube Thickness in Petroleum Refineries |
| | |
| **AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)** | |
| AISC | Manual of Steel Construction, Allowable Stress Design |
| AISC | Specification for Structural Steel Buildings |
| | |
| **American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)** | |
| | |
| **National Fire Protection Association (NFPA)** | |
| NFPA 13 | Sprinkler System Installation |
| NFPA 14 | Standpipe and Hose System |
| NFPA 1496 | Electrical Equipment, for Purged and Pressurized Enclosure |
| NFPA 15 | Water Spray Fixed System |
| NFPA 2001 | Fire Extinguishing Systems, Clean Agents |
| NFPA 30 | Flammable and Combustible Liquids Codes |
| NFPA 496 | Purged and Pressurized Enclosures for Electrical Equipment |
| NFPA 497 | Classification of Flammable Liquids, Gases, or Vapors and of Hazardous (Classified) Location for Electrical Installation in Chemical Process Areas |
| NFPA 497A | Classification of Class I Hazardous (Classified) Locations for Electrical Installations in Chemical Plants |
| NFPA 70 | Electric Code, National |
| NFPA 78 | Lightning Protection Code |
| | |

| | |
|---|---|
| **National Association of Corrosion Engineers (NACE)** | |
| NACE RP0178 | Fabrication Details, Surface Finish Requirements, and Proper Design Considerations for Tanks and Vessels to be Lined for Immersion Service |
| | |
| **Rubber Manufacturer's Association (RMA)** | |
| RMA Technical Bulletins Numbers 1 & 2 | *Protective Linings* |
| | |
| **Steel Joist Institute (SJI)** | |
| | |
| Wozinak, R.S. and Mitchell, V.W. "Basis of Seismic Design Provisions for Welded Steel Storage Tanks" | |
| (Ref' API 1978 Proceedings - Refinery Department) | |
| | |
| **Steel Structures Painting Council (SSPC)** | |
| SSPC-PA 1 | Shop, Field, and Maintenance Painting |
| SSPC-PA 2 | Guide to Safety in Paint Application |
| SSPC-Vis 1 | Visual Standard for Abrasive Blast Cleaned Steel |
| SSPC-SP 1 | Solvent Cleaning |
| SSPC-SP 2 | Hand Tool Cleaning |
| SSPC-SP 3 | Power Tool Cleaning |
| SSPC-SP 10 | Near-White Blast Cleaning |
| SSPC-SP 11 | Power Tool Cleaning to Bare Metal |
| | |
| **American National Standards Institute (ANSI)** | |
| ANSI C2 | National Electrical Safety Code |
| | |
| **Institute of Electrical and Electronic Engineers (IEEE)** | |
| IEEE 80 | Guide for Safety in AC Substation Grounding |
| IEEE 141 | Recommended Practice for Electric Power Distribution for Industrial Plants |
| IEEE 142 | Recommended Practice for Grounding of Industrial and Commercial Power System |
| IEEE 446 | Recommended Practice for Emergency and Standby Power Systems for Industrial and Commercial Applications |
| | |
| **National Electrical Manufacturers Association (NEMA)** | |
| NEMA MG-1 | Motors and Generators |
| NEMA ICS-1 | General Standards for Industrial Controls and Systems |
| NEMA/ANSI Various | Current Editions of Equipment Standards equally adopted by the American National Standards Institute |
| | |
| **Engineering Equipment and Material Users Association (EEMUA)** | |
| | |

| | |
|---|---|
| EEMUA Publication No. 104 | Noise; A Guide to Information Required from Equipment Vendors |
| EEMUA Publication No. 140 | Noise Procedure Specification |
| EEMUA Publication No. 141 | Guide to the Use of the Noise Procedure Specification |
| EEMUA Publication No. 161 | Guide to the Selection and Assessment of Silencers and Acoustic Enclosures |
| | |
| **Conservation of Clean Air and Water - Europe (CONCAWE)** | |
| CONCAWE Report 4/81 | The Propagation of Noise from Petroleum and Petrochemical Complexes to Neighboring Communities |
| CONCAWE Report 87/59 | The Prediction of Noise Radiated from Pipe Systems - An Engineering Procedure for Plant Design |

## 6.4 STATUTORY AND REGULATORY ENGINEERING DESIGN CRITERIA (SREDC)

The engineering, manufacturing and construction will be in accordance with the regulations applicable in Egypt.

Egyptian Marine Construction Codes and Regulations [1]

Egyptian Law 4 of 1994, " Law for the Environment "

Egyptian Law 12 of 1984 - Egyptian General Shore Protection Authority

Egyptian Law 1 of 1996 relating to Ports

## 6.5 STATE AND LOCAL

## 6.6 PERMITS AND LICENSES

### 6.6.1 FEDERAL (National), STATE AND LOCAL

Engineering and Construction Licenses will be required to be obtained from the Egyptian Authorities by the EPC Contractor undertaking the work

The following lists the Permits required:

Contractor will be responsible for obtaining the following permits and all others not indicated that could be required for the Performance of Works:

- Materials registration, testing, and approval
- Permits for transportation of materials by _____(barge)
- Electrical equipment certification
- Permits for radiography

- Egypt Police permit
- Hazardous and non-hazardous waste management areas for construction
- Permits for radio _____
- Civil aviation permits for tall structures
- Import and certification permits for construction equipment
- Permits related to disposal of construction wastes
- Permits related to the opening and operations of _____
- Permits related to temporary facilities
- Civil Defense permits related to fire fighting equipment and _____ for temporary works
- Permits for offshore dredging and trenching
- Import permits for materials

- Overall Licensee for import and use by Owner of the Materials (if required)
- _____ Construction Permit and LNG _____ Jetty construction [1]
- Civil Defense permits related to firefighting equipment and facilities for the Plant [1]
- Safety and Hazard Civil Defense [1]
- Environmental Impact Assessment [1]
- Hazardous and non-hazardous waste management areas for plant operation
- Plant Operation Permits
- Permits related to marine facilities operation such as navigation aid, berth monitoring system, etc.

# 7.0 CONSTRUCTION

## 7.1 Construction Utilities Available at the Selected Site

The availability of various kinds of energy for construction at the enterprise (available utilities) is as noted in the following table:.

| Category | Characteristics | Source direction | Unit cost |
|---|---|---|---|
| Steam | None | | |
| Power | Limited to 2 MW for Construction | Within the Port Area | $0.22/Kwh |
| Service water | Very limited supply from Municipal Main Water Authority | Within the Port Area | |
| Compressed air | None | | |
| Fuel gas | Egas | $1.00/MMBTU | |
| Drinking water | Limited | Within the Port Area | |
| Fire water | Limited, consider using sea water | Within the Port Area | |

## 7.2 CONSTRUCTION AREAS (Fabrication and storage)

**7.2.1** Shown on map/drawing no. B.5.3.1.1

**7.2.2** **Restrictions on Use:** LATER

## 7.3 TEMPORARY BUILDINGS

**7.3.1** **Mandatory Local Codes:** LATER

**7.3.2** **Client Requirements for Temporary Buildings** LATER

**7.3.3** **Disposal at Project Completion**

In accordance with the environmental Base Line Study and E.P.A..

**7.3.4** **Location Restrictions** within Construction Area

The site will be within an Industrial Free Trade Zone. As such, the perimeter will be secured by the government and access will be controlled by the local police and customs agents.

## 7.4 TRANSPORTATION

**7.4.1 Access roads:** Location
The construction areas have peripheral paved roads of No 1 category with asphalt or concrete pavement, of conventional width (2 lane main highway exists outside site).

**7.4.2 Parking spaces:** Location: LATER Railroad LATER
Area Available: _____

**7.4.3 Conditions at Port :** The Contractor will dredge two dedicated slips at the Damietta Port with a draft of 14.5 meters. Access to/from these dedicated slips will be under the control of the DPA.
The majority of the imported equipment will be imported through Damietta Port.

**7.4.4 Details of railroad transportation to site:** - LATER
Structure clearance and rolling stock outline diagrams for mm gage railroad".

Restrictions on sizes during transportation by railroad are such as is shown below:

There are possibilities to exceed the standard gauge by application to the ..... Rail Authorities for a special permit.

## 7.5 LABOR REGULATIONS

**7.5.1 Plant Rules**
Trade Unions will be allowed.

**7.5.1 Local and State rules**
Labor codes and regulations will be followed.

## 7.6 DISPOSAL OF SCRAP

**7.6.1 Area available at job site**
A dedicated and controlled area will be allocated for both noxious and non-noxious scrap and waste.

**7.6.2 Other:** The municipal waste disposal centers will be investigated.

## APPENDIX 6

## POSSIBLE USA SUPPLIERS

The document in this Appendix is a list of potential U.S. Equipment Manufacturers. This list is appended as a source of information only and does not in any way construe Granherne's approval of these suppliers.

A table of potential US export values follows.

**U.S. Export Potential – Ammonia & 50% offsites, utilities, marine - USD thousands**

| Commodity | Total | US Export Portion | Estimated Local Content | Estimated Foreign Content | Estimated US Competitive-ness | Estimated High US Content | Estimated Realistic US Content |
|---|---|---|---|---|---|---|---|
| Total Installed Cost | 313,741 | 142,752 | 78,435 | 92,554 | | | |
| Procurement: | | | | | | | |
| Equipment | 87,509 | 47,124 | | 40,385 | B | 38,641 | 32,044 |
| Bulk Matls. | 30,952 | 8,097 | 9,518 | 13,337 | B | 6,640 | 5,506 |
| Subcontracts | 48,400 | 11,713 | 34,606 | 2,081 | | 9,370 | 8,023 |
| Services: | | | | | | | |
| Engineering | 24,518 | 19,614 | | 4,904 | A | 17,221 | 13,730 |
| Constn. Mgt. | 9,763 | 5,858 | 1,953 | 1,953 | A | 5,009 | 3,983 |
| Construction | 25,460 | | 25,460 | | B | | |
| Start-up | 11,151 | 10,192 | 535 | 424 | A | 8,154 | 8,154 |
| *TOTAL* | *237,753* | *102,598* | *72,071* | *63,084* | | *85,035* | *71,440* |

| U.S. Export Potential – Methanol Production & 50% offsites, utilities, marine - USD thousands | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Commodity** | **Total** | **US Export Portion** | **Estimated Local Content** | **Estimated Foreign Content** | **Est. US Competitive-ness** | **Estimated High US Comp.** | **Estimated Realistic US Comp** |
| **Total Installed Cost** | **438,000** | **192,720** | **127,458** | **117,822** | | | |
| **Procurement:** | | | | | | | |
| **Equipment** | **129,659** | **75,202** | | **54,457** | **B** | **61,666** | **51,138** |
| **Bulk Matls.** | **61,031** | **20,140** | **7,324** | **33,567** | **B** | **16,515** | **13,695** |
| **Subcontracts** | **47,441** | **35,154** | **5,930** | **6,357** | | **28,123** | **24,080** |
| **Services:** | | | | | | | |
| **Engineering** | **35,431** | **28,345** | | **7,086** | **A** | **24,887** | **19,841** |
| **Constn. Mgt.** | **14,309** | **8,586** | **2,862** | **2,862** | **A** | **7,341** | **5,838** |
| **Construction** | **37,311** | | **37,311** | | **B** | | |
| **Start-up** | **11,978** | **8,265** | **1,473** | **2,240** | **A** | **6,612** | **6,612** |
| ***TOTAL*** | ***337,161*** | ***175,692*** | ***54,900*** | ***106,569*** | | ***145,143*** | ***121,205*** |

| Overall Export Summary<br>Methanol | | Overall Export Summary<br>Ammonia |
|---|---|---|
| US Manufacturing. Exports | $95,342,450 | $55,240,640 |
| Labor Portion | $66,739,715 | $38,654,448 |
| Average Loaded Labor | $26/hr | $26/hr |
| Person Hours | 2,566,912 | 1,486,710 |
| Manufacturing Person Years | 1,426 | 826 |
| | | |
| Technical Service Exports | | |
| Engineering | $44,472,148 | $35,093,852 |
| Environmental | $723,124 | $570,632 |
| Total Services | $45,195,273 | $35,664,484 |
| TOTAL EXPORTS | $140,537,723 | $90,885,123 |
| | | |
| Person Hours Services | | |
| Engineering | 592,962 | 467,918 |
| Environmental | 8,035 | 6,340 |
| TOTAL TECHNICAL PERSON HOURS | 600,997 | 474,258 |
| SERVICE PERSON YEARS | 334 | 263 |
| | | |
| TOTAL PERSON YEARS | 1,760 | 1,089 |

## POSSIBLE USA SUPPLIERS

### U.S. Manufacturers

The following is an abbreviated list of U.S. Equipment Manufacturers is representative of some of the major manufacturers and fabricators in the United States that supply equipment to the oil and gas processing industries. These companies, amongst others, may be considered as potential suppliers. This list is appended as a source of information only and does not in any way construe Granherne's approval of these suppliers.

### EXCHANGERS – BOILERS/HEATERS & SCRUBBER COLUMNS

**Hughes-Anderson Eng. Corp**
1001 North Fulton Street
Tulsa, OK 74115-6001
Attn: Monte Stewart
Phone: 918-836-1681
Fax: 918-836-5967
mail@hughes.com

**Southern Heat Exchangers**
PO Box 3364
Pasadena, TX 77501
Attn: Phil Notar
Phone: 713.475.8500
Fax: 713.475.8507
Phil.Notar@Souheat.com

**YUBA Heat Transfer Division**
2121 North 161st East Ave.
Tulsa, OK 74116-3158
Attn: Steve Barber
Phone: 918-234-5500
Fax: 918-234-3345
maniss@yuba.com

### SHELL & TUBE EXCHANGERS

**Cust-O-Fab Companies**
1900 North 161 East Ave.
Tulsa, OK 74116
Attn: Frank Wolfe
Phone: 832-386-9090
Fax: 832-386-9696
fwolfe@custofabsc.com

## SHELL & TUBE EXCHANGERS (Continued)

**Southern Heat Exchangers**
PO Box 3364
Pasadena, TX 77501
Attn: Phil Notar
Phone: 713.475.8500
Fax: 713.475.8507
Phil.Notar@Souheat.com

**Energy Exchange**
C/O Apogee Engineering
110 Cypress Station Dr., Ste.171
Houston, TX 77090
Attn: Byron Dearixon
Tel. 281/580-7670
Fax 281/580-2595
APOG2@AOL.com

## TOWERS AND COLUMNS

**Beaird Industries, USA**
601 Benton Kelly Road
Shreveport, LA 71106-7198
Attn: James Norman
Phone: 318.865.6351
Fax: 318.868.1701
James.norman@beairdind.com

**Enpro Systems, Inc.**
16315 Market Street
Channelview, TX 77530-4427
Attn: Mark Taylor, VP Sales & Marketing
Phone: (281) 452-5865
Fax: (281) 452-5251
marktaylor@enprosys.com

**General Welding Works, Inc.**
6800 Old Katy Road
Houston, TX 77024
Phone: 713.869.6401
Fax: 713.869.5405
Mr. P. Thompson
pthompson@generalwelding.com

## COMPRESSORS AND TURBINES

DRESSER-RAND
1200 W. SAM HOUSTON PARKWAY N.
HOUSTON, TX 77043
Attn: Mr. Roger Vincent
Phone: 713-935-3423
Fax: 713-935-3490
Roger_w_vincent@dresser-rand.com

## ELECTRICAL AND SWITCHGEAR

**Schneider Electric**
9821 Katy Freeway, suite 350
Houston, TX 77024
Contact: Mr. Stan G. Rucas
Phone: 713-935-6210
rucass@squared.com

**Alstom USA Inc**
11767 Katy Freeway, suite 990
Houston, TX 77079
281-496-9449
Contact: Mr. Frank J. Reyna
frank.reyna@tde.alstom.com

**ABB**
3010 Briarpark Dr.
Houston, TX 77042
Phone: 713-821-4008
Attn: Mr. John L. Hurter
john.hurter@us.abb.com

## CARBON STEEL TANKS

**Jett Weld, Inc.**
12118 FM 529
Houston, TX 77041
Attn: Bruce Ball
Phone: 713.937.6200
Fax: 713.937.0178
jettweld@jettweld.com

## CARBON STEEL TANKS (Continued)

**Modern Welding of Texas, Inc.**
715 Sakowitz Street
Houston, TX 77020
Mr. Vernon Rinewalt
Phone 713.675.4211
Fax: 713.673.4062
vrinewalt@modweldco.com

**General Welding Works, Inc.**
6800 Old Katy Road
Houston, TX 77024
Phone: 713.869.6401
Fax: 713.869.5405
Contact: Mr. P. Thompson
pthompson@generalwelding.com

## CRYOGENIC TANKS

**Chicago Bridge a Division of CB&I Constructors, Inc.**
10200 Grogan's Mill Road
Suite 300
The Woodlands, TX 77380
Attn: Don Mallek
Phone: **281.774.2263**
Fax: **281.774.2201**
DMALLEK@CHICAGOBRIDGE.COM

## REACTORS

**Beaird Industries, USA**
601 Benton Kelly Road
Shreveport, LA 71106-7198
Attn: James Norman
Phone: 318.865.6351
Fax: 318.868.1701
James.norman@beairdind.com

**General Welding Works, Inc.**
6800 Old Katy Road
Houston, TX 77024
Phone: 713.869.6401
Fax: 713.869.5405
Contact: Mr. P. Thompson
pthompson@generalwelding.com

## DRUMS & TANKS

Taylor Forge (Steam Drum)
208 North Iron
Paola, Kansas 66071
Attn: Ms. Donna McMahon
Phone: 913-294-5331
Fax: 913-294-5337
Engineered@tfes.com

**Beaird Industries, USA**
601 Benton Kelly Road
Shreveport, LA 71106-7198
Attn: James Norman
Phone: 318.865.6351
Fax: 318.868.1701
James.norman@beairdind.com

**General Welding Works, Inc.**
6800 Old Katy Road
Houston, TX 77024
Phone: 713.869.6401
Fax: 713.869.5405
Contact: Mr. P. Thompson
pthompson@generalwelding.com

The following is a more complete list of potential U.S. Suppliers:

## SUPPLIER'S LIST

## TABLE OF CONTENTS

**POSSIBLE USA SUPPLIERS** 4

## USA SUPPLIER / MANUFACTURER'S LIST

### DESCRIPTION/ VENDOR

### 1.0 GROUP - FURNACES

#### 1.1 REGENERANT FURNACES

TECHNIP KTI
ENFAB
PETRO-CHEM

#### 1.2 MANUFACTURING BURNERS, ETC.

JOHN ZINK
CALLIDUS
ZEECO

#### 1.3 INCINERATORS

FOSTER WHEELER
CALLIDUS
JOHN ZINK
ZEECO
ABB LUMMUS

#### 1.4 FLARE AND STACK

JOHN ZINK
NATIONAL AIR OIL
CALLI DUS
FLAREGAS

### 2.0 *GROUP - EXCHANGERS*

#### 2.1 CARBON STEEL AND STAINLESS STEEL, UP TO 1000 MM ID

ENERGY EXCHANGERS
KRUEGER
YUBA
FABSCO
CUSTOFAB
OHMSTEDE

2.2 **HEAT EXCHANGERS, SHELL & TUBE, CARBON STEEL AND STAINLESS STEEL, 1000- 2500 MM ID**

EFCO
ENERGY EXCHANGERS
KRUEGER
YUBA EXCHANGERS
HUGHES ANDERSON
OHMSTEDE
ALTEX

2.3 **HEAT EXCHANGERS, SHELL & TUBE, CARBON STEEL AND STAINLESS STEEL, OVER 2500 MM ID**

YUBA
EFCO

2.4 **HEAT EXCHANGERS, AIR COOLED**

BALKE-DURR
GEA RAINEY
HUDSON PRODUCTS
SMITHCO
ECODYNE MRM
COOLING PRODUCT
HAMMCO

2.5

## HEAT EXCHANGERS, DOUBLE PIPE / MULTI-TUBE DOUBLE PIPE

ALCO
BROWN FINTUBE USA

2.6

## HEAT EXCHANGERS, DOUBLE PIPE / FINNED TUBES

BAS TEX CORP. (BROWN FINTUBE USA)
BROWN FINTUBE
R.W.HOLLAND

2.7 **HEAT EXCHANGERS, PLATE & FRAME**

BALKE-DURR
TRANTER
APV
VICARB
ALFA-LAVAL
GRAHAM

2.8

## HEAT EXCHANGERS, ELECTRIC HEATERS

ARMSTRONG
WELLMAN THERMAL SYSTEMS
RAYCHEM
GAUMER
CHROMALOX

2.9 **HEAT EXCHANGERS, MAIN CRYOGENIC ( LNG) - ALUMINUM CORE WOUND**

APCI

2.10 **HEAT EXCHANGERS, PLATE FIN**

CHART

2.11

## HEAT EXCHANGERS, AMBIENT AIR VAPORIZER

CRYOQUIP
THERMAX

2.12 **COLD BOX**

AIR PRODUCTS
ALTEC

2.13 **SURFACE CONDENSERS**

YUBA
GRAHAM
KRUEGER

**3.0**

## *GROUP - PRESSURE VESSELS*

3.1

## PRESSURE VESSEL, CARBON STEEL, SMALL UP TO 20 T UP TO 30 MM

CHATTANOOGA BOILER
FABRICON
FABWELL
FREEPORT WELDING

GENERAL WELDING
HANOVER
JETT WELD
MCIVER SMITH
MODERN WELDING
ROWELL
WILLIAM SCHMIDT
CUSTOFAB
VOLKS
HSI
TEX FAB
POWERCON

3.2

## PRESSURE VESSEL, CARBON STEEL, MEDIUM UP TO 40 T UP TO 60 MM

BEAIRD INDUSTRIES
CHATTANOOGA BOILER
CUSTO-O-FAB
ENPRO
EXCALIBUR
FABWELL
FREEPORT WELDING
GENERAL WELDING
HANOVER
JETT WELD
MCIVER SMITH
MITTERNIGHT BOILER
MODERN WELDING
SAUDER
WILLIAM SCHMIDT
MARK STEEL
TEX FAB
EXCALIBUR
VOLKS
POWERCON

3.3

## PRESSURE VESSEL, CARBON STEEL, LARGE OVER 40 T UP TO 60 MM

BEAIRD IND
CBI CONTINENTAL FAB
GENERAL WELDING
HANOVER
MITTERNIGHT BOILER
OFFENHAUSER
SAUDER
ENPRO
MARK STEEL

3.4

## PRESSURE VESSEL, STAINLESS STEEL, SMALL UP TO 20 T UP TO 30 MM

BEAIRD IND
BOARDMAN
BRIGHTON
CHEM FAB
CURTIS KELLY
FABWELL
GENERAL WELDING WORKS, INC.
JETT WELD
OFFENHAUSER
TEX FAB

3.5 **PRESSURE VESSEL, STAINLESS STEEL, MEDIUM UP TO 40 T UP TO 60 MM**

JOSEPH OATES
ALLOY WELDING
BEAIRD IND
BOARDMAN
BRIGHTON
CURTIS KELLY
FABWELL
GULF COAST ALLOY
MITTERNIGHT
OFFENHAUSER
WELFAB
ENPRO
PRECISION COMPONENTS

3.5 **PRESSURE VESSEL, STAINLESS STEEL, MEDIUM UP TO 40 T UP TO 60 MM**

JOSEPH OATES
ALLOY WELDING
BEAIRD IND
BOARDMAN
BRIGHTON
CURTIS KELLY
FABWELL
GULF COAST ALLOY
MITTERNIGHT
OFFENHAUSER
WELFAB
ENPRO
PRECISION COMPONENTS

3.6

## PRESSURE VESSEL, STAINLESS STEEL, LARGE OVER 40 T UP TO 60 MM

BEAIRD INDUSTRY
BRIGHTON
CURTIS KELLY INC.
JOSEPH OATES
MITTERNIGHT
REILEY-BEAIRD
TAYLOR FORGE
PRECISION COMPONENTS

3.7 **PRESSURE VESSEL, 3.5% NI ALLOY**

CHEM FAB
CURTIS KELLY
FABWELL
JOSEPH OATES
PRECISION COMPONENTS

3.8 **PRESSURE VESSEL, 9.0% NI ALLOY**

PRECISION COMPONENTS

3.9

## PRESSURE VESSELS, CLAD STEEL. SMALL & MEDIUM SIZES, UP TO 40 T

BRIGHTON
CURTIS KELLY INC.
GA. MOSITES
GENERAL WELDING WORKS, INC.
REILEY-BEAIRD
TAYLOR FORGE
PRECISION COMPONENTS

3.10 **PRESSURE VESSELS, HEAVY WALL, OVER 60 MM.(ALL MATERIALS)**

GENERAL WELDING WORKS, INC.
REILEY-BEAIRD (CS ONLY) (≤ 100 MM)
TAYLOR FORGE
PRECISION COMPONENTS

3.11

## COLUMN TRAYS DRAW-OFF AND CALMING SECTIONS AND HIFI

NUTTER
ACS
INDUSTRIAL ALLOY FABRICATION
KVAERNER PROCESS SYSTEMS
UOP

3.12 **SCHOEPENTOETERS - VANE TYPE**

KOCH / GLITSCH
BURGESS MANNING

3.13

## DEMISTING SCREENS - METAL/SYNTHETIC

ACS

3.14 **PACKING**

NORTON CHEMICAL PROCESS

3.15 **SWIRL TUBE DECKS/TRAYS**

3.16

## VANE OR OTHER PROPRIETARY INTERNALS

PECO
PEERLESS
SEPARATION TECHNOLOGIES
YORK

3.17 **LOOP REACTORS**

TAYLOR FORGE
MITTERNIGHT BOILERS

3.18 **MIXERS & AGITATORS FOR VESSELS**

PLENTY MIXERS
LIGHTNIN MIXERS
CHEMINEER
PHILADELPHIA GEAR
KOCH
KOFLO

MIXING EQUIPMENT
CLEVELAND MIXERS

3.19 **GRAVITY BLENDERS & SILOS**

FULLER
ENGINEERED STORAGE PRODUCTS
(A.O. SMITH)

3.20 **FCC CYCLONES**

BEULLE DIV. of FISHER KLOSTERMAN
EMTROL

**4.0**

## *GROUP - ROTATING EQUIPMENT*

4.1

## PUMPS, CENTRIFUGAL, HORIZONTAL SINGLE & MULTISTAGE, API 6 1 0

DAVID BROWN PUMPS
FLOWSERVE
SULZER
FLUID-POWER EQUIPMENT
CO.(JOHNSTON PUMP)
GOULDS
DAVID BROWN UNION PUMPS
UNITED

4.2

## PUMPS, CENTRIFUGAL, AGRU SERVICES, API 610

DAVID BROWN UNION PUMPS
FLOWSERVE

4.3 **PUMPS, CENTRIFUGAL, VERTICAL SUBMERGED, API 610 (RADIAL SPLIT) -SEA WATER PUMPS**

SULZER
CRANE DEMING
FISHER INDUSTRIES
JOHNSTON PUMPS
PHOENIX PREERLESS

4.4 **PUMPS, HIGH SPEED**

SUNDYNE-SUNSTRAND

4.5 **VERTICAL IN-LINE PUMPS(BS 4082.CLASS R)**

FLOW SERVE
DRESSER RAND
GOULDS
PACO

4.6 **PUMPS, ROTARY SINGLE SCREW**

4.7 **PUMPS, (SUMP TYPE)**

DAVID BROWN PUMPS
FLOWSERVE
INGERSOLL-DRESSER PUMPS
GOULDS

4.8 **PUMPS, CRYOGENIC SUBMERGED**

J.C. CARTER
EBARA, CRYODYNAMICS

4.9 **PUMPS, CRYOGENIC (COLD VERTICAL CAN TYPE)**

DBU
FLOWSERVE
SULZER
SHIN NIPPON
EBARA

4.10 **PUMPS, ASME B73**

GOULDS
IDP

4.11 **RECIPROCATING DOSING PUMPS**

FLOW SERVE
VOLU MAX
CRANE CO. CHEMPUMP DIVISION
HILLS MCCANNA
MILTON ROY
WILLIAMS

4.12

## ROTARY POSITIVE DISPLACEMENT PUMPS

FLOW SERVE
IMO
VIKING

4.13 **SUBZERO CENTRIFUGAL PUMPS (BELOW -25 C)**

FLOW SERVE

4.14 **SEALESS PUMP**

SUNDSTRAND

4.15 **SULFUR PUMP**

CHAS LEWIS
LAWRENCE
STERLING LABOUR

4.16

## COMPRESSORS, CENTRIFUGAL, IN ACCORDANCE WITH API 617

SIEMENS DEMAG DELAVAL TURBO
MACHINERY
AC COMPRESORS
ELLIOT TURBOMACHINERY
DRESSER RAND

4.17

## COMPRESSORS, INTEGRALLY GEARED, (PROCESS) API 672

ATLAS COPCO
COOPER INDUSTRIES

4.18

## COMPRESSORS, INSTRUMENT AIR COMPRESSORS, A1014 API 617

COOPER - JOY
ELLIOTT
SULLAIR
JOY
AIRDYNE

UNIVERSAL COMPRESSION

4.19

## COMPRESSORS, CENTRIFUGAL, MAIN MR/ PROPANE, API 617 FOR LNG SERVICE

ELLIOT - EBARA
DRESSER RAND

4.20

## COMPRESSORS, CENTRIFUGAL, BOIL OFF GAS (API 617)

ELLIOT-EBARA
SIEMENS DEMAG DELAVAL TURBO
MACHINERY
AIRDYNE
NEUMAN & ESSER

4.21

## COMPRESSORS, RECIPROCATING, TO API 618

COOPER INDUSTRIES
DRESSER RAND

4.22

## COMPRESSORS, RECIPROCATING, LABYRINTH

4.23 **GAS TURBINES, MECHANICAL DRIVERS (G.E. FRAME 7)**

GENERAL ELECTRIC - NUOVO PIGNONE

4.24 **GAS TURBINES, MECHANICAL DRIVERS (G.E. FRAME 6)**

GENERAL ELECTRIC - NUOVO PIGNONE

4.25 **GAS TURBINES, POWER GENERATION UNITS (G.E. FRAME 5 OR EQUIVALENT)**

GENERAL ELECTRIC - NUOVO PIGNONE

4.26 **ELECTRIC MOTORS (API 541)**

ALSTOM
ABB
GENERAL ELECTRIC
SIEMENS
WESTINGHOUSE

4.27 **ELECTRIC MOTORS (IEEE 841)**

GENERAL ELECTRIC
RELIANCE
SIEMENS
WESTINGHOUSE

4.28 **ELECTRIC MOTORS (API 546)**

ABB

4.29 **ELECTRIC GENERATORS (3000 KW AND SMALLER)**

BRUSH
KATO
ONAN

4.30 **ELECTRIC GENERATORS (LARGER THAN 3000 KW)**

BRUSH

4.31

## EXPANDERS - TURBINES, LIQUID, CRYOGENIC – 196C LNG SERVICE

FLOWSERVE ( BWIP)
EBARA

4.32 **EXPANDERS – FOR PETROCHEMICAL SERVICE**

MAFI TRENCH
ROTOFLOW (ATLAS COPCO)

4.33 **SCREW AIR COMPRESSOR (INTEGRAL GEAR)**

ATLAS COPCO

4.34 **AIR COMPRESSORS / BLOWERS / FANS**

ABB GARDEN CITY FANS
HOWDEN
ROOTS
T.D. WILLIAMSON, INC.
DRESSER RAND
DRESSER HOLMES

4.35

## STEAM TURBINES (GENERAL PURPOSE) WITH API611

COPPUS
DRESSER RAND
ELLIOTT

4.36 **GEARBOXES, GENERAL PURPOSE**

LUFKIN
BHS-CINCINNATI

4.37 **GEARBOXES, API 613**

LUFKIN

4.38 **DIESEL ENGINES AND DIESEL ENGINE GENERATOR DRIVERS, FOR 250 KW & OVER**

CATERPILLER
WAUKESHA
RUST POWER
CUMINS
DETROIT ALLISON

4.39 **COUPLINGS (FOR COMPRESSORS)**

TRW - LUCAS

4.40 **REFRIGERATION SYSTEMS**

VILTER MANUFACTURING
FRICK RECO (YORK)
TOROMONT ( LEWIS ENERGY SYSTEMS)
FES (CARRIER)
AMERICAN STANDARD
MYCOM

**5.0**

## *GROUP - SPECIAL EQUIPMENT*

5.1 **CPI SEPARATORS - INTERCEPTORS/CORRUGATED PLATES (CPI)**

MONARCH SEPARATORS
HYDRO FLO TECHNOLOGIES
NATCO (formerly Serck Baker)
EIMCO ( part of Dorr-Oliver)
US FILTER

5.2 **DESALINATION UNITS**

ALFA LAVAL
METITO
AQUA CHEM
BEAIRD
MECO

5.3 **SEA WATER INTAKE SCREENS**

US FILTER – ENVIREX

## 5.4 ELECTRO-CHLORINATION UNITS

METITO
SEVERN TRENT DENORA
ELECTRO CATALYTIC
BAKER HUGHES PROCESS SYSTEMS
EXCELTEC INTERNATIONAL (Severn Trent)
US FILTER

## 5.5 CHLORIINATORS

CAPITOL CONTROLS CO. INC.
FISCHER & PORTER
WALLACE & TIERNAN DIV. of PENNWALT
INCHLOR

## 5.6 WATER TREATMENT- ION EXCHANGE /DEMINERIALIZER/ REVERSE OSMOSIS CONDENSATE POLISHING, WATER PRETREATMENT

DEGREMONT
METITO
INONICS
GRAVER
US FILTER
HUNGERFORD & TERRY
EPS
PROCESS EQUIPMENT

AQUACHEM
WATER & POWER TECHNOLOGIES

## 5.7 CHEMICAL INJECTION PACKAGES

METITO
BRAN AND LUBBE
MILTON ROY
EMCO ENGINEERING
JOHNSON MARCH SYSTEMS,INC.
ENGINEERED PROCESS EQUIPMENT
NEPTUNE CHEMICAL PUMP COMPANY
EPS (ENGINEERED PROCESS SYSTEMS)
DATUM COMPANY
DURAMETER

## 5.8 INSTRUMENT AIR DRYERS

AIRDYNE,INC.
AIRTECH
CM KEMP
PENUMATECH
SULLAIR

TIDE-AIR.INC.
ZURN

5.9 **VACUUM PACKAGE**

GRAHAM MNUFACTURING

5.10 **STEAM-VACUUM CONDENSERS**

GRAHAM

5.11 **LOADING ARMS, LNG/LPG**

FMC CORP.

5.12 **LOADING ARMS CONDENSATE/LIQUIDS**

FMC CORP.
OPS

5.13 **NITROGEN PRODUCTION UNITS (AND NITROGEN STORAGE/VAPORIZER PACKAGE)**

TAYLOR WHARTON

5.14 **PROCESS FILTERS**

AMF
FACET FILTERS
DOLLINGER INTERNATIONAL
CM KEMP
FRAM
KING TOOL
PALL
PECO (PERRY EQUIPMENT)
PEERLESS
RONNINGEN PETTER
SOUTHWEST FILTER
WINSTON
CUNO

5.15 **PACKAGED EQUIPMENT, AIR FILTERS**

DONALDSON
CONSLER
DOLLINGER INTERNATIONAL
KEMP
NAFCO
PALL
AAF

5.16

## SANITARY TREATMENT EQUIPMENT, INCLUDING LIFT STATIONS

US FILTER
METITO
OWENS KLEEN TANK
PURESTREAM
RED FOX ENVIRONMENTAL
SANITAIRE
SMITH & LOVELESS
S & D WORLDWIDE ENTERPRISES
POLLUTION CONTROL SYSTEMS INC.

5.17 **WASTE WATER TREATMENT**

US FILTER
EPS

5.18 **API SEPARATORS**

MONARCH SEPARATORS
WESTECH
US FILTER
HYDRO FLO TECHNOLOGIES
PAN AMERICAN ENVRONMENTAL
MONROE ENVIRONMENTAL
HUDSON INDUSTRIES

5.19 **COOLING TOWERS**

HAMON
BALKE-DURR (ZURN)
MARLEY
PYSCROMETRIC SYSTEMS INC. ( PSI )
MIDWEST TOWERS INC.
GEA THERMAL

5.20

## SEAWATER RO UNIT / ELECTRONIONIZATION

METITO
GE WATER SYSTEMS
IONICS
US FILTER
WATER & POWER TECHNOLOGIES
AMBI DESIGN
AQUATECH
BOB JOHNSON ASSOCIATES

5.21

# DRINKING WATER TREATMENT PACKAGE

BOB JOHNSON ASSOCIATES
ENGINEERED PROCESS SYSTEMS (EPS)
INPAK
NEPTUNE

## 5.22 CARBON FILTER

PECO/PERRY
SOUTHWEST FILTER
TIGG
US FILTER

## 5.23 STRAINERS, GENERAL PURPOSE

AMF
SPIRAX SARCO
MUELLER
KEYSTONE
PROCESS STRAINERS
RONNINGEN PETTER
YARWAY
APOLLO ENGINEERING
HAYWARD
BOLLFILTER
S.P. KINNEY
R.P. ADAMS
ACME ENGINEERING
HELLAN
TATE ANDALE
WEAMCO

## 5.24 STRAINERS. FEED GAS

SPIRAX SARCO

## 5.25 PIG RECEIVERS

PECO
SAGEBRUSH PIPELINE SUPPLY CO.
T.D. WILLIAMSON, INC.
TAYLOR FORGE ENGINEERING

## 5.26 SLUG CATCHER -DESIGN&FABRICATORS

TAYLOR FORGE ENGINEERING

5.27 **MIXERS, TOP ENTRY**

LIGHTNIN MIXER
CHEMINEER
SHARPE
PROQUIP
JENSEN
PHILADELPHIA GEAR
BRAWN
SHARPE
STELZER

5.28 **GLYCOL DEHYDRATION SYSTEM**

5.29 **MOLECULAR SIEVES**

UOP - MOL SIEVE DIV
ZEOCHEM
ATOFINA

5.30 **SULFUR RECOVERY UNITS (SRU) also TAIL GAS TREATING/ACID GAS REMOVAL**

TECHNIP USA/TECHNIP ITALY
TPA
BLACK & VEATCH
PETROFAC
PARSONS
PROQUIP

5.31 **PSA UNITS ( ISOBUTANE/NITROGEN RECOVERY UNITS)**

UOP
AIR PRODUCTS
MEMBRANE TECHNOLOGY

5.32 **HYDROGEN PURIFICATION UNITS**

AIR PRODUCTS
UOP
NATCO
IGS

5.33 **HYDROGENATION UNIT**

AIR PRODUCTS

## 6.0 GROUP - SOLIDS PROCESSING EQUIPMENT

### 6.1 HOISTS AND CRANES

INGERSOLL RAND (AIR HOISTS)
GAFFEY
YALE
CRANEMANN

### 6.2 HANDLING EQUIPMENT, GENERAL

INGERSOLL RAND

### 6.3 PNUEMATIC CONVEYING SYSTEMS

MAC EQUIPMENT

### 6.4 PLASTIC PALLETIZING EXTRUDER

### 6.5 PELLET DRYERS

GALA INDUSTRIES
CARTER DAY
ALFA LAVAL SEPARATION

### 6.6 BAGGING AND PALLETIZING SYSTEMS

SLIDELL
TAYLOR PRODUCTS

### 6.7 ADDITIVES FEEDING SYSTEMS

MERRICK INDUSTRIES
ACRISON
ACCURATE (SCHENK)

### 6.8 CATALYST FEEDERS

COPELAND INDUSTRIES

### 6.9 CATALYST ACTIVATORS

PETSI
BIGELOW-LIPTAK

### 6.10 ADDITIVE DUMP STATION

PHILLIPS

6.11 **SCALPING SCREEN**

KASON
PENWALT
ROTEX

6.12 **CONVEYORS & SHIPLOADERS**

BMH-PHB
ROBERTS & SCHAEFER
FMC
DEVCO ( FABER ENGINEERING)

6.13 **SCRAP DISPOSAL SYSTEMS**

6.14 **TRASH COMPACTOR**

MARATHON

6.15 **CYLINDER ROLLER**

ASP

6.16 **SOLID SULFUR HANDLIG (Pastillation Unit)**

DEVCO
SANDVIK

## 7.0 *GROUP – UTILITY EQUIPMENT*

7.1 **BOILERS**

ABCO
BABCOCK AND WILCOX
SOUTHWEST BOILERS
ZURN
HOLMAN
INDECK
NEBRASKA

7.2 **DEAERATORS**

CRANE/COCHRANE
KANSAS CITY DEARERATOR
STERLING DEAERATOR
EPS (ENGINEERED PROCESS SYSTEMS)

7.3 **WASTE HEAT BOILER**

TECHNOTHERM
DELTAK
BABCOCK & WILCOX
HOLMAN

7.4 **HEAT RECOVERY STEAM GENERATORS HRSG UNITS**

DELTAK
NOOTER/ERIKSEN
FOSTER WHEELER
VOGT-NEM
ERIE BOILER (ALBORG USA)

7.5 **SEAWATER DESALINATION UNITS**

ALFA LAVAL
AQUA CHEM
BEAIRD INDUSTRIES
MECO

**8.0**

## GROUP - PIPING, SYSTEMS AND REFRACTORIES

8.1 **PIPE (ALL STEEL)**

| | | C (carbon), LA (low alloy), SS (stainless) Welded (EW/SAW) Seamless (SM) SP(SPIRAL WELDED) | |
|---|---|---|---|
| AVESTA POLARIT | USA | SS | EW |
| LONE STAR STEEL | USA | C | EW |
| NAPA | USA | C | SAW |
| STUPP CORP. | USA | C | EW |
| USX ( US STEEL ) | USA | C | EW SM |
| BERG | USA | C | SAW |
| SOUTHERN TEXAS STEEL (SAW PIPE) | USA | C | SAW |
| KOPPEL STEEL | USA | C, LA | SM |
| MICHIGAN SEAMLESS TUBE (QUANEX) | USA | LA | SM |
| WYMAN GORDON (CURTIS WRIGHT) | USA | C, LA, SS | SM |
| SPECIAL METALS (INCO ALLOY) | USA | SS | SM |
| HAYNES | USA | SS | SM cont'd |
| PEXCO | USA | SS | SM |
| BRISTOL | USA | SS | EW |
| NORTH STAR (VNM SUMITOMO) | USA | C, LA | SAW/EW |
| SHARON STEEL | USA | C | EW |

| | | | |
|---|---|---|---|
| TEXTUBE | USA | C | EW |
| ALGOMA (TENARIS) | USA | C. LA | SM |

## 8.2 REINFORCED CONCRETE PIPE

AMERON CONCRETE & STEEL PIPE

## 8.3 FRP PIPE

| | | |
|---|---|---|
| AMERON | USA | |
| BETTLE | USA | |
| CONELY | USA | |
| ERSHIG | USA | |
| FABRICATED PLASTIC LTD. | USA | |
| FIBERCAST | USA | |
| SMITH FIBERGLASS | USA | |
| STAR (API) | USA | (API) |
| TUBULAR FIBERGLASS (API) | USA | (API) |

## 8.4 HDPE PIPE

| | |
|---|---|
| AMERON | USA |
| PERFORMANNCE PIPE | USA |
| RESISTOFLEX | USA |
| PHILIPS DRISCOPIPE | USA |
| POLYPIPE | USA |
| SCHMITZ & SCHULTE | USA |

## 8.5 PVC PIPE/FITTINGS

| | |
|---|---|
| AMERON | USA |
| WAVIN | USA |
| RESISTOFLEX | USA |
| CHARLOTTE PIPE | USA |
| SCHMITZ & SCHULTE | USA |

8.6 **SEAMLESS CARBON STEEL BW FITTINGS**

CUSTOM ALLOY (GENOYER)
FLO-BEND (TRINITY)
HACKNEY (TRINITY)
TUBE-LINE
LADISH
PRESCOR
STEEL FORGINGS
FLOWLINE
PENN MACHINE

8.7 **WELDED CARBON STEEL BW FITTINGS**

CUSTOM ALLOY (GENOYER)
HACKNEY (TRINITY)
TUBE-LINE

8.8

## FORGED-CARBON STEEL SW & SCREWED FITTINGS

ANVIL
PENN MACHINE
VOGT
WFI
CAPITOL
WESTBROOK

8.9 **SEAMLESS LOW-ALLOY BW FITTINGS**

ANVIL
CUSTOM ALLOY
FLOWLINE
GERLIN
PENN MACHINE
VOGT

8.10

## SEAMLESS STAINLESS STEEL BW FITTINGS

CUSTOM ALLOY
FLOWLINE
GERLIN

8.11 **WELDED STAINLESS STEEL BW FITTINGS**

CUSTOM ALLOY (GENOYER)
FLOWLINE
GERLIN

8.12

## FORGED STAINLESS STEEL & ALLOY SW & SCREWED FITTINGS

ANVIL
VOGT
LADISH
WFI
WESTBROOK
PENN MACHINE
ALLOY FITTING
STEEL FORGING

8.13 **BLOCK TYPE FORGED STEEL FITTINGS**

8.14 **FLANGES**

| | | |
|---|---|---|
| COFFER | USA | CS |
| DL FLANGE (GENOYER) | USA | CS |
| HACKNEY | USA | CS |
| NATIONAL FLANGE | USA | CS, LA, SS |
| TEXAS FLANGE/METAL | USA | LA, SS |
| NEWMANS | USA | |
| LADISH | USA | CS, |
| WFI | USA | CS, LA, SS |
| FLOWBEND | USA | LA, |
| FLOWLINE | USA | LA, |
| BOLTEX | USA | CS, |
| IDEAL | USA | LA, |
| MAAS | USA | LA, |
| KERKAU | USA | CS, |
| PIPING PRODUCTS | USA | CS, LA, SS |
| TUBE-LINE | USA | CS, LA, |
| WESTERN | USA | LA, SS |

8.15 **BELLOWS, CRYOGENIC**

PATHWAY BELLLOWS
SENIOR FLEXONICS

8.16 **METALLIC EXPANSION JOINT**

SENIOR FLEXONICS PATHWAY
HYSPAN
PATHWAY BELLOWS
US BELLOWS
EXPANSION JOIINT SYSTEMS (EJS)
BADGER
MICRO-FLEX
ADSCO

8.17 **RUBBER EXPANSION JOINT**

GARLOCK
GOODALL RUBBER
HOLTZ
UNAFLEX
SENIOR FLEXONICS PATHWAY
RESISTOFLEX
MERCER
PROCO EXPANNSIONN JOINTS

8.18

## BALL VALVES, API 6D, FLANGED AND BUTT WELD ENDS, SPLIT BODY DESIGN, LOW TEMP, SERVICE DOWN TO MINUS 50 C – MATL. A105 LF2 & SS

FLOW CONTROL
ORBIT
T.K. VALVE
TYCO INTERNATIONAL
GROVE
WKM
DEMCO
KF

8.19 **BALL VALVES, API 6D, FLANGED AND BUTT WELD ENDS, DESIGN.LOW TEMP, SERVICE DOWN TO MINUS 50C**

ORBIT
T.K. VALVE
CAMERON
WKM
DEMCO
KF

8.20

## BALL VALVES, FLANGED, STAINLESS STEEL 316, LOW TEMP MINUS 80C

STARLINE
ORBIT
TYCO INTERNATIONAL
GROVE

8.21

## BALL VALVES.FLANGED, STAINLESS STEEL 316, LOW TEMP MINUS 196C

STARLINE
TYCO INTERNATIONAL

8.22 **BALL VALVES, FLANGED, SS 316 AND SS 316 NACE, LOW TEMP, MINUS 196C**

STARLINE
GROVE
ORBIT
TYCO INTERNATIONAL
T.K. VALVE

8.23 **CHECK, GATE, GLOBE, VALVES, FLANGED, SS 316, FOR LOW TEMP, SERVICE DOWN TO MINUS 80 C AND DOWN TO MINUS 196 C**

8.24 **PILOT OPERATED TYPE, FOR CRYOGENIC SERVICE DOWN TO MINUS 196C**

DRESSER
ANDERSON GREENWOOD
CROSBY
FARRIS CURTISS WRIGHT

8.25 **CONVENTIONAL TYPE, API STD 526, FOR CRYO SERVICE DOWN TO MINUS 196C**

8.26 **LOW TEMPERATURE BUTTERFLY VALVES DOWN TO MINUS 80 AND MINUS 196C**

ENERGY CONTAINER (ROYAL) (SOFT SEATED)
FISHER(POSI-SEAL)
SURE FLOW ( METAL SEATED )

8.27

## HI-PERFORMANCE BUTTERFLY VALVES

FLOW SEAL (CRANE)
ZWICK

8.28 **CAST BRONZE VALVES (GATE/GLOBE/CHECK/BALL)**

STOCKHAM
CRANE

8.29 **CAST IRON & DUCTILE IRON VALVES (GATE/GLOBE/CHECK)**

AMERICAN-DARLING

CRANE
US METRO SEAL
KENNEDY CLOW
MILWAUKEE

8.30 **FORGED STEEL VALVES (GATE/GLOBE/CHECK) (CARBON/ALLOY/STAINLESS STEEL)**

BONNEY FORGE
VOGT
EDWARDS
SMITH
ANVIL
DRAGON
DSI
CONBRACO

8.31 **CAST CARBON STEEL VALVES (GATE/GLOBE/CHECK)**

DSI
EDWARDS
LADISH
PACIFIC
POWELL
QAP

8.32 **CAST ALLOY STEEL VALVES (GATE/GLOVE/CHECK)**

COOPER
PACIFIC
EDWARDS
QAP

8.33 **CAST STAINLESS STEEL VALVES(GATE/GLOBE/CHECK)**

COOPER
LADISH
PACIFIC
POWELL ( up to 12" )
EDWARDS
DSI
QAP

8.34 **BUTTERFLY VALVES**

BRAY VALVE
DEZURIK
ENERGY CONTAINER (ROYAL)
FISH ER (POSI-SEAL)
XOMOX
TYCO ( KEYSTONE )

SURE SEAL

8.35 **BALL VALVES**

COOPER (GATE/BALL)
DANIEL
GROVE (GATE/BALL)
HILLS MCCANNA (SPLIT TOP ENTRY)
ORBIT VALVE (BALL VALVE, TOP ENTRY)
WKM

8.36 **PLUG VALVES**

DANIEL (DAN-EX)
FLOWSERVE (DURCO-NON LUBRICATED)
GENER-AL (TWIN SEAL)
ORBIT (TRUSEAL)
CRANE (WEDGE PLUG TYPE)
XOMOX

8.37 **WAFER CHECK VALVES**

CRANE
HYGRADE
GULF

8.38 **DIAPHRAGM VALVE**

ITT GRINNELL
GIE

8.39

## Y-PATTERN VALVES & BLOW-DOWN VALVES

HILLS MCMANNA
YARWAY
CONVAL
EDWARD VALVE

8.40 **NON-SLAM CHECK VALVES (AXIAL ISC TYPE)**

DRESSER

8.41 **STEAM TRAPS/VACUUM TRAPS**

ARMSTRONG
KEYSTONE

8.42 **PIPE SUPPORTS**

GRINNEL CORP.
PIPING TECHNOLOGY
RILCO
AAA TECHNOLOGY
BERGEN-POWER

8.43 **CRYOGENIC PIPE SUPPORTS (COLD SHOES/PUFF)**

RILCO
PIPING TECHNOLOGY
POWER PIPING / C&P

8.44 **SPRING HANGERS**

FRONEK
GRINNEL CORP.
PIPING TECHNOLOGY
RILCO

8.45 **VALVE LOCKING DEVICE**

8.46 **TRANSITION JOINTS (FOR LOW PRESSURE AND LOWTEMP. SERVICE: "DOWN TO - 196C"**

BARCLAD
TUBE TURNS

8.47 **TEFLON SLIDE PLATES**

FLUOROCARBON
PIPING TECHNOLOGY & PRODUCTS

8.48 **BOLTS & NUTS, STUDSBOLTS**

CONSOLIDATED SPECIALTIES
TEXAS BOLT COMPANY
LONE STAR
SPINDLETOP
THREADED STEEL PRODUCTS

8.49 **PIPE - SHOP FABRICATORS**

BOCCARD GROUP
SHAW GROUP
IPS
CROWN PIPE

8.50 **MIXERS, STATIC IN-LINE**

CHEMINEER
KOCH INT.
KOFLO
KOMAX

**9.0**

## *GROUP - STRUCTURAL*

9.1 **GANGWAY**

9.2 **STRUCTURAL STEEL**

CTIW (THAI HERRICK)
MARAUDER CO.
MARKLE STEEL
CIVES STEEL
PAX INC.

**10.0 GROUP - ELECTRICAL**

10.1

## ELECTRICAL DISTRIBUTED CONTROL SYSTEM

GE

10.2 **BUS DUCT**

GE
POWELL INDUSTRIES
CUTLER-HAMMER
UNIBUS

10.3 **CAPACITORS**

SCHNEIDER ELECTRIC
SIEMENS
ABB
COOPER SYSTEMS
GENERAL ELECTRIC

10.4 **POWER TRANSFORMERS**

ABB
ALSTOM
PAUWELS
SCHNEIDER
SIEMENS
COOPER POWER INDUSTRIES

MAGNATEK
NIAGARA

10.5 **CABLE POWER & CONTROL**

INSTR. CABLE = IC, VOLTAGE= LOW(LV), MEDIUM(MV), HIGH (HV)

| | |
|---|---|
| ALCATEL/GORSE | LV, MV, HV, IC |
| PIRRELI | LV, MV, HV |
| ABB | LV, MV, HV |
| SUMITOMO | LV, MV |
| OKONITE | LV, MV |
| PHILLIPS | LV, MV |
| ROME | LV, MV |
| SOUTHWIRE | LV, MV |

10.6 **POWER CONTROL BUILDINGS**

ELECTRICAL POWER SYSTEMS
POWELL INDUSTRIES
TESLA
PCI
SEIMENS
ALLEN BRADLEY

10.7

## UNINTERRUPTIBLE POWER SUPPLY SYSTEMS

CYBEREX
CHLORIDE STANDBY SYSTEMS
SEIMENS
SAFT-NIFE
EMERSON
SOLIDSTATE CONTROL
CUSTOM POWER

10.8

## SWITCHGEAR - LOW VOLTAGE AND MEDIUM VOLTAGE UP TO 33kV

ABB
GENERAL ELECTRIC
CUTLER-HAMMER - LOW VOLTAGE
SEIMENS - MEDIUM VOLTAGE
POWELL INDUSTRIES

10.9

## SWITCHGEAR – HIGH VOLTAGE 132 kV +

GENERAL ELECTRIC

ABB
SIEMENS

10.10 **ELECTRIC MOTORS –**

ABB
SEIMENS
GENERAL ELECTRIC

10.11

## MOTOR CONTROL CENTERS – LOW & MEDIUM VOLTAGE

ALLEN BRADLEY
POWELL INDUSTRIES
CUTLER-HAMMER
SIEMENS

10.12

## BATTERY CHARGERS

CUSTOM POWER
LA MARCHE
YUASA/EXIDE

10.13 **BATTERIES**

C&D
YUASA/EXIDE

10.14 **TELECOMMUNICATION CABLES**

ALCATEL/GORSE
DRAKA

10.15

## PLANT RADIO SYSTEM: BASE STATION VHF/ UHF

AE
TAIT
GENERAL ELECTRIC
MOTOROLA
SHIPMATE

10.16 **PORTABLES, TWO WAY (INTRINSICALLY SAFE)**

TAIT
GENERAL ELECTRIC
MOTOROLA

10.17

## PAGING RECEIVERS, ONE WAY, MESSAGES

GAI-TRONICS CORP
MOTOROLA

10.18 **H.F.EQUIPMENT**

CODAN
MOTOROLA

10.19 **CLOSED CIRCUIT TV SYSTEM**

THOMSON
VICON

10.20 **INTRINSICALLY SAFE TELEPHONE SETS**

SIEMENS

10.21 **CONVENTIONAL TELEPHONE SETS**

NORTHERN TELECOM

10.22 **UHF RADIO LINKS**

COMMTECH
TRT

10.23 **OPTICAL FIBER LINKS AND DIGITAL MUX**

SIEMENS
AT & T

10.24 **PUBLIC ADDRESS SYSTEM**

MOTOROLA
SEIMENS
GAI-TRONICS
GE

10.25 **INTEGRATOR**

10.26 **CATHODIC PROTECTION**

CORRPRO COMPANY
GALVOTEC ALLOYS INC.

HARCO

10.27 **ELECTRICAL MATERIALS SUPPLIER - ELECTRICAL BULKS**

BEN FIELD

10.28 **LIGHTING FIXTURES**

ABB-CEAG
COOPER-CEAG-CROUSE-HINDS
PHILIPS
APPLETON
CROUSE HINDS

10.29 **LOCAL CONTROL DISTRIBUTION PANEL**

APPLETON
CROUSE-HINDS

10.30 **SOCKET OUTLET**

CEAG-CROUSE-HINDS

10.31 **CABLE TRAY**

COPE
PW
B-LINE
THOMAS & BETTS

## 11.0 GROUP - INSTRUMENTATION

11.1 **HAND SWITCH**

MOORE INDUSTRIES
IDEL

11.2 **CONTROL VALVE (CONVENTIONAL & LOW NOISE)**

FLOWSERVE/VALTEK
CCI
FISHER-ROSEMOUNT
MASONEILAN

11.3 **CONTROL VALVE (SEVERE)**

FLOWSERVE/VALTEK
CCI
FISH ER-ROSEMOUNT

MASONEILAN

11.4 **CONTROL VALVE (BUTTERFLY)**

MASONEILAN
EMERSON-FISCHER CONTROLS
FLOWSERVE-VALTEK

11.5 **CONTROL VALVE (PLUG)**

XOMOX
DURCO
ORBIT (TRUSEAL)

11.6 **CONTROL VALVE (REGULATOR)**

FISHER
MASONEILAN

11.7 **CONTROL VALVE (V-BALL)**

EMERSON-FISHER
FLOWSERVE/VALTEK
MASONEILAN
DEZURIK

11.8 **SHUT OFF VALVE( BALL)**

KITZ

11.9 **SHUT OFF VALVE( HI PERF BUTTERFLY)**

11.10 **SHUT OFF VALVE( BALL-MOLECULAR SIEVE)**

ORBIT

11.11 **SHUT OFF VALVE( GATE)**

DEZURIK
WKM

11.12 **TANK BLANKET SYSTEM**

FISHER-ROSEMOUNT
AGCO

11.13 **SAFETY RELIEF VALVE (CONVENTIONAL/PILOT)**

AGCO (CROSBY) ( TYCO )

11.14 **QUARTER TURN ON-OFF ACTUATOR**

BETTIS

11.15

## HYDRAULIC ACTUATOR AND POWER PACK

SHAFER/BETTIS
PANTEX
BAFCO

11.16 **AIR FILTER REGULATOR**

FISHER-ROSEMOUNT
MASONEILAN

11.17 **SOLENOID VALVE (TO BE MOUNTED ON VALVE)**

ASCO

11.18 **E/P POSITIONER (SMART)**

FISHER-ROSEMOUNT
MOORE PRODUCT

11.19 **LIMIT SWITCH (PROXIMITY)**

WESTLOCK
GO

11.20 **ANALYZER PACKAGE SYSTEM**

ABB PASTECH
MEASUREMENTATION
ATI

11.21 **DISTRIBUTED CONTROL SYSTEM**

HONEYWELL
EMERSON
INVENSYS - FOXBORO
YOKOGAWA
FISHER
ABB

11.22 **TMR**

TRICONEX
HONEYWELL
ICS

11.23 **PLC**

SCHNEIDER-MODICON
ALLEN BRADLEY
GENERAL ELECTRIC

11.24 **FIRE AND GAS SYSTEM**

TRICONEX
NOTIFIER
ABB
SIEGER
GAS TECH
SIEMENS
HIMA
ROCKWELL
AUGUST
GENERAL MONITORS
DETECTOR ELECTRONICS

11.25 **VIBRATION INSTRUMENTATION**

BENTLY-NEVADA
METRIX*
* for Inquiry, Award
Subject to Owner Approval

11.26 **HIPS** (High Intensity Protection System)

TRICONEX

11.27

## ELECTRONIC FIELD TRANSMITTER & IP CONVERTER

FISHER-ROSEMOUNT
YOKOGAWA
FOXBORO

11.28

## PNEUMATIC FIELD TRANSMITTER/CONTROLLER/INDICATOR

YOKOGAWA
MOORE PRODUCT
FOXBORO

11.29 **VARIABLE AREA METERS (ROTAMETERS)**

ABB-FISCHER & PORTER
BROOKS

11.30 **AVERAGING PITOT FLOW ELEMENTS**

PRESO
DIETERICH (ANNUBAR)

11.31 **ORIFICE PLATES**

DANIEL
FMC (SMITH/PECO)

11.32 **INTEGRAL ORIFICE ASSEMBLY**

FISHER-ROSEMOUNT
YOKOGAWA
FOXBORO

11.33 **PD METER**

FISHER-ROSEMOUNT
FMC (SMITH/PECO)

11.34 **TURBINE METERS**

FISHER-ROSEMOUNT
FMC (SMITH/PECO)

11.35 **ULTRASONIC METERS**

CONTROLOTRON
ENDRESS HAUSER
PANAMETRICS

11.36 **VORTEX METERS**

YOKOGAWA
ENDRESS HAUSER
FOXBORO

11.37 **VENTURI TUBES**

AITKEN
FLUIDIC TECHNIQUES
BADGER
FMC (SMITH/PECO)

11.38 **DISPLACER TYPE LEVEL INSTRUMENT**

MASONEILAN
EMERSON-FISHER CONTROLS

MAGNETROL

11.39 **GAUGE GLASSES**

DANIEL
K-TEK
JERGUSON

11.40 **LEVEL DETECTORS (CAPACITANCE TYPE)**

ENDRESS & HAUSER
DREXEL BROOK
ROBERTSHAW

11.41 **LEVEL SWITCHES**

EMERSON-FISHER CONTROLS
MAGNETROL
SOR

11.42 **RECEIVER INDICATOR**

ASHCROFT
ITT BARTON
ORANGE RESEARCH

11.43 **DRAFT GAUGES**

DWYER
ASHCROFT

11.44 **PRESSURE GAUGE**

AMETEC
ASHCROFT

11.45 **PRESSURE SWITCHES**

DELTA CONTROLS
SOR
UE

11.46 **TEMPERATURE GAUGE & WELL**

ABB KENT-TAYLOR
ASHCROFT
GAYESCO

11.47 **RTD & WELLS**

SANDELIUS

EMERSON-ROSEMOUNT
THERMO ELECTRIC
GAYESCO

11.48 **THERMOCOUPLES & WELLS**

SANDELIUS
THERMO ELECTRIC
GAYESCO

11.49 **TEMPERATURE SWITCH & WELL**

ACROMAG
MOORE INDUSTRIES
SOR
UE

11.50 **SKIN TEMPERATURE ELEMENT**

THERMO ELECTRIC
GAYESCO

11.51 **ANALYSERS (CO)**

FISHER-ROSEMOUNT
SIERRA
FOXBORO

11.52 **ANALYSERS (HYDROCARBONS)**

FISHER-ROSEMOUNT
DELPHIAN
SIERRA

11.53 **ANALYSERS (H2S)**

FOXBORO

11.54 **GAS CHROMATOGRAPHS**

APPLIED AUTOMATION
ABB
HEWLET PACKARD
FOXBORO

11.55 **CONTINUOUS EMISSION MONITORS**

KVB
RJ BAMBECK
ANARAD

11.56 **ANALYSER (CO) CONTROL**

FISH ER-ROSEMOUNT
RJ BAMBECK
MEASUREX

11.57 **ANALYSER (O2) CONTROL**

SERVOMEX
TELEDYNE
FISHER-ROSEMOUNT (BECKMAN)
DELTA

11.58 **ANALYSER CONDUCTIVITY**

FOXBORO
FISHER-ROSEMOUNT
ELTRAN

11.59 **ANALYSER DISTILLATION**

APPLIED AUTOMATION
DANIEL
BENDIX
ABB ANALYTIC
FOXBORO

11.60 **FLAME SCANNERS (ULTRAVIOLET AND INFRA-RED)**

HONEYWELL
FIREYE
FORNEY

11.61 **INFRA-RED DETECTORS**

FOXBORO
APPLIED AUTOMATION
FISHER-ROSEMOUNT(BECKMAN)
MSA
TELEDYNE

11.62 **ANALYSER MOISTURE IN VAPOR**

PANAMETRICS
DUPONT
AMETEK

11.63 **ANALYSER OIL IN WATER**

MICRO MOTION
AGAR

11.64 **ANALYYSER OXYGEN/COMBUSTIBLES**

FISHER-ROSEMOUNT
THERMOX
BAMBECK

11.65 **ANALYSER PH**

FISHER-ROSEMOUNT
TBI (BAILEY)
FOXBORO

11.66 **ANALYSER TOTAL ORGANICS (TOC)**

FISHER-ROSEMOUNT
IONICS
HACH

11.67 **ANALYSER DISSOLVED OXYGEN**

FISHER-ROSEMOUNT
FOXBORO

11.68 **TANK GAUGING SYSTEMS**

ENDRESS & HAUSER
EMERSON SAAB
WHESSO-VAREC

11.69 **METERING SYSTEM**

FISHER-ROSEMOUNT (DANIEL)
INSTROMET
ENFAB
FMC (SMITH/PECO)

11.70 **MQV SYSTEM**

11.71 **INSTRUMENT CABLE**

FIJIKURA
DRAKA

11.72 **FIBER OPTIC CABLE**

DRAKA
SELCOR
CORNING

11.73 **CABLE GLAND**

11.74 **JUNCTION BOX**

GO VAN

11.75 **TERMINAL STRIPS**

PHOENIX
WEIDMULER
ENTRELEC

11.80 **TUBE FITTING**

SWAGELOCK
PARKER HANNIFIN

11.80 **TRANSMITTER MANIFOLD**

## 12.0 GROUP – FIRE & SAFETY

12.1 **UV/IR FIRE DETECTORS (FLAME)**

GENERAL MONITORS(MIR)
DET-TRONICS
SPECTRX

12.2 **FIRE DETECTORS (HEAT/RATE OF RISE/RATE COMPENSATED)**

DET-TRONICS
HONEYWELL
FIREYE

12.3 **FIRE DETECTORS (SMOKE)**

12.4 **COMBUSTIBLE GAS DETECTORS**

GENERAL MONITORS
DET-TRONICS
MSA

12.5 **TOXIC GAS DETECTORS (H2S)**

DET-TRONICS
GENERAL MONITORS
MSA

12.6 **MANUAL CALL POINT**

12.8 **WATER SYSTEMS**

AKRON BRASS
ELKHART BRASS
WILLIAMS FIRE & HAZARD
STANG MANUFACTURING

12.9

## SPRAY/SPRINKLER/DELUGE VALVES IN SPRAY SYSTEMS

WORMALD
VIKING CORP
GRINNELL
AUTOMATIC SPRINKLER
OCV
CLA-VAL
BERMAD
BERMAD

12.10

## FIRE EXTINGUISHERS, WHEELED & PORTABLE

ANSUL
AMEREX
BADGER

12.11 **FOAM HOSE REELS,WATER HOSE REELS, FIRE FIGHTING EQUIP, HYDRANTS (FABRICATED)**

WILLIAMS FIRE & HAZARD
DOOLEY TACKABERRY
SUMMIT SUPPLY
WILLIAMS FIRE EQUIPMENT
HILLER

12.12 **POST INDICATOR VALVES**

PRATT
KENNEDY
AMERICAN DARLING
KEYSTONE

12.13

## NFPA 20, FIRE PUMPS (UL LISTED/FM APPROVE

FLOWSERVE
PEERLESS PUMP
FISHER INDUSTRIES

WORTHINGTON
PATTERSON
ITT

12.14 **HIGH EXPANSION FOAM SYSTEM**
**7**

ALISON CONTROLS (CHUBB)
KIDDE
ANGUS
ANSUL

12.15 **DRY CHEMICAL FIXED SYSTEMS**

CHUBB
ANSUL
AMEREX

12.16 **CLEAN AGENT OR CO2 EXTINGUISHING SYSTEM FOR BUILDINGS, GAS TURBINES, COMPRESSORS**

WORMALD
ANSUL
KIDDE-FENWAL
CHEMETRON

12.17 **SAFETY SHOWERS & EYE WASH**

HAWS
ENCON
SPEAKMAN

12.18 **AMBULANCES**

MEDICMASTER
MILLER COACH

12.19 **FOAM TRUCKS**

CHUBB NATIONAL FOAM
EMERGENCY ONE

## 13.0 GROUP - CHEMICAL & CATALYST

BASF
CALGON CARBON CORPORATION
NORTON COMPANY
ZEOCHEM

## APPENDIX 7

## EGYPTIAN SUBCONTRACTORS

The document in this Appendix is a list of potential Egyptian suppliers. This list is appended as a source of information only and does not in any way construe Granherne's approval of these suppliers.

| Subcontractor | Scope of Work | Telephone Contact |
|---|---|---|
| **CIVIL WORKS:** | | |
| Petrojet | General Civil Works | Eng. Hazem El |
| Hefnawy | Structural Steel Erection<br>Mechanical Works | 066 3580802 / 4 / 1 |
| Bauer-Egypt<br>Khashaba | Piling Works | Eng. Mohamed<br>012 326 9981<br>3031790 |
| Keller | Piling Works | |
| Soltanche | Piling Works | |
| Sefi Fontec | Piling Works | |
| OCI/Misr Raymond | Piling Works | 749 2276 |
| Hassan Allam Sons<br>Sayed | General Civil Works | Eng. Hesham El |
| | Admin Bldgs<br>Civil Finishing works | 012 17 22019<br>2666917 |
| Orascom | General Building Works | 461 1111 |
| SIAC | General Civil Work | |
| Ginza | General Civil Work | |
| Ezaco | General Civil Work | |
| Freyssinet | Pre-stressed Concrete | |

**ROADS:**

| | | |
|---|---|---|
| Orascom Roads | General Road Construction | |
| Nile General Co. | General Road Construction | |
| Rizko | General Road Construction | |

**WELL DRILLING:**

| | | |
|---|---|---|
| Regwa | General Drilling contractor | |

**MARINE WORKS:**

| | | |
|---|---|---|
| Orascom/BESIX | Jetty Marine Works | 461 1111 |
| Archirodon Construction | General Marine Works | |

**STEEL FABRICATION:**

| | | |
|---|---|---|
| NSF | General Steel Fabricators | |
| Shotmed | General Steel Fabricators | |

**TANK FABRICATION/ERECTION:**

| | | |
|---|---|---|
| DELT | Tank Erection | ____ |
| Orascom | Tank Civil Works | 461 1111 |
| DSD | Tank Structural Steel, and Mechanical Works | 012 7425416 |

**PIPE FABRICATION/ERECTION:**

| | | |
|---|---|---|
| Dodsal Pte Ltd. | | |
| Petrojet | | |

**MECHANICAL ERECTION:**

| | | |
|---|---|---|
| Dodsal Pte Ltd. | Mechanical Works | _____ |

**ELECTRICAL/CONTROLS INSTALLATION:**

| | | |
|---|---|---|
| PPC | Temporary Electrical Works<br>Electrical and Instrument Works | _____ |
| Siemens ABB | | |
| AEG | | |
| Alsthom | | |

**SCAFFOLDING/VESSEL AND PIPE INSULATION:**

| | | |
|---|---|---|
| Orascom Cape JV | Insulation Works | 461 1111 |
| Cape East | Common Scaffolding | _____ |

**NON-DESTRUCTIVE TESTING:**

| | | |
|---|---|---|
| SGS Egypt | NDE Works | Mrs. Rania<br>3842811 |

# APPENDIX 8 - LIST OF ABBREVIATIONS

| Abbreviation | Description |
|---|---|
| $/MT | U.S. Dollars per Metric Ton |
| A | Amperes |
| AC | Alternating Electrical Current |
| ADB | Asian Development Bank |
| aMDEA | Advanced Methyl DiEthanol Amine for carbon dioxide removal, Licensed by BASF Corporation |
| AN | Ammonium Nitrate |
| ANSI | American National Standards Institute |
| ATR | Auto-Thermal Reformer, used in the Ammonia Process |
| bara | Pressure measurement bars absolute |
| barg | Pressure measurement bars gauge |
| BFW | Boiler Feed Water |
| Btu | British Thermal Units |
| CAFDS | Cash Available for Debt Service |
| CAPEX | Capital Expenditure |
| CM | Construction Management |
| CO | Carbon Monoxide |
| $CO_2$ | Carbon Dioxide |
| CoMox | Cobalt Molybdenum Catalyst |
| CW Pumps | Cooling Water Pumps |
| DAP | Di-ammonium Phosphate Fertilizer |
| DC | Direct Electrical Current |
| DCS | Distributive Control System, instrumentation for plant operation |
| DSCR | Debt Service Coverage Ratio |
| DSRA | Debt Service Reserve Account |
| EBRD | European Bank for Reconstruction and Development |
| ECA | Export Credit Agency |
| ECHEM | Egyptian Petrochemicals Holding Company |
| EF | Exposure Fee |
| EPC | Engineering, Procurement and Construction |
| FAO | Food and Agricultural Organization of the United Nations |
| G Cal | Giga Calorie |
| G Cal/MT | Energy Content, Giga calories per metric ton |
| GDP | Gross Domestic Product |
| H/N Ratio | The ratio of hydrogen to nitrogen. Used in ammonia plants when monitoring gas analysis for making ammonia. The ideal ratio is 3 to1. |
| $H_2S$ | Hydrogen Sulfide |

| Abbreviation | Description |
|---|---|
| HHV | Higher Heating Value |
| HP | High Pressure, Usually referring to steam pressure |
| HPBFW | High Pressure Boiler Feed Water |
| $mg/nm^3$ | Concentration Measurement, milligrams per normal cubic meter |
| mg-equiv/liter | Milligram equivalent of an ionic species per liter of solution |
| MLA | Multi-Lateral Agency |
| mm | Millimeters |
| mmBTU | Millions of BTU's |
| MP | Medium Pressure, Usually referring to steam pressure |
| MPa | Mega Pascals Absolute, Pressure |
| HTS | High Temperature Shift Converter, a Catalytic Reactor for converting carbon monoxide and water to hydrogen and carbon dioxide at a higher temperature. |
| Hz | Hertz, Frequency Unit of Measure, cycles per second |
| ID | Inside Diameter |
| IDC | Interest During Construction |
| IEC | International Electric Commission, an Electrical Standards Agency |
| IFC | International Finance Corporation, associated with the World Bank |
| IRR | Internal Rate of Return |
| ISBL | Inside the Battery Limits (perimeter of the Process unit) |
| JBIC | Japan Bank of International Cooperation |
| KBR | Kellogg Brown & Root, a Division of Halliburton |
| $kg/cm^2$ | Pressure Measurement in kilograms per square centimeter |
| kg/d | Kilograms per day |
| kgs | Kilograms |
| KRES | Kellogg Reformer Exchanger System |
| kV | Kilovolt |
| kW | Kilowatt |
| kWH | Kilowatt Hour |
| LE | Egyptian Pounds (Currency) |
| LHV | Lower Heating Value, usually related to the heating value of a combustible material |
| LP | Low Pressure, usually referring to steam pressure |

| Abbreviation | Description |
|---|---|
| LTS | Low Temperature Shift Converter, a Catalytic Reactor for converting carbon monoxide and water to hydrogen and carbon dioxide at a lower temperature. |
| m/sec | Meters per Second |
| $m^3$ | Cubic Meter |
| $MAC_{da}$ | Daily average concentration in the atmosphere of populated localities. |
| $MAC_{mo}$ | Maximum one-time concentration in atmosphere of populated localities |
| $MAC_{wa}$ | Allowable concentration in the working area |
| *mg/liter* | Milligrams per liter |
| $mg/nm^3$ | Concentration Measurement, milligrams per normal cubic meter |
| mg-equiv/liter | Milligram equivalent of an ionic species per liter of solution |
| MLA | Multi-Lateral Agency |
| mm | Millimeters |
| mmBTU | Millions of BTU's |
| MP | Medium Pressure, Usually referring to steam pressure |
| MPa | Mega Pascals Absolute, Pressure |
| $mg/nm^3$ | Concentration Measurement, milligrams per normal cubic meter |
| mg-equiv/liter | Milligram equivalent of an ionic species per liter of solution |
| MLA | Multi-Lateral Agency |
| mm | Millimeters |
| mmBTU | Millions of BTU's |
| MP | Medium Pressure, Usually referring to steam pressure |
| MPa | Mega Pascals Absolute, Pressure |
| MPBFW | Medium Pressure Boiler Feed Water |
| MTD | Metric Tons Per Day |
| MTPA, mtpa | Metric Tons Per Annum (year) |
| MTPD | Metric Tons Per Day |
| MVA | Mega Volt Amperes of Electricity |
| MW | Megawatts of Electricity |
| MWK | M. W. Kellogg, predecessor to KBR |
| N | Nitrogen, as in regards to fertilizer nutrients |
| NA | Nitric Acid |
| NAZ | Navoiazot |
| NFPA | National Fire Protection Association |
| $NH_3$ | Ammonia |

| Abbreviation | Description |
|---|---|
| $Nm^3$ | Normal Cubic Meter |
| $NO_x$ | Nitrogen Oxides, NO or $NO_2$ |
| NPK | A Blended Fertilizer containing the major nutrients |
| °C | Temperature Measurement, degrees Celsius |
| ONAF | Natural (convection) cooled oil-filled transformer with forced-air radiator cooling of the oil. |
| OPEX | Operating Expenses |
| OSBL | Outside the Battery Limits of the Production Facility, usually includes utilities and offsite equipment |
| P, $P_2O_5$ | Phosphorus, as in regards to fertilizer nutrients |
| PEA | Preliminary Environmental Assessment |
| PIV | Post Indicator Valve, normally used in fire water systems to indicate whether a valve is open or closed |
| ppmv | Concentration measurement, parts per million by volume |
| ppmw | Concentration measurement, parts per million by weight |
| PVC | Polyvinyl chloride plastic |
| REM | Removal |
| RFP | Request For Proposal |
| ROI | Return on Investment |
| S/C Ratio | Steam to Carbon Ratio |
| $SO_x$ | Sulfur Oxides, $SO_2$ or $SO_3$ |
| Synloop | The Synthesis Loop where ammonia is synthesized from hydrogen and nitrogen. |
| T/Y | Tonnes per year |
| TDA | United States Trade Development Agency |
| TDS | Total Dissolved Solids, referring to the concentration of minerals in water |
| TIC | Total Installed Cost |
| Tonnes | Metric Tons |
| TSP | Total Suspended Particulates |
| UPS | Uninterruptible Power Supply |
| US | United States |
| USD | United States Dollar |
| USDA | United States Department of Agriculture |
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