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INTEGRATED DEVELOPMENT OF NITRIC ACID-BASED INDUSTRIES IN INDONESIA

FINAL REPORT

BEICIP/CIPROCON

AUGUST 1987

Ingénieur conseil

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REVIEW OF FIRST PHASE FINDINGS

1. INTRODUCTION

This chapter summarizes the findings of first phase of work and in fact of Interim Report relating to :

- the domestic market of nitric acid-based products
- the export potentialities
- the prescreening of projects

As recalled in figures 1 and 2 which illustrate the main routes of production the main products derived from nitric acid and one of its key derivatives, aniline, concern the following fields of application :

- nitric acid itself
- fertilizers, more particularly ammonium nitrate and calcium nitrate
- explosives, with emphasis on ammonium nitrate and mention of nitrocellulose, nitroglycerine and TNT
- nitrocellulose, in coating outlets
- polyurethane foams and their raw materials, isocyanates (TDI, MDI)
- pharmaceuticals, with emphasis on paracetamol and to a lesser extent on sulphamides
- pesticides, more particularly carbofuran
- rubber chemicals which derive from aniline
- dyestuffs, in so far as their production can be justified downstream an aniline production
- sodium cyclamate, with its raw material cyclohexylamine

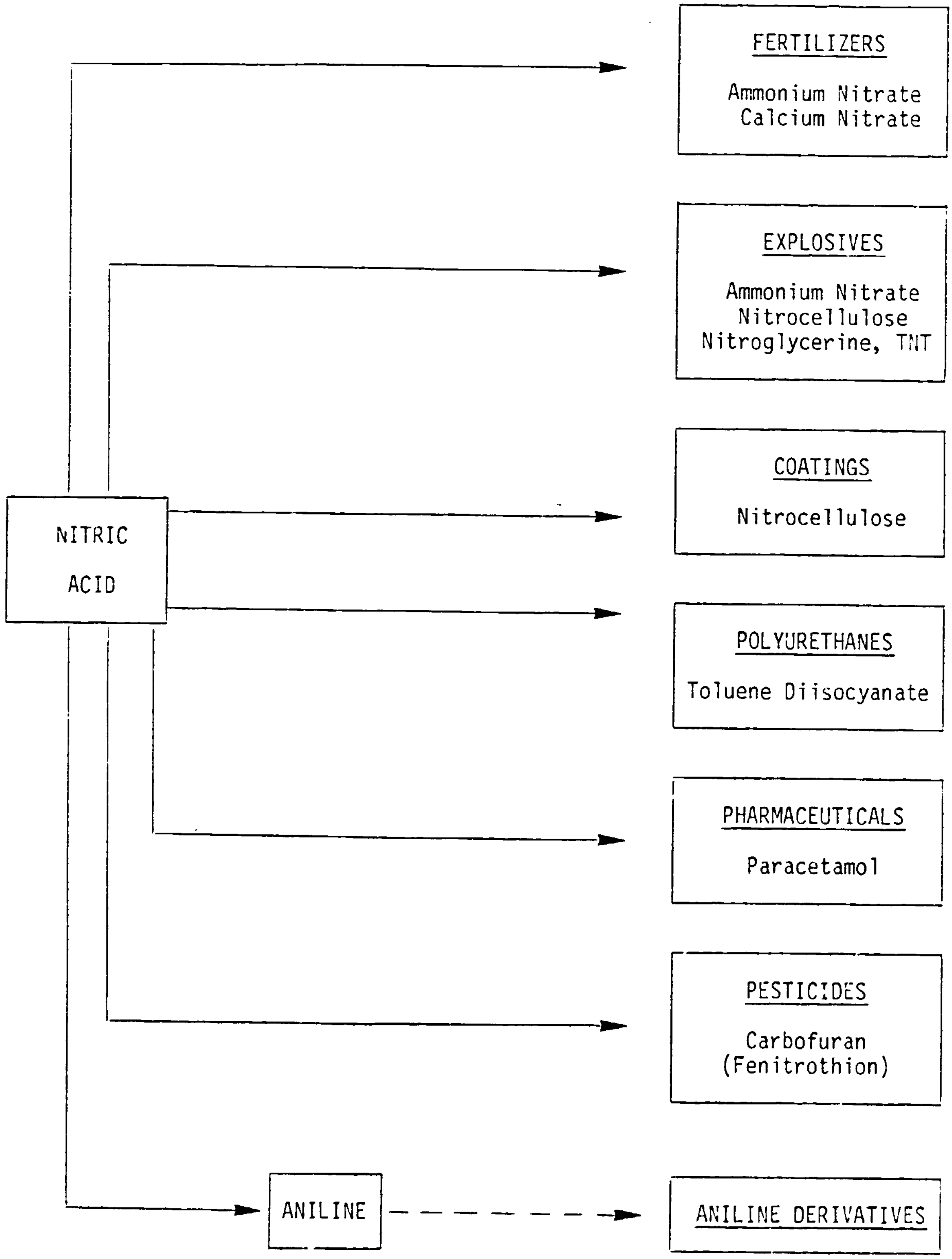

FIG.1 - DOWNSTREAM NITRIC ACID PRODUCTIONS

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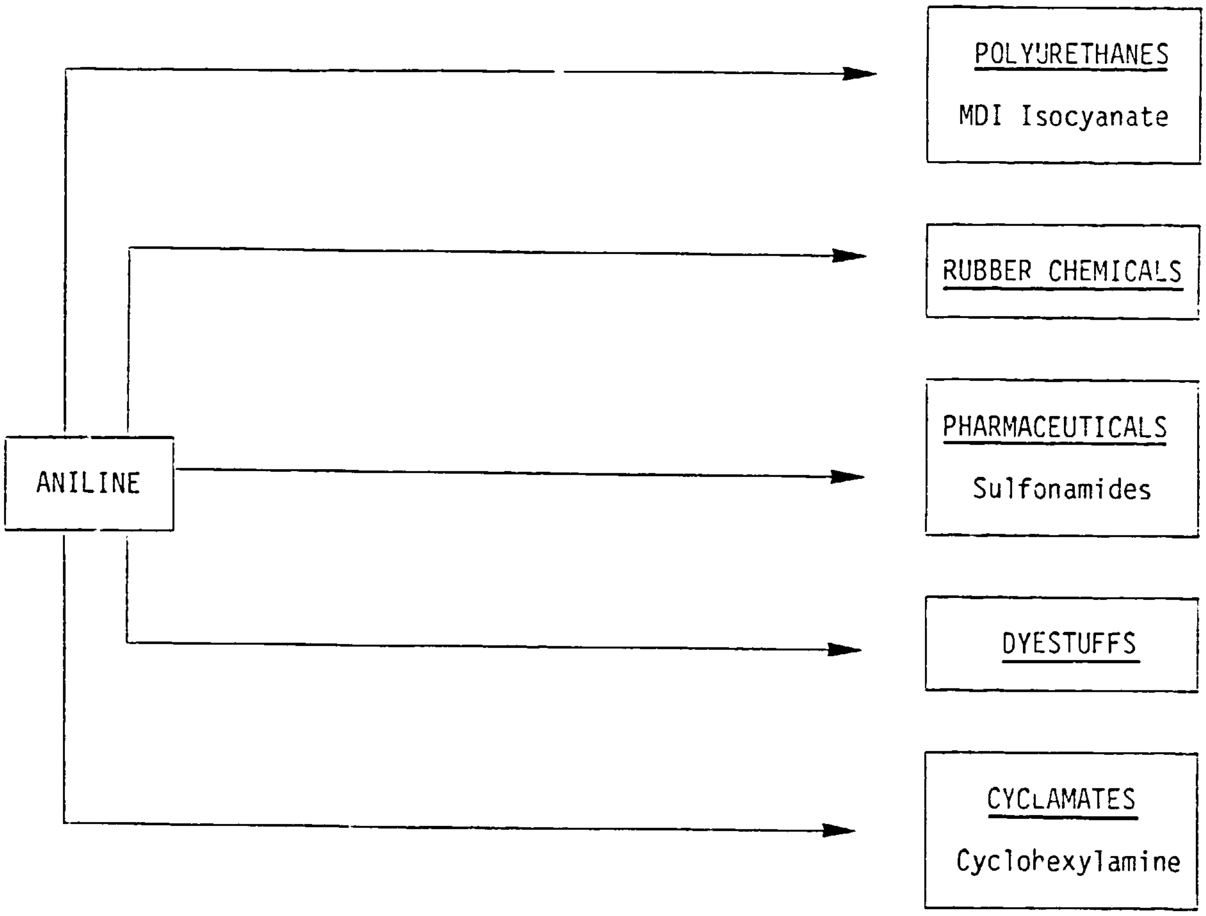

FIG. 2 - DOWNSTREAM ANILINE PRODUCTIONS

2. DOMESTIC MARKET OF PRODUCTS

2.1. Methodology and Sources of Information

Different sources of information were investigated and crosschecked in view of a precise evaluation of past and present demand and market pattern as well as present and likely near future status of industry :

- Trade statistics from Indonesia and major exporting countries
- Detailed field survey with visits and interviews of the main consumers, industrialists in Indonesia
- Available information in BEICIP, in other organizations, completed with contacts and visits to some major exporters of products

A list of Indonesian firms contacted or visited is given in table 1 hereafter. Main contributors to the analysis and data on specific markets are : PUPUK KUJANG (fertilizers, explosives), BPPT and PERUM DAHANA (explosives), PT LINSEA (nitrocellulose), PT RIA SIMA ABADI (paracetamol, paraaminophenol), PT KODEL and AGROCARB (carbofuran).

The evaluation of future status of industry and future consumption and market is then based on the knowledge of new projects which have been applied for and on a sectoral analysis approach.

2.2. Findings on the Domestic Market and Industry

For each specific product or field of application the domestic market as well as the status of local industry were investigated. Forecast volumes are summed-up in table 2 hereafter.

Direct uses of **nitric acid itself** are rather limited in steel industry, in metal pickling and for small chemical uses.

Among the **nitric acid based fertilizers** ammonium nitrate (fertilizer grade) does not find and will unlikely find outlets in the near future in Indonesia, due to :

. the existence of well developed habits and infrastructure for its competitor urea
. the safety aspects for handling and the hygroscopic nature
. the difficulty to build a new subsidizing policy and to educate people

On the other hand calcium nitrate has already found a market in tobacco crops which is likely to grow in the short and medium term. Potassium nitrate will represent only minor tonnages.

Ammonium nitrate (explosive grade) is by far the major product in the **explosive** sector, with the following estimate by main users, where it appears the higher growth will come from uses in coal mining.

Tentative forecasts of ammonium nitrate demand (Technical grade) in Indonesia by main users, (in tons)

	1986* (BEICIP estimate)	1993	1998
Cement industries	3000-3500	5000	6500-7000
Coal mining	1500-2000	5000-6500	6000-8500
Other mining	1500		
		3000-3500	3500-4500
Other (civil works...)	1000		
TOTAL	7000-8000	13000-15000	16000-20000

Evaluation of the market for military explosives (nitroglycerine, TNT, nitrocellulose) shows relatively low tonnages, with the possible exception of the latter in the medium term.

On all above products (nitric acid, ammonium nitrate - explosive grade, possibly calcium nitrate) PUPUK KUJANG has applied for a project of production which was analyzed. Such a project starts from the future availability of an excess of ammonia in their existing ammonia / urea complex.

Nitrocellulose for coating outlets already represents significant volumes for which two competitive projects of production have been applied for.

For the evaluation of toluene diisocyanate (TDI) and MDI markets, the **polyurethane foam** industry was surveyed. Rigid foams share very low quantities in the total production and even with significant rates of growth will lead to small requirements of MDI. Flexible foams will require more significant volumes of TDI.

In the field of **pharmaceuticals** a production of paracetamol (and soon of paraaminophenol presently under construction) will meet the requirements of the local market ; other nitric acid-based products were investigated : sulphamides and pyrazolones.

Among the **pesticides** the main product envisaged is carbofuran (from ortho-nitrochlorobenzene as raw material), since another possible outlet, fenitrothion, has been banned from last November. Here again a project for producing carbofuran is planned by several firms in a joint operation.

Rubber chemicals consumption will directly follow the production of rubber articles, chiefly represented by tyre manufacturing. For each group of chemicals -accelerators, antioxidants, antiozonants, retarders - the potential aniline requirements were measured, leading to small amounts (up to 1 000 tons in 1998) of aniline.

Dyestuffs, insofar as some of them can derive from aniline via their raw materials, aromatic amines for azo dyes, were investigated.

Estimates of the total dyestuff consumption (6 500 tons in 1986, at least the double by 1998) correspond to small volumes - a few hundred tonnes - for the one or two most common raw materials directly derived from aniline.

Sodium cyclamate is produced to a very large extent, giving to Indonesia the leading position in the world as regards the consumption of this sweetener. New regulations will however lessen the demand and lead to relatively small requirements of cyclohexylamine, its main raw material.

TABLE 1

LIST OF FIRMS CONTACTED

OR VISITED IN INDONESIA

In addition to Official Organizations, i.e. **Ministry of Industry, Ministry of Health, BPS** who have provided the bulk frame of data on market and industry.

Fertilizers

PT PUPUK KUJANG

Explosives

PT PUPUK KUJANG who have performed a detailed market survey after enquiries to consumers

PERUM DAHANA

BPPIT

ICI Explosives

PT BATUBARA

Nitrocellulose

NITRACELL project

PT LINSEA INC

Polyurethanes

PT VITAFOAM

PT PARDIC JAYA

PT JAYA ABADI MULIA KIMIA

RHONE - POULENC

PT SUPER POLY FOAM

Pharmaceuticals

PT RIA SIMA ABADI (or DARYA VARIA)

PT KIMIA FARMA

RHONE POULENC

Pesticides

PT AGROCARB

PT KODEL

ICI

CIBA GEIGY

Rubber chemicals

PT GOODYEAR and Association of Tyre Manufacturers

PT INTIRUB

PT GADJAH TUNGGAL

Cyclamates

PT INTI MANIS

Association of Cyclamate Producers

Nitric Acid

PT ANEKA KIMIA

Table 2

DOMESTIC CONSUMPTION OF NITRIC ACID-BASED FINAL PRODUCTS IN INDONESIA (in tons)

	Present	1993	1998
Ammonium nitrate (fertilizer)	0	negl.	negl.
Calcium nitrate	6-7,000	10,000	13,000
Potassium nitrate	< 1,000	1,000	
Ammonium nitrate (explosives)	7-8,000	13-15,000	16-20,000
Nitrocellulose (explosives)	to be eval.	to be eval.	
Nitrocellulose (surface coatings)	1,300-1,500	1,700-1,900	2,100-2,300
Flexible polyurethane foams (corresponding TDI equivalent)	14-15,000 (4,500-5,000)	19,000 (6,500)	22,000 (7,500)
Rigid polyurethane foams (corresponding MDI equivalent)	400-600 (200-300)	2,000 (1,000)	3,500 (1,750)
Paracetamol (Paranitrophenol (1) equivalent)	1,100 (900)	1,500 (1,250)	2,000 (1,650)
Sulphamides	200	300	400
Pyrazolones (antypyretics)	450	600	800
Fenitrothion (2)	0		
Carbofuran	1,000	1,500	2,000
Rubber chemicals	1,400	2,000	2,600
Sodium cyclamate (3) (corresponding cyclohexylamine equivalent)	4,000 2,000	ab.1,000 500	

(1) 1,800 T/yr unit under construction, which leaves an excess of 500 T/yr over the requirements of the 1,500 T/yr paracetamol unit

(2) Consumption just cancelled after banning. No forecasts for the future

(3) Order of magnitude in line with the intent of Authorities

3. EXPORT MARKET

3.1. Methodology and Sources of Information

If we except particular cases (trade agreements, opportunities for exchange deals, ...) the target countries for export potentialities refer to neighbouring countries and chiefly to ASEAN member countries.

Among the products covered in the domestic market analysis the export market evaluation was conducted on products easily tradeable and for which domestic requirements would nearly justify to set up a production unit.

Sources of information on the market and production status refer to trade statistics, published reports and studies, complemented through contacts with a few leading firms on the world scene.

Emphasis was put on the competitive plants or projects in the area and on the policy which may be adopted by international firms in that respect.

3.2. Findings

Results of export market evaluation are summarized in table 3 hereafter. The forecast possibilities in the short and medium term represent marginal quantities in comparison with domestic requirements which ensure temporary exports at the start-up of the plants and more economical sizes and conditions of production, this for :

- possibly nitric acid as such, if an excess is available from a local production
- calcium nitrate fertilizer, to a relatively small extent
- ammonium nitrate explosive, especially in Thailand and Malaysia, in competition with a plant in the Philippines
- nitrocellulose, if competitive prices are proposed
- TDI (toluene diisocyanate), with the same condition
- paraaminophenol, to the maximum extent of excess production made available from the project presently under construction

. nitrochlorobenzenes, as raw materials for future paraaminophenol or carbofuran production projects in other countries

. rubber chemicals, depending on the regional policy of firms ready to invest a production plant in Indonesia

. sodium cyclamate or cyclohexylamine, to a much smaller extent in comparison with the Indonesian level of consumption.

These export outlets were investigated without taking into account possible country to country trade agreements or special exchange trades.

Table 3

EXPORT POSSIBILITIES FOR NITRIC ACID-BASED FINAL PRODUCTS

(in tons)

	Present	1993	1998
Calcium nitrate	A very few thousand tons		
Ammonium nitrate (explosive)		3,000	5,000
Nitrocellulose (surface coatings)		200-300	300
TDI		1,500-2,000	2,000
Paraaminophenol	A very few hundred tons		
Nitrochlorobenzenes	A few hundred tons		
Rubber chemicals	A few hundred tons		
Sodium cyclamate	A very few hundred tons		
Cyclohexylamine	A few hundred tons		

4. CONCLUSIONS ON THE MARKET

By adding forecast volumes on the domestic market and complementary export possibilities, future outlets for the most promising products were evaluated and reflected back to upstream product consumptions and raw materials.

Table 4 hereafter summarizes these results at the level of potential consumptions for nitric acid and direct intermediates. Such amounts are based on various estimates of likely productions to be (or already) implemented in line with the evaluation of future domestic and export demands.

As an illustration the potential consumption of 30 600 (up to 40 100) tons of nitric acid (100 % basis) in 1993 is made with the following :

4 000 tons of nitric acid as such	
14 000 tons for the production of	17 000 tons of ammonium nitrate
9 000 tons for the production of	12 000 tons of calcium nitrate
1 400 tons for the production of	2 000 tons of nitrocellulose (100 % basis)
2 200 tons for the production of	5 000 tons of nitrochlorobenzenes

to which may be added, in case of downstream productions at that time

7 600 tons for the production of	8 000 tons of TDI

and most unlikely 1 900 tons for the production of 2 700 tons of aniline (on the optimistic basis of producing at that time an assurned high tonnage of 2 000 tons of cyclohexylamine, and justifying such a low size of production for aniline).

Table 4

POTENTIAL CONSUMPTIONS OF INTERMEDIATE AND BASIC PRODUCTS AND NITRIC ACID (in tons)

	Near Future (around 1988)	1993	1998
Ammonium nitrate(1)	10,000	16-18,000	21-25,000
Calcium nitrate	8-9,000	12,000	15,000
Nitrocellulose (100% basis) (2)	1,500	2,000	2,500
TDI	5,500	8,000	9,500
Ortho-nitrochlorobenzene	1,500	2,000	2,700
Para-nitrochlorobenzene	1,600	2,250	3,000
Nitrochlorobenzenes (3)	4,000	5-6,000	7-8,000
Cyclohexylamine (4)	1,000-1,500	500 (or more?)	500 (or more?)
Aniline (5)	-	2,700	3,900
Nitric acid (6)	20,300	30,600-40,100	40,200-52,000

(1) Explosive grade. Exports limited to neighbouring countries, without taking into account specific deals with other countries

(2) Nitrocellulose for surface coatings only

(3) Size guided by the production of o-nitrochlorobenzene (35% of total mixture of p- and o-nitrochlorobenzene) ; this leaving an excess of p-nitrochlorobenzene for further exports

(4) Potential consumption of 2,500 tons per year in 1985-86; high range assumptions of 2,000 t/yr in 1993 and 1998

(5) Includes 2,000 t/yr for the production of 2,000 t/y of cyclohexylamine (high range assumptions)

(6) Includes the consumption of nitric acid as such; no production of TDI and aniline in the near future; range in 1993 and 1998 due to the production or not of TDI and aniline, this latter based on high range consumptions of cyclohexylamine.

5. PRESCREENING OF PROJECTS

5.1. General

Prescreening of projects to be investigated in view of further steps of the study and a preliminary but clear approach to decisions and to Master Plan implementation, was conducted.

A presentation and analysis of most critical factors or obtacles as well as a restriction of the number of projects were presented in the "Prescreening of Projects" volume of the Interim Report.

The main critical factors to be taken into account are :

. Market size (domestic demand for all products considered, complemented with export opportunities for some of them)

. Raw materials availability

. Competition with World and / or East Asia in the case of productions achieved by very few producers worldwide

. Obstacles for technology acquisition

. Financing and investment opportunities

Findings and conclusions of this screening step form the basis of the next step of the study, the prefeasibility evaluation of projects.

5.2. Market Size

By obviously reasons of unsufficient sizes of market, some productions are discarded as regards their implementation in the short and the medium-term, i.e. for meeting market requirements within 8-10 years from now :

- ammonium nitrate as fertilizer
- potassium nitrate
- MDI as isocyanate raw material for rigid polyurethane foams
- pyrazolone antipyretics
- fenitrothion, for obvious reasons of official decisions already taken

Same elimination applies due to the very low volume involved, for each intermediate, e.g. each aromatic amine, required in the production of dyestuffs.

5.3. Other Major Critical Factors

Possible constraints or decisive advantages were identified at the level of **raw material availability.**

Direct availability of ammonia at low cost, due to its production as an excess from existing feedstocks, definitely gives a significant advantage in the economics of nitric acid and ammonium nitrate productions.

Obstacles or constraints apply to some other types of production, which need to be carefully weighed at the stage of prefeasibility evaluation :

- large number of critical raw materials required in TDI production (chlorine and carbon monoxide for the production of phosgene as basic material, hydrogen in significant quantities)
- specific quality for limestone (low content in chlorides) utilized as feedstock for the calcium nitrate production
- quality of linkers to be used in nitrocellulose manufacturing

- ready availability of some raw materials which, even found in tradeable quantities on the world scene, are in the hands of very few producers (para-nitrochlorobenzene for para-aminophenol, pyrocatechol for carbofuranol,...)

Access to technology and world competition, translated into the policy of few producing and licensing firms, will present other obstacles in the production of fine chemicals, i.e. rubber chemicals (quasi-monopol from Bayer and Monsanto), pesticides (Bayer, Sumitomo, FMC, Rhone-Poulenc,...) or pharmaceuticals (very few producers in the sulphamide chain and even less in the declining market of pyrazolone antipyretics).

Another important constraint concerns the **high level of investment** and financing requirements which may be needed in some productions.

This is particularly illustrative when a complete chain of production, from nitric acid up to final tradeable products, is envisaged, such as :

. chlorobenzene - o.nitrochlorobenzene - aminophenol - pyrocatechol - carbofuranol - carbofuran

. chlorobenzene - p.nitrochlorobenzene - p. aminophenol - paracetamol

. aniline - MBT - rubber chemicals

These obstacles may be overpassed through a logical schedule (or master plan) of implementation which, along time, plans several steps of production.

It also applies to the TDI unit which, by itself and for the production of its raw materials, requires a high investment in the order of about 50 MM US$, even for a size limited to 10 000 tons/year.

PROJECT PREFEASIBILITY

1. CHARACTERISTICS OF PROJECTS

1.1. Introduction

As a conclusion of the first steps of the study - market evaluation and prescreening of projects - the list of productions to be investigated and evaluated in the project prefeasibility has been proposed, presented and agreed upon at the meeting held in Jakarta after submission of the Interim Report.

This list of prescreened projects includes the following productions :

- Nitric acid
- Ammonium nitrate as explosive
- Calcium nitrate
- Nitrocellulose for surface coatings
- Toluene diisocyanate
- Nitrochlorobenzenes
- Cyclohexylamine
- Aniline
- Sulphamides
- Rubber chemicals (or MBT as raw material)

The sulphamide project is not covered in the present evaluation, due to its quite particular industrial environment and to the difficult access to data reliable enough at this stage of evaluation. It appears however feasible facing an already significant domestic demand. Its evaluation requires a specific study which can only be initiated by direct contacts with foreign producing firms.

1.2. Sizes of Production Units for the Purpose of Prefeasibility Evaluation

1.2.1. Nitric Acid

The determination of the size of the nitric acid production unit will depend on various aspects, at first of the total available quantity of ammonia estimated by Pupuk Kujang at about 47 tons per day, secondly of the demand of ammonium nitrate, the production of which requires nitric acid as well as ammonia and finally of the respective demands in nitric acid of other derivatives.

In terms of volume requirements and already established market sizes the main potential users of nitric acid are ammonium nitrate and calcium nitrate and nitric acid as such, total annual quantity being estimated at 27 000 tons (100 % basis) by 1993. To this figure other potential quantities for other derivatives may be added, such as nitric acid for nitrocellulose and for nitrochlorobenzenes estimated at 3 600 tons.

A realistic potential annual consumption in 1993 is estimated at 30 600 tons or 92 tons/day ; this figure could be increased up to about 40 000 tons if a production unit of TDI (later on and moreover unlikely due to various constraints) is set up. In daily capacity, based on 330 days of operation, the size of the unit to meet this market would be comprised between 92 tons and 120 tons. Since the investment has the same order of magnitude in this range of capacity, the selected nominal daily capacity for nitric acid (100 % basis) is the higher figure, i.e. 120 tons per day, this for the purpose of prefeasibility evaluation.

In coherence with a 47 tons/day ammonia availability and a 26,000 t/yr ammonium nitrate plant, the size presently planned by Pupuk Kujang for the nitric acid project is 100 tons/day (or 33 000 t/yr) ; this on conservative bases for yields in nitric acid and ammonium nitrate productions (up to 35 000 t/yr could be envisaged).

For information on the nitric acid unit sizes **on a worldwide basis,** the capacity generally depends on the main applications, and especially if nitric acid is produced in view of either fertilizers or other chemical applications.

Between 1968 and now, the sizes of nitric acid units built in the world, out of the US, can be roughly divided into 4 categories and the respective numbers of units for each category are as follows:

- 15 units with a size lower than 100 tons/day
- 12 units with a size range comprised between 100 and 200 tons/day
- 40 units with a size range comprised between 200 and 500 tons/day
- 100 units with a size higher than 500 tons/day

In 1985, in the US, the operating nitric acid units with the same categories were the following:

- 30 units with a size lower than 100 tons/day
- 25 units with a size range comprised between 100 and 200 tons/day
- 10 units with a size range comprised between 200 and 500 tons/day

For the planned projects the present trend in the world is rather towards units with a size higher than 500 tons/day. However there are three small projects in Egypt, Sweden and Australia.

1.2.2. Ammonium nitrate (explosive grade)

As indicated in the market survey, the production of ammonium nitrate as fertilizer is discarded for obvious reasons of unsufficient sizes of market. The only ammonium nitrate production considered is the explosive grade, i.e. the low density or porous grade. The production of both grades in the same unit is not usual and not very advisable even if the first part of the production unit up to the prilling is the same. Some plants produce both grades but with a lot of difficulties. The reasons are numerous but mainly the production of low density or porous grade for explosive is more difficult to carry out because the product requires a better purity for preventing any explosion risk ; consequently it is necessary to operate by campaign and to clean the unit before the production of porous grade. Moreover the current sizes for units are very different, 100 tons per day for the explosive grade, 600-1000 tons per day for the fertilizer grade.

The potential annual domestic market in 1993 is estimated between 13-15 000 tons and the export possibilities estimated at 3 000 tons, without taking into account specific country to country agreements or possible exchange deals.

The sizes will be comprised between 20 000 tons (1993 figures) and 26 000 tons (1998 figures). The investment for these two sizes is about the same. It is proposed to take 80 tons per day as nominal capacity (about 26 000 tpa), this for the purpose of prefeasibility evaluation.

For information on the ammonium nitrate unit sizes **on a worldwide basis** the capacities for fertilizer production, out of the US, are generally higher than 500 tons per day.

Still on a worldwide basis the standard size for fertilizers is obviously much higher than the one for explosives.

In the US in 1985 for both applications, the respective numbers for different ranges of sizes were as follows:

- 20 units with a size lower than 100 tons/day
- 20 units with a size range comprised between 100 and 200 tons/day
- 10 units with a size range comprised between 200 and 500 tons/day
- 5 units with a size range higher than 500 tons/day

For porous ammonium nitrate intended to ANFO explosives, the usual sizes are generally lower: the largest ones are higher than 500 tons per day, the lowest ones amount to 50 tons per day, for instance 50 tons per day in Tunisia, 60 tons per day in Jordan. It has to be noted that information on existing units for this product are often considered as confidential by producers and consequently by licensors.

1.2.3. Sizes of Other Units

The sizes of other units considered for the purpose of project prefeasibility study are the following :

Calcium nitrate	12 000 tons/year
Nitrocellulose	2 000 tons/year
Toluene diisocyanate	10 000 tons/year
Nitrochlorobenzenes	5 000 tons/year
Cyclohexylamine	2 000 tons/year
Aniline	5 000 tons/year
Rubber chemicals	1 000 tons/year for the MBT plant

Justifications for these choices at this stage of the study are given hereafter in the chapters dealing with the evaluation of each individual project. For certain units, sizes indicated above do not correspond to the potential markets identified in the market study and are rather higher than these market figures, in order to reach standard levels of either economic sizes or the lowest sizes of existing and planned units in the world.

In the particular case of **calcium nitrate** and for information on the unit sizes **on a worldwide basis** it should be noted that calcium nitrate, as such, is less used than before; being replaced more and more by calcium ammonium nitrate, as by-product in nitrophosphate production. The sizes of existing plants vary between 15,000 and 200,000 tons/year.

New projects are thus very seldom although some units have been closed down in the last five years. Two projects are planned in Europe, in Norway with a 100,000 t/year capacity and in Yugoslavia with a presumed 29,300 t/year capacity.

1.3. Scheme of Implementation of Projects

The projects identified as potentially feasible in the prescreening may be implemented according to two different schemes

either on the same location as the nitric acid plant and according to an integrated scheme based on Pupuk Kujang with the possibility of sharing land, utilities supply and general facilities

or according to an isolated scheme independent of Pupuk Kujang, on the same location or different locations, which involves for the plant its own utilities supply and its own general facilities.

The projects which belong to the first integrated scheme are :
- nitric acid production
- ammonium nitrate production
- calcium nitrate production

Nitrocellulose production project can be implemented either according to an integrated scheme or an isolated scheme. However, it is likely that, if only coatings grades are produced, the production unit will be more probably set up according to an isolated scheme.

The other projects will probably be promoted and set up by private companies and can be built on other locations, since the proximity of nitric acid supply does not seem an essential advantage.

These projects are :

- TDI
- Nitrochlorobenzenes
- Cyclohexylamine
- Aniline
- Sulphamides
- Rubber chemicals (MBT as raw material)

However, it should be noted that due to requirements of other raw materials not easily handled or transported (hydrogen, chlorine) some of these projects will likely be integrated in other industrial platforms where these raw materials are available. It concerns the aniline and cyclohexylamine projects for hydrogen requirements as well as the TDI project (chlorine requirement or hydrogen and carbon monoxide needs).

2. AVAILABLE TECHNOLOGIES

2.1. Introduction

The availability of technologies will vary according to the product.

For relatively large tonnage petrochemical products like nitric acid and ammonium nitrate the situation is relatively easy since there are numerous licensors which compete extensively and are not always producers, hence not constrained to protect their market.

For fine chemicals like pesticides, rubber chemicals, dyestuffs, pharmaceuticals, cyclamates, even nitrocellulose, the number of producing / licensing companies is relatively small. They are generally multinational companies which develop their markets all over the world. They license their processes directly or through engineering companies after their agreement.

For the major part of products considered there is presently an overcapacity in the world and the present trend from these companies is to be more careful in the sale or dispersion of their technology and to reduce the number of new projects. Each request is a specific case which is carefully studied by the potential supplier of technology with respect to its own policy of licensing, of marketing and of keeping the leading positions in the region.

In the following paragraphs the lists of existing technologies are given for each product. For certain products, the number of licensors is very important and these lists will not include all the licensors but they will focus on the most important ones. Concerning the availability of these technologies for certain fine chemicals, the only procedure is to contact directly the companies in order to know if they are desirous to sale their technology.

2.2. Nitric Acid

a) The main processes commercially available for weak acid are :
Agrichem - Laroche (USA)
Espindesa (Spain)
Grande Paroisse (France)
Montedison (Italy)
Rhone Poulenc (France)
Stamicarbon (Netherlands)
Uhde (West Germany)

b) Techniques for producing concentrated nitric acid have been developed by several companies ;

- Technique by sulphuric acid addition :
  Chemetics International Limited
  Jenaer Glaswerk Schott of West Germany
  Rhone Poulenc

- Technique by magnesium nitrate addition
  Hercules Incorporated (Maggie process)

- Technique by direct synthesis
  Bamag (West Germany)
  Davy Mac Kee
  Humphrey and Glasgow (United Kingdom)
  Sumitomo Chemical (Japan)
  Uhde (West Germany)

2.3. Ammonium Nitrate (explosive grade)

Generally licensors propose the technology for both ammonium nitrate grades, low density and high density. The main process licensors existing in the world are :

DSM / Stamicarbon (Netherlands)
Dupont (USA)

ICI (United Kingdom)
Kaltenbach - Thuring (France)
Kema - Nord
Rhone Poulenc (France)
Sumitomo (Japan)
Uhde (West Germany)

However some licensors have more developed, during the last ten years, their process for low density grade (explosive) :
Kaltenbach-Thuring
Kema Nord
Uhde

2.4. Calcium Nitrate

Calcium nitrate is produced by two principal routes. In one route, calcium nitrate is produced by direct reaction between calcium carbonate and nitric acid ; in the other route the calcium nitrate is formed as a co-product in nitrophosphate processes.

The selected route for Indonesia is the direct reaction. Presently very few companies propose this technology.

In Western Europe, Quimigal from Portugal and Uhde from West Germany would be ready to propose their technology.

2.5. Nitrocellulose

The main processes existing in the world are :
Daicel Chemical Industries (Japan)
Hercules (USA)
ICI (United Kingdom)
Société Nationales des Poudres et Explosifs (SNPE - France)

2.6. Toluene diisocyanate (TDI)

The main processes existing in the world are :

Allied Chemical (USA)
BASF (West Germany)
Bayer (West Germany)
E.I. Dupont de Nemours (USA)
ICI (U.K.)
Mitsubishi Chemical Industries (Japan)
Mitsui Toatsu Chemicals (Japan)
Rhone Poulenc (France)
Sumitomo Chemical (Japan)

2.7. Nitrochlorobenzenes

As indicated in the market survey, o-nitrochlorobenzene is an intermediate product in carbofuran production and p-nitrochlorobenzene an intermediate product in paracetamol production, via p-nitrophenol and p-amino phenol. Both nitrochlorobenzenes derive from the nitration of monochlorobenzene.

The main process licensors for monochlorobenzene are :
Bayer (West Germany)
Hoechst (West Germany)
Monsanto (USA)
PPG industries (USA)
Rhone Poulenc (France)

The main process licensors for o- and p-nitrochlorobenzene are :
Bayer (West Germany)
Dupont (USA)
Hoechst (West Germany)
Monsanto (USA)

2.8. Cyclohexylamine

Cyclohexylamine can be obtained either by the hydrogenation of aniline or by the ammoniation of cyclohexanol, cyclohexanone or a mixture of the two.

The cyclohexanol route also yields dicyclohexylamine which may acccunt for over 20 % of the product mix.

The aniline route is the most widely used. The main process licensors existing in the world are :

BASF (West Germany)
Bayer (West Germany)
ICI (U.K.)

2.9. Aniline

Aniline can be obtained either by reduction of mononitrobenzene or by ammonolysis of phenol.

Nitrobenzene reduction can be carried out either by means of hydrogen or using the iron/hydrogen process (Bechamp process).

The main process licensors for mononitrobenzene are :
Biazzi process (Switzerland)
Meissner process (West Germany)
Canadian Industries (Canada)
Sumitomo Chemical (Japan)

The main process licensors for aniline are :

Ex Mononitrobenzene :

Allied Chemical (USA)
American Cyanamid (USA)
Meissner (West Germany)
Lonza (Switzerland)
Mitsui Toatsu (Japan)
Rhone Poulenc (France)
Sumitomo Chemical (Japan)

Ex Phenol :

Halcon International / Scientific Design (USA)

2.10. Sulphamides

Sulphamides are produced by reacting acetyl sulphanil chloride with compound containing an amine function followed by deacetylation of the acetamide group. Acetyl sulphanilyl chloride is obtained by reacting acetanilide with chlorosulphonic acid. Acetanilide is obtained by reacting aniline with acetic acid. In the case of Indonesia, it is likely that only the last step will be envisaged, i.e. the reaction of acetyl sulphanilyl chloride with a compound containing an amine function.

The main process licensors for this production are :

American Cyanamid (USA)
Grindsted (Denmark)
Rhone Poulenc (France)

2.11. Rubber Chemicals

As indicated in the market survey, aniline-based rubber chemicals cover almost the whole range of chemicals that are added to natural and synthetic rubber during their processing into the finished goods.

One possible project is the production of rubber accelerators derivated from 2-Mercaptobenzothiazole (MBT) or the production of MBT itself.

The main process licensors for MBT and thiazole type rubber accelerators are :
Bayer (West Germany)
Monsanto (USA)
Pennwalt (USA)

2.12. General Comments

For certain fine chemicals, two or even more chemical routes for the production exist, consequently a selection is possible but generally the only criterium of choice is the agreement of one licensor company to sale its licence.

This may be the case for the carbofuran production and in fact for the production of its intermediate pyrocatechol which can come from three routes of production :

- hydroxylation of phenol
- nitration of phenol to o-nitrophenol and conversion to pyrocatechol
- nitration of chlorobenzene, hydrolysis to o-nitrophenol and conversion to pyrocatechol

As the first two routes are developed till now by only one producer who is not ready to license its technology, the latter would have to be used. It has moreover the advantage of starting from o-nitrochlorobenzene which may be a by-product of a future p-nitrochlorobenzene production in the paraaminophenol/paracetamol chain of production.

3. BASIC DATA - METHODOLOGY FOR ECONOMIC STUDY

3.1. Introduction

As indicated, projects to be studied are divided in two groups according to the concept scheme for their implementation.

1. Integrated scheme for nitric acid, ammonium nitrate, calcium nitrate plants
2. Isolated scheme for the other projects or individual productions

Each group will be characterized by the following aspects :

In the integrated scheme, utilities will be supplied by a central unit and a part of general facilities will be common ; that will lead to lower costs for utilities.

In the isolated scheme, at the difference of integrated scheme, production plants will have to buy from outside a part of their required utilities or to produce their own utilities, that will lead to a higher cost for utilities and total investment.

A final case of evaluation is constituted by the entire integrated complex - nitric acid, ammonium nitrate, calcium nitrate - for which the methodology, bases and results are developed in a separate part at the end of following chapter (see chapter 4.11)

3.2. Methodology for Economic-Financial Evaluation of Individual Productions

3.2.1. Investment Costs

All investment costs are estimated under 1987 conditions and expressed in US$.

They are obtained as follows :

- fixed investment costs include erected costs plus licence and pre-operating expenses
- some expenses are excluded, such as taxes and custom duties
- interests during the construction are estimated on the basis of a capital breakdown of 30 % equity / 70 % loans
- total investment costs include working capital

- **Erected cost in Indonesia**

The budget for erected cost in Indonesia deals with erected costs of process units, utilities production units and general facilities plus licence fees. Estimates are carried out on an European basis, then adjusted to Indonesian conditions.

According to BEICIP/CIPROCON experience in the evaluation and cost follow-up of similar projects in Indonesia, the erected cost in Indonesia is about at the same level as the erected cost in Europe, all taken into account (cost of local and imported equipments, civil engineering and erection costs).

- **Pre-operating expenses**

Pre-operating expenses are estimated in relation or as a ratio of erected cost. These expenses include contractor's activities, pre-contract expenses, suppliers' assistance during erection, follow-up of the project, hiring and training of manpower, start-up expenses.

Altogether pre-operating expenses are estimated to represent around 15 % of the erected cost.

- **Interests during the construction**

Interests during the construction are directly estimated in the economic evaluation ; they apply on the part being financed with a fixed yearly rate.

The bases taken are : 12 % as average yearly rate of interest and 70 % of the overall investment being borrowed, i.e. an equity / debt ratio of 30/70.

These rates of interest on loans apply only on a very minor part of total investment (interests during construction). In the final evaluation of the integrated complex - nitric acid, ammonium nitrate, calcium nitrate - higher interest rates are considered, at 18%, at the request of Indonesian counterparts.

- **Working capital**

The working capital includes the necessary inventories in spare parts, initial charges of catalysts and chemicals, imported raw and secondary materials.

For the purpose of the study, working capital is estimated to represent 2 months of product sales.

3.2.2. Other Economic Requirements and Bases for Economic Evaluation

It concerns the evaluation of all costs entering in the variable charges, the fixed charges and all economic and financial bases needed in.

a) Costs for variable charges

These costs will be essentially utility costs. These costs will vary according to the scheme, either integrated or isolated, as follows :

Utilities in US$/unit

	Chemical complex including nitric acid ammonium nitrate calcium nitrate	Isolated plants
Raw water (m3)	0.03	0.03
Electricity (1) (kWh)	0.04	0.065
Steam (ton)	7.00	10.50

(1) Marginal cost in the complex, on the basis of fuel at US$ 3.00 per MMBTU.

b) Costs for Fixed Charges

Labour costs

The number of personnel indicated concerns only production people and excludes :

. maintenance personnel for which the annual costs are taken into account in overall maintenance costs

. all administrative, commercial, head office costs and personnel not directly assigned to the production for which the annual costs are taken into account in overhead expenses

The annual average total cost per worker (from manager up to unskilled worker) is estimated at US$ 2,500.

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Maintenance costs

Maintenance costs cover the following items :

- depreciation and return on all equipment investment for maintenance
- manpower personnel
- running spare parts consumed every year
- lubricating oils, greases and other consumables

The order of magnitude of maintenance costs is taken at 3 % of total fixed investment cost.

Overhead expenses

Overhead expenses which cover overhead expenses in the producing unit as well as those outside the units are estimated at 1.5 % of total fixed investment cost + 100 % of operating labour cost.

Insurance costs are estimated at 0.375 % of total fixed investment cost.

c) Other Economic and Financial Bases

For the purpose of the evaluation of production costs, depreciation is taken on a 10 year basis or 10 % per year on a straight line method.

For the purpose of prefeasibility evaluation no taxes on profit or others are considered in the study.

3.3. Methodology for the Evaluation of Individual Projects by Calculation of Production Costs and Product Values

This economic evaluation is performed through the analysis of costs of production and product values in each production unit.

The production costs and product values are estimated at full rate of production.

The production cost in each unit and resulting product values are evaluated according to a methodology which refers to yearly costs.

At full production, the total **production cost** is the sum of :

- Cost of raw materials
- Variable charges
- Fixed charges including labour, maintenance, overhead expenses, insurance and interests on working capital
- Depreciation (at 10 % of fixed investment)

The **product value** is then obtained by adding a profit expressed in terms of return on total investment cost of the unit (ROI).

For ensuring reasonable returns both on the investment and on the equity a figure of 10 % of total investment is taken for ROI in our basic evaluations.

3.4. Final Economic Evaluation of Individual Projects

Final economic evaluation is performed by comparison between product values or ex-factory prices with international standard prices of the product available under similar conditions in Indonesia in the medium term.

International prices are considered on a general coherent trend of prices (refer to interrelated scale of prices between aromatics like benzene and derivates like chlorobenzene or nitrochlorobenzenes, aniline and derivates like cyclohexylamine and MBT).

The comparisons bear on :

- the **differential** between the **calculated product value** and the **international competitive price**

- the **internal rate of return (IRR) on investment,** by taking a product price equal to the international competitive price

IRR is calculated at the level of discounted gross cash flow, i.e. before tax and financial charges, where yearly gross cash flows are the result of yearly sales revenues from which are deducted all yearly production costs (raw materials, variable and fixed charges).

For its evaluation, the investment of each project is expected to be disbursed in two years (50 % the 1st year, 50 % the 2nd year). Production lifetime for the evaluation is taken at 15 years.

Operating rates are assumed to level at :

- 80 % of nominal capacity, the 1st year of production
- 90 % of nominal capacity, the 2nd year of production
- 100 % of nominal capacity, from the 3rd year of production

4. DESCRIPTION AND EVALUATION OF PRODUCTION UNITS

4.1. Introduction

This following chapter includes the technical description, the definition of plant facilities and the evaluation of each production unit with the following supporting tables :

- total investment
- technical requirements
- production cost and product value

4.2. Nitric Acid Production

4.2.1. Technical Description and Definition of Plant Facilities

a) Technical Description (see simplified flowsheet - Figure 3 hereafter)

All nitric acid plants are now based on the gas-phase oxidation of ammonia in air over a heterogeneous catalyst (usually a platinum alloy) for forming nitric oxide (NO), further oxidation to nitrogen dioxide and then absorption of the dioxide in water to give nitric acid.

The initial reaction, oxidation of ammonia :

$$4NH_3 + 5O_2 \rightleftarrows 4NO + 6H_2O$$

proceeds rapidly under a wide range of operating conditions with the conversion efficiency primarily influenced by the temperature of the catalyst gauze.

In the presence of further oxygen nitric oxide is converted to nitrogen dioxide (NO2) :

$$2NO + O_2 \rightleftarrows 2NO_2$$

Part of the nitrogen dioxide formed rapidly dimerizes to nitrogen tetroxide (N_2O_4)

$$2NO_2 \rightleftarrows N_2O_4$$

Nitric acid (HNO_3) is formed by absorption of nitrogen dioxide and nitrogen tetroxide in water.

$$3NO_2 + H_2O \rightleftarrows 2HNO_3 + NO$$
$$3N_2O_4 + 2H_2O \rightleftarrows 4HNO_3 + 2NO$$

The nitric oxide gas, coproduced with nitric acid, is re-oxidized by the remaining oxygen and the acid forming sequence is repeated.

The nitric acid process is thus a question of balancing two separate operations - formation of nitrogen oxides, for which lower pressures are more favourable, and absorption of nitrogen oxides, which is favoured by higher pressures. Although several combinations of operating pressures are possible, in recent years three process schemes have dominated new orders for nitric acid plants. These are the medium-medium single-pressure, medium high dual pressure, and the high-high single pressure processes.

As an example, the process description of a single-pressure weak nitric acid unit with a capacity of 100 t/day HNO_3 (100%) is presented hereafter.

The main features of the process are :

. Same pressure for ammonia oxidation and nitrogen gas absorption

. This pressure is relatively high ; that leads to a smaller size for equipment and a lower investment cost

. Use of a high efficiency absorption system, which, in combination with high pressure, allows to obtain a very low NO_x content in tail gases, in accordance with the strictest pollution regulations

. Air and gas compression

The compressor set consists of one air compressor, one tail gas expander and one electric motor

. Preparation of air ammonia mixture

Liquid ammonia is received at battery limits and passes then to the ammonia evaporator. Ammonia is evaporated against cooling water. Oil and water present in the ammonia feed are separated out in the ammonia auxiliary evaporator. The gaseous ammonia passes through a filter after it has been superheated in an exchanger. From the filter ammonia passes to a mixer where it is mixed with air. Process air passes through a two stage filter, is compressed to 9.0 bar abs. and split into primary and secondary streams. The secondary air is used in the denitration or bleaching of the product acid. The primary air passes to the ammonia air-mixer.

. Ammonia combustion and heat recovery

The air ammonia mixture flows downward in a converter where a special distribution system allows a good repartition of the flow all over the surface of the platinum-rhodium gauzes. The mixture of nitrous gases, nitrogen and oxygen resulting from ammonia combustion with a resultant temperature of about 910°C passes through several exchangers, boiler-heat exchanger-economizer, where they are cooled and heat is recovered.

. Absorption and bleaching of acid

The gas stream is cooled down by cooling water in a water condenser where nitric acid is condensed and fed into a absorber ; it passes then through a separator and is sent to absorbers.

The acid at design concentration at the first tray of absorber passes through the bleacher, equipped with trays and located inside the lower part of the absorber. Bleaching is accomplished by contacting the acid with the secondary air to strip out the dissolved gas. The air from the bleacher, containing nitrous gases, is mixed with the main stream at inlet of the absorber. The product acid is withdrawn under level control and discharged to storage tanks.

. Tail gases

Tail gas from the absorber contains less than 200 ppm of NO_x. The gas passes through an external separator and is heated in some heat exchangers.
The hot gas passes then through the tail gas expander. The tail gas is discharged to the plant stack.

. Steam system

Steam is produced in a boiler at 16 bar abs. A part of the saturated steam is used in auxiliary ammonia evaporator, ammonia superheater and deaerator. Excess saturated steam is discharged to battery limits.

b) Definition of plant facilities

The plant facilities include all the equipment required by the process described above plus the electricity production and distribution system, the steam system, the cooling water system and all the general services and buildings.

The storage facilities include storages for two weeks of production.

4.2.2. Total Investment

The nominal capacity of the production unit is 120 tons/day or about 40 000 tons per year.

The battery limits investment in Europe is estimated at US$ 7 000 000, investment figure based on the process presented previously. This investment figure is based on a process scheme with a maximum steam export and a minimum electricity production.

The erected cost in Indonesia is estimated at US$ 9 450 000 and the total fixed investment cost including pre-operating costs and interests during the construction amounts to US$ 11 880 000.

Such investment figures vary within a narrow range for size capacities between 90 and 120 tons/day (30 000 to 40 000 tons/year).

The detailed investment cost is presented in table 5.

4.2.3. Technical Requirements

The technical requirements include the consumptions of raw materials and utilities, the costs of catalysts and chemicals and the costs of operating manpower.

In the utility costs the cooling water costs are derived from equivalent electricity and raw water expenses.
Technical requirements are presented in table 6.

4.2.4. Production Cost and Product Value

The production cost and product value are calculated according to the basis presented in the methodology related to the calculation of variable charges, fixed charges and depreciation.

The results are presented in table 7

This table lets appear the most important part taken by the **investment-related charges or return** (fixed charges, depreciation, ROI) and the significant effect of **ammonia cost** (nearly 30 % of the total product value). Utility costs are very low, due to the assumption of a good valorization for steam credit.

4.2.5. Economic Results. Comparison with International Prices

International prices for nitric acid (weak acid), in accordance with medium-term international prices at around 180-200 $/ton for ammonia, will lie within a 140-160 $/ton range. A 170 $/ton price is taken for the product rendered in Indonesia.

Due to the low starting cost of ammonia and to the advantages obtained through integration in an industrial complex, the product value of 114 $/ton is quite attractive as compared with the international price.

Similarwise the internal rate of return of the project, on the basis of a 170 $/ton sales price for nitric acid, is quite attractive : 28.4 % in the base case.

4.2.6. Sensitivity Analysis. Conclusions

Main influing factors are possible variations in **ammonia costing or investment evaluation :**

- an ammonia price of 170 $/ton (corresponding to FOB prices for reaching international markets) would decrease the IRR only to 24.3 % and increase the product value up to 131 $/ton, which are still attractive figures

- a 20 % increase on the investment would decrease the IRR to 23.5 %, still a quite attractive figure

In the light of economic results, this project of nitric acid appears quite justified.

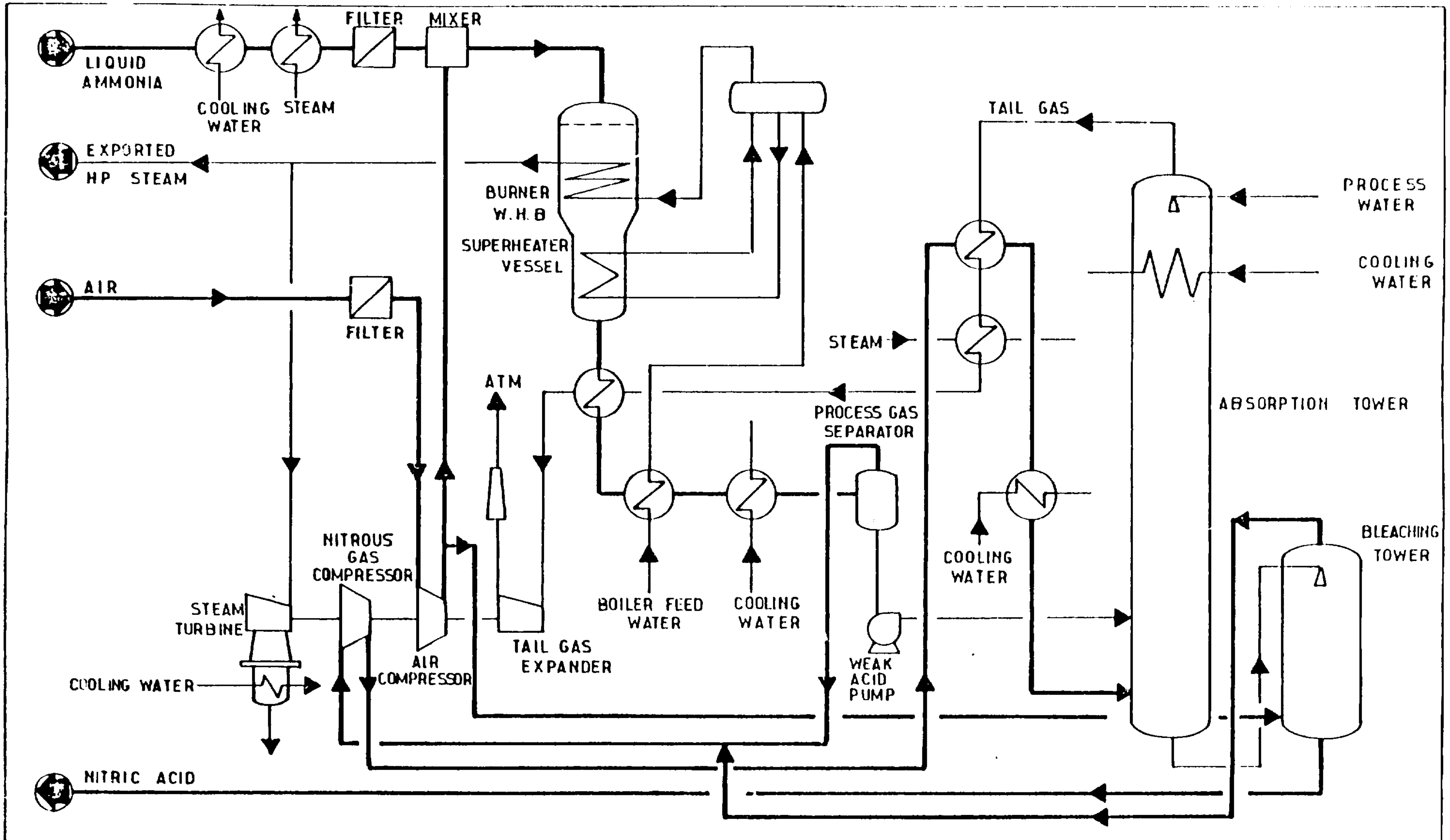

FIGURE 3

MANUFACTURE OF NITRIC ACID
SCHEMATIC FLOW DIAGRAM

Table 5

NITRIC ACID (Weak Acid)

120 tons/day (100 % basis)

TOTAL INVESTMENT COST

	In 10^3 US$
Total battery limits	7 000
Off-sites	2 450
Erected cost in Indonesia	**9 450**
Pre-operating expenses	1 400
Fixed investment cost	10 850
Interests during the construction	1 030
Total fixed investment cost	**11 880**
Working capital	800
TOTAL INVESTMENT COST	12 680

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Table 6

NITRIC ACID (Weak Acid)

120 tons/day (100 % basis)

TECHNICAL REQUIREMENTS

Raw Materials and By-Products		Per unit Ton / Ton	Annual (in tons)
Ammonia		0.284	11 360

Utilities consumption		Per ton	Annual
Power	in kWh	270	10 800 000
Cooling water	in m^3	100	4 000 000
Process water	in m^3	0.298	11 920
Steam	in 10^6 Kcal	(0.823)	(32 920)

Catalysts and chemicals	Per ton in US$	Annual in US$
	1.7	68 000

Manpower	Number	Cost per person	Annual cost in US$
	35	2 500	87 500

Table 7

NITRIC ACID (Weak Acid)

40 000 tons/year (100 % basis)

PRODUCTION COST AND PRODUCT VALUE

RAW MATERIALS	
Ammonia (at $/ton 110)	1 249 600
VARIABLE CHARGES	
Utilities	482 000
Catalysts and chemicals	68 000
Steam (credit)	(354 500)
FIXED CHARGES	
Labour	87 500
Maintenance	356 000
Overhead expenses	265 700
Insurance, taxes	45 000
Interests on working capital	80 000
DEPRECIATION	1 085 000
COST OF PRODUCTION (US$)	**3 364 300**
ROI	1 188 000
TOTAL SALES	4 552 300
PRODUCT VALUE (US$/ton)	**114**

4.3. Ammonium Nitrate (porous grade for ANFO) Production

4.3.1. Technical Description and Definition of Plant Facilities

a) Technical Description (see simplified flowsheet - Figure 4 hereafter)

Ammonium nitrate is manufactured by the neutralization of nitric acid with ammonia. The main stages in the manufacture of ammonium nitrate include :

- Ammonia evaporation and air cooling
- Neutralization reaction
- Solution concentration
- Prilling
- Conditioning

As an exemple, the process description of a porous ammonium nitrate production is presented hereafter.

Ammonium nitrate prills to be produced will be used for ammonium nitrate fuel oil mixture (ANFO). The prills should be the best adapted to the final use, especially as regards the granulometry, the density and the porosity.

. Ammonia evaporation and air cooling

Liquid ammonia is partially evaporated in an air cooler depending on the needs of the air cooling system and the rest of it is evaporated in an evaporator supplied with hot water.

. Neutralization reaction

Gaseous ammonia and liquid nitric acid are injected into the bottom part of neutralizer. The reaction is exothermic, automatically recorded and controlled by the injection of process condensates.
The neutralizer receives also a certain amount of sulphuric acid mixed with nitric acid to increase the hardness of the prills.

. Solution concentration

Ammonium nitrate solution is concentrated in a falling film heated evaporator operating under vacuum. The vapours extracted from the evaporator are condensed. The concentrated ammonium nitrate solution is sent to the top of the prilling tower.

. Process steam and condensates systems

Steam recovered from the exothermic neutralization reaction is used essentially for ammonium nitrate solution concentration in the evaporator.
Condensates from the process steam of neutralizer and condensates from the primary evaporator are sent to a barometric tank. When it is necessary, these condensates are scrubbed in treatment columns where nearly all ammonium nitrate is removed and recycled.
Free ammonia in process steam and vapours from the evaporator is neutralized with nitric acid and the resulting ammonium nitrate is recycled.

. Prilling

Solution collected in a tank is sent to calibrated prilling nozzles. Nitrate prills solidify when falling inside the tower and are collected on a conveyor at the bottom of the tower. Air coming from the tower is washed in scrubbers located at the top of the prilling tower and clean air is discharged to the atmosphere.

. Drying and screening

Ammonium nitrate prills are brought by a conveyor to a special dryer drum with two sections allowing a very progressive drying which gives prills of appropriate strength and porosity.
Hot air loaded with dust is sent to cyclones and then to washing tower. When the requested concentration of ammonium nitrate washing solution is reached, the solution is recycled to the ammonium nitrate solution preparation section.
Ammonium nitrate prills are sent to screens, the fines and the oversize prills are recycled.

. Final cooling

Ammonium nitrate is cooled in a fluidized bed cooler. After the cooler, prills are sprayed with a flowing agent when requested.

b) Definition of Plant Facilities

The plant facilities include all the equipment required by the process described above, plus the electricity distribution system, the steam system, the cooling water system and all the general services and buildings.

The storage facilities include storages for 2 months of production and storages for 8 days of consumption of raw materials.

4.3.2. Total Investment

The nominal capacity of the production unit is 80 tons per day or about 26 000 tons per year.

The battery limits investment in Europe is estimated at US$ 4 000 000, investment figure based on the process presented previously, which varies within a narrow range for size capacities between 60 and 80 tons/day.

The erected cost in Indonesia is estimated at US$ 5 400 000 and the total fixed investment cost including pre-operating costs and interests during the construction amounts to US$ 6 790 000.

The detailed investment cost is presented in table 8.

4.3.3. Technical Requirements

The technical requirements include the consumptions of raw materials and utilities, the costs of catalysts and chemicals and the costs of operating manpower.

In the utility costs the cooling water costs are derived from equivalent electricity and raw water expenses.

Technical requirements are presented in table 9.

4.3.4. Production Cost and Product Value

The production cost and product value are calculated according to the basis presented in the methodology related to the calculation of variable charges, fixed charges and depreciation.

The results are presented in table 10.

This table lets appear the most important part taken by the costs of raw materials, ammonia and nitric acid, intervening for over 55 % of the total product value.

Effect of investment is still appreciable but not to a too large extent.

4.3.5. Economic Results. Comparison with International Prices

In accordance with medium-term international prices at around 180-200 $/ton for ammonia and 140-160 $/ton for nitric acid, the international prices for ammonium nitrate (low density grade for explosives) will lie within a 210-240 $/ton range. A 230 $/ton price is taken, as a compromise between the price on the domestic market for the most part of production and the export price for less important quantities.

Despite a **relatively low size of production** the product value of 203 $/ton is attractive as compared with the international price. This is chiefly due to the **low costs of ammonia and nitric acid** as raw materials and, to a lesser extent, to the **integration** in an industrial complex.

Similarwise, the internal rate of return of the project, on the basis of a 230 $/ton sales price for ammonium nitrate, is attractive : 20.8 % in the base case.

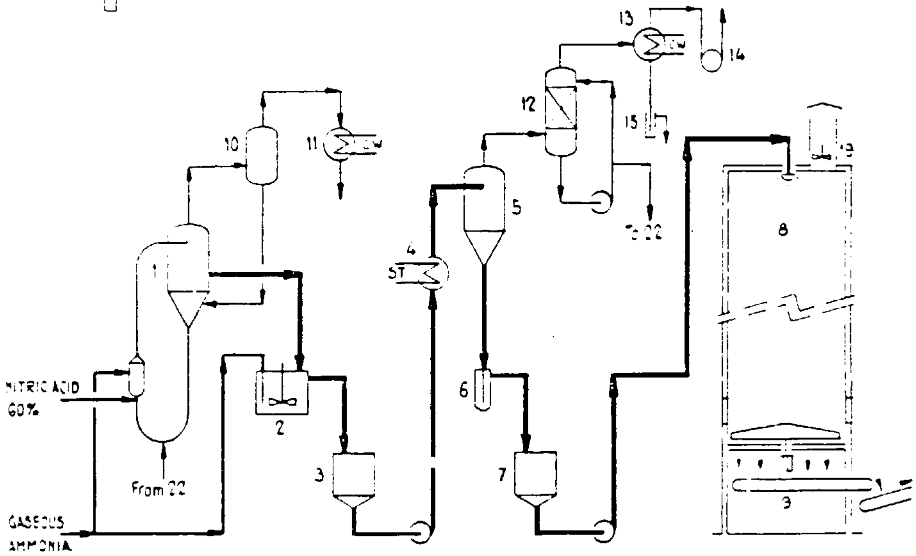
4.3.6. Sensitivity Analysis. Conclusions

The **main influing factor is the variation on ammonia-nitric acid pricing,** since as nitric acid cost of 131 \$/ton associated with an ammonia cost of 170 \$/ton would :

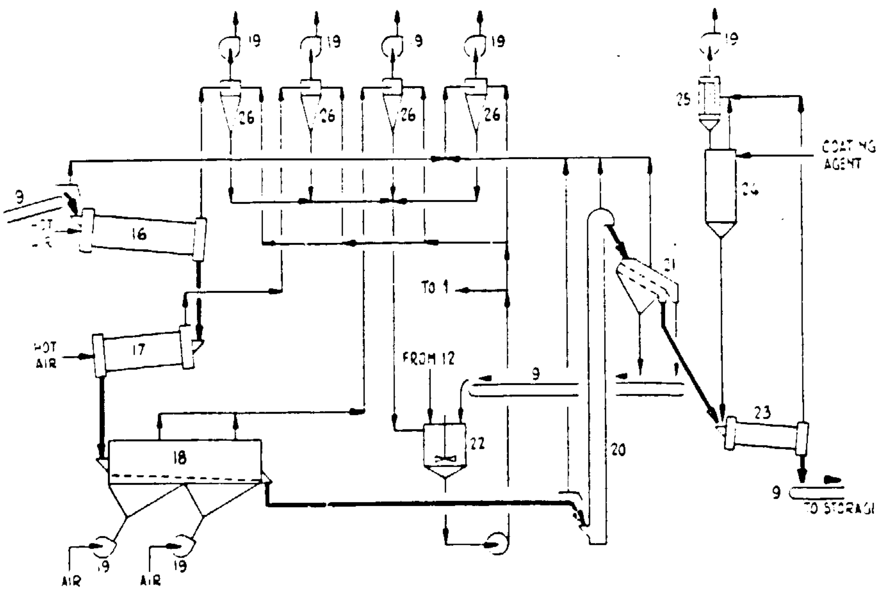
- increase the product value to 230 \$/ton
- decrease the IRR down to 12.6 %, which is still an acceptable value

A 20 % increase on the total investment would only increase the product value up to 216 \$/ton.

In the light of economic results this project of ammonium nitrate appears justified.



1: Neutralizer
2: 2nd neutralizer
3: 85% AN solution inter tank
4: Evaporator
5: Separator
6: Seal pot
7: 96% AN solution storage tank
8: Prilling tower
9: Belt conveyor
10: Demister
11: Neutralizer vapor condenser
12: Off gas scrubber
13: Condenser
14: Vacuum pump
15: Seal pot



16: Predryer
17: Drying drum
18: Fluid bed cooler
19: Fans
20: Bucket elevator
21: Coarse and fine screen
22: Dissolving tank
23: Coating drum
24: Coating agent bin
25: Filter
26: Wetted cyclones

FIGURE 4 : Schematic flow diagram of ammonium nitrate production

Table 8

AMMONIUM NITRATE (Low Density)

80 tons/day

TOTAL INVESTMENT COST

	In 10^3 US$
Total battery limits	4 000
Off-sites	1 400
Erected cost in Indonesia	**5 400**
Pre-operating expenses	800
Fixed investment cost	6 200
Interests during the construction	590
Total fixed investment cost	**6 790**
Working capital	900
TOTAL INVESTMENT COST	7 690

Table 9

AMMONIUM NITRATE (Low Density)

80 tons/day or 26 000 tons/year

TECHNICAL REQUIREMENTS

Raw Materials and By-Products		Per unit Ton / Ton	Annual (in tons)
Ammonia (as 100 %)		0.215	5 590
Nitric Acid (as 100 %)		0.794	20 644
Utilities consumption		Per ton	Annual
Power	in kWh	45	1 170 000
Cooling water	in m^3	25	650 000
Process water	in m^3	0.22	5 720
Steam	in 10^6 Kcal	0.2	5 200
Catalysts and chemicals		Per ton in US$	Annual in US$
		4	104 000

Manpower	Number	Cost per person	Annual cost in US$
	40	2 500	100 000

Table 10

AMMONIUM NITRATE (Low Density)

26 000 tons/year

PRODUCTION COST AND PRODUCT VALUE

RAW MATERIALS	US$
Ammonia	614 900
Nitric acid	2 353 400
VARIABLE CHARGES	
Utilities	112 800
Catalysts and chemicals	104 000
Packaging	182 000
FIXED CHARGES	
Labour	100 000
Maintenance	203 700
Overhead expenses	201 850
Insurance, taxes	25 500
Interests on working capital	90 000
DEPRECIATION	620 000
COST OF PRODUCTION (US$)	**4 608 150**
ROI	679 000
TOTAL SALES	5 287 150
PRODUCT VALUE (US$/ton)	**203**

4.4. Calcium Nitrate Production

4.4.1. Technical Description and Definition of Plant Facilities

a) Technical Description (see simplified flowsheet - Figure 5 hereafter)

As indicated before, calcium nitrate may be produced by the following commercial processes : treatment of limestone with nitric acid or as a by-product in the treatment of phosphate rock with nitric acid for the manufacture of nitrophosphate. The selected process is the treatment of limestone with nitric acid.

The mixture of nitric acid and grounded limestone (at specifications, exempt from or with a very low content of chlorides) is sent to agitated reactors. The calcium nitrate solution is decanted and neutralized with gaseous ammonia. The purposes of these operations carried out in two steps are to extract insoluble residue and to neutralize nitric acid in excess in the solution. The neutralized solution is fed to evaporation section where it is concentrated and then is sent to granulation section after mixing with recycled solids.

Calcium nitrate coming from granulation section is dried up with hot air, sent to a screening section, then cooled down. The product is then coated by anti-caking products and sent to packing and storage sections.

Specifications of limestone for calcium nitrate production

For its fertilizer use, chiefly in tobacco crops, calcium nitrate should be exempt or have a very low content of chlorides; this involves very severe specification on limestone as regards the chloride content.

The best is to utilize limestone already exempt from chlorides at the source, which is the present case of world producers (according to a well known European producer and exporter to Indonesia no calcium nitrate producer in the world carries out an extraction of chlorides from limestone).

Without suitable quality for the raw material the treatment would be to wash with very large quantities of unsalted water. Such process requires a lot of water and would appear more costly than the imports of suitable limestone.

Cost adopted in the study for limestone takes into account the opportunity of utilizing imported limestone for which the price will be mainly constituted of freight costs. A final price of 30 US$/ton is kept for the purpose of evaluation in the base case.

b) Definition of Plant Facilities

The plant facilities include all the equipment required by the process described above, plus the electricity distribution system, the steam system, the cooling water system and all the general services and buildings.

The storage facilities include storages for 2 months of production and storages for 8 days of consumption of nitric acid.

4.4.2. Total Investment

The nominal capacity of the production unit is 12 000 tons/year (in line with a nearer term, 1993-1995 market).

The battery limits investment in Europe is estimated at US$ 4 000 000, investment figure based on the process presented previously.

The erected cost in Indonesia is estimated at US$ 5 400 000 and the total fixed investment cost including pre-operating costs and interests during the construction amounts to US$ 6 800 000.

The detailed investment cost is presented in table 11.

4.4.3. Technical Requirements

The technical requirements include the consumption of raw materials and utilities, the costs of catalysts and chemicals and the costs of operating manpower.

In the utility costs the cooling water costs are derived from equivalent electricity and raw water expenses.

Technical requirements are presented in table 12.

4.4.4. Production Cost and Product Value

The production cost and product value are calculated according to the basis presented in the methodology related to the calculation of variable charges, fixed charges and depreciation.

The results are presented in table 13.

This table lets appear the important parts taken by the investment-related charges or return (depreciation, ROI) and the costs of raw materials (nitric acid, limestone).

4.4.5. Economic Results. Comparison with International Prices

In accordance with medium-term international prices for nitric acid, the international prices for calcium nitrate will lie within a 210-230 \$/ton range. A 240 \$/ton price is taken for the product rendered in Indonesia.

Even higher the product value of 265 \$/ton is not far from being comparable with the international price but the internal rate of return (8.6 % in the base case for the 240 \$/ton international price) is below an acceptable level for an individual project.

Explanations on this unsufficient profitability come from the fact that the high investment cost per ton due to the low capacity installed outweighs the advantage brought by the low nitric acid cost.

The integration of this unit with the upstream nitric acid production and the nearby ammonium nitrate production leads however to an acceptable profitability for such a low sized unit, as illustrated in the evaluation of the nitric acid integrated complex (see chapter 4.11).

4.4.6. Sensitivity Analysis. Conclusions

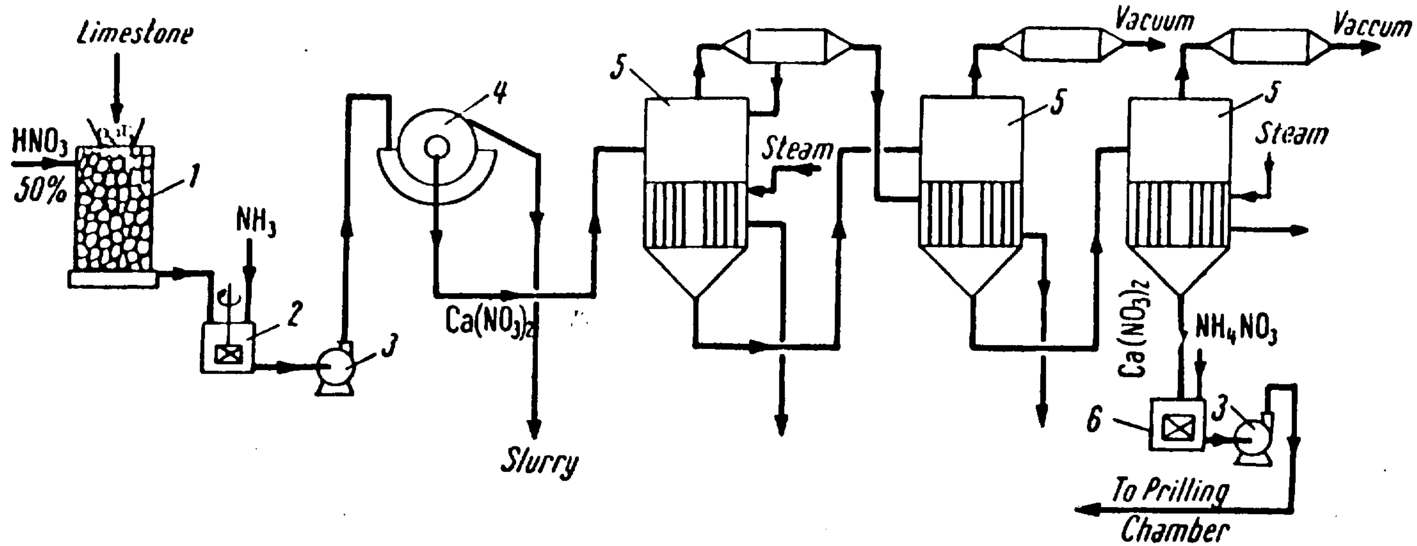
Main influing factors are possible variations in **nitric acid costing or investment evaluation :**

- a nitric acid transfer price of 131 $/ton instead of 114 $/t would lead to unattractive figures by decreasing the IRR to 7.5% and increasing the product value up to 277 $/ton

- a 20 % increase on the investment would lead to even more unattractive figures : 293 $/ton for the product value, 6.1% for the IRR

For ensuring an attractive return, the implementation of the project is thus subject to the confirmation of **low nitric acid transfer prices** from the nitric acid plant, more easily obtained through the integration of these two plants together, and to the ready availability of **limestone at competitive costs.**

FIGURE 5



Flow Diagram of Calcium Nitrate Manufacture:

1 — Dissolution tower; *2* — Final neutralizer; *3* — Centrifugal pumps; *4* — Rotary filter; *5* — Evaporator; *6* — Mixing vessel.

Table 11

CALCIUM NITRATE

12 000 tons/year

TOTAL INVESTMENT COST

	In 10^3 US$
Total battery limits	4 000
Off-sites	1 400
Erected cost in Indonesia	**5 400**
Pre-operating expenses	810
Fixed investment cost	6 210
Interests during the construction	590
Total fixed investment cost	**6 800**
Working capital	530
TOTAL INVESTMENT COST	7 330

Table 12

CALCIUM NITRATE

12 000 tons/year

TECHNICAL REQUIREMENTS

Raw Materials and By-Products		Per unit Ton / Ton	Annual (in tons)
Limestone		0.52	6 240
Nitric acid (as 100 %)		0.66	7 920
Ammonia		0.016	192
Utilities consumption		Per ton	Annual
Power	in kWh	65	780 000
Cooling water	in m^3	34	408 000
Steam	in 10^6 Kcal	0.6	7 200

Catalysts and chemicals	Per ton in US$	Annual in US$
	3	36 000

Manpower	Number	Cost per person	Annual cost in US$
	30	2 500	75 000

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Table 13

CALCIUM NITRATE

12 000 tons/year

PRODUCTION COST AND PRODUCT VALUE

RAW MATERIALS	
Limestone	187 200
Nitric acid	902 900
Ammonia	21 100
VARIABLE CHARGES	
Utilities	113 200
Catalysts and chemicals	36 000
Packaging	84 000
FIXED CHARGES	
Labour	75 000
Maintenance	204 000
Overhead expenses	177 000
Insurance, taxes	25 500
Interests on working capital	53 000
DEPRECIATION	621 000
COST OF PRODUCTION (US$)	**2 499 900**
ROI	680 000
TOTAL SALES	**3 179 900**
PRODUCT VALUE (US$/ton)	**265**

4.5. Nitrocellulose Production

As indicated before, nitrocellulose has various uses in military applications and in civilian applications, such as paints, varnishes, printing inks, celluloid and cellulose films. The selected production unit will deal only with civilian applications ; however it is to be noted that in the same production unit, both products for military and civilian applications could be produced.

4.5.1. Technical Description and Definition of Plant Facilities

a) Technical Description (see simplified flowsheet - Figure 6 hereafter)

As an example, the SNPE process is presented hereafter. Nitrocelluloses are manufactured from cellulose, cotton linters or wood pulp and a nitrosulphuric solution.

The cellulose to be nitrated is first of all subjected to a chemical purification and then to a bleaching. Nitrating acids are a mixture of nitric acid at 98.5 % and oleum at 20 %.

- Nitration

Nitration of nitrocellulose is a balanced esterification of the topochemical type :

$\text{Cell-OH} + 2(\text{HO-NO}_2) \longrightarrow \text{Cell - ONO}_2 + \text{NO}_2\text{-OH, H2O}$

Nitration with nitrosulphuric mixtures yields the best result when high nitrogen content is requested.

Nitration can be carried out in a continuous process or in batches (depending on the plant capacity) and generally at an average temperature of 35°C.

After nitration, the nitrocellulose thus obtained is separated from the nitration bath (waste acids) through centrifugation.

- Stabilizing

Nitrocellulose coming from nitration still contains residual acids which cannot be eliminated by water washing. The chemical instability of the product is due to the presence of such acids.

The stabilizing operation consists of long treatment with boiling water in an autoclave (under pressure or not).
The duration and temperature of this treatment in the autoclave are the two parameters which make possible to test the product stability and to determine its final viscosity.

- Finishing - Packaging

After stabilization, nitrocelluloses in floss for industrial uses are processed for final packaging as specified by user (alcohol wetted or alcohol dehydrated flosses). Collodions, plasticized granules ... can also be produced.

Nitrocelluloses in floss for military uses are subjected to a different processing.

- Materials

Parts of equipment in contact with acid baths are made of stainless steel, as are stabilization autoclaves and cookers. In addition in manufacturing nitrocellulose for industrial uses (paints and varnishes) it is better to use stainless steel for other parts and storage tanks, which does not affect the transparency and colour of nitrocellulose solutions.

- Safety

With an historical background of more than 100 years the production of nitrocellulose benefits from a very long experience on risks involved and related precautions and can be considered as safe as any other chemical production.

Whereas dry nitrocellulose is a dangerous product, all other wet forms do not present particular risks:

- in the industrial unit nitrocellulose after nitration is automatically stabilized in water or an organic liquid
- transportation and handling of wet nitrocellulose are carried out as for a current chemical product, being classified as a flammable solid when wet with water and as flammable liquid when wet with a flammable organic liquid.

The most sensitive operation in the process is the centrifugation separation after the nitration, before stabilizing; but the existing processes have adequately solved the handling of this particular operation in terms of safety.

b) Definition of Plant Facilities

The plant facilities include all the equipment required by the process described above, plus the electricity distribution system, the steam system, the cooling water system and all the general services and buildings.

The storage facilities include storages for 1 month of production and storages for 8 days of consumption of nitric acid.

4.5.2. Possibility of Production of Both Nitrocelluloses, Military and Industrial, in the Same Unit

As regards the possibility of producing both nitrocellulose grades for military applications and industrial applications in the same unit, it can be indicated that a plant designed to produce industrial products can produce military applications but not the reverse. It comes from the fact that the production of industrial application grades requires equipment in stainless steel, for reasons of optical quality, which is not required for military applications.

Besides the process schemes are different after the stabilization.

Nitrocellulose in floss intended for industrial uses are processed for final packaging as specified by the user. Nitrocellulose in floss intended for military uses are subjected to a different processing:

1. Mechanical refining which reduces the fibres in length, as necessary for guncotton to be used for powder manufactures and for the elimination of the last traces of acid occluded in fibres.

2. Alkaline post stabilizing through boiling at atmospheric pressure for removing the last traces of acid released by refining. Thereafter the product goes through a series of washing, rinsing operations (clarifying) for elimination of boiling water and the miscellaneous decay products that may still be present in nitrocellulose.

After completion of clarifying, the product is completely manufactured, the subsequent operations are only intended to improve its final presentation and to ensure its packaging.

4.5.3. Total Investment

The nominal capacity of the production unit (coating grade only) is 2 000 tons per year.

The battery limits investment in Europe is estimated at US$ 8 000 000, investment figure based on the process presented previously, and including the concentration of nitric acid.

The erected cost in Indonesia is estimated at US$ 11 200 000 and the total fixed investment cost including pre-operating costs and interests during the construction amounts to US$ 14 100 000.

The detailed investment cost is presented in table 14.

4.5.4. Technical Requirements

The technical requirements include the consumptions of raw materials and utilities, the costs of catalysts and chemicals and the costs of operating manpower.

In the utility costs the cooling water costs are derived from equivalent electricity and raw water expenses.

Technical requirements are presented in table 15.

4.5.5. Production Cost and Product Value

The production cost and product value are calculated according to the basis presented in the methodology related to the calculation of variable charges, fixed charges and depreciation.

The results are presented in table 16.

This table lets appear the important part taken by the **investment-related charges and return** (depreciation, ROI) which reach around 55 % of the total sales.

4.5.6. Economic Results. Comparison with International Prices

In accordance with medium-term international prices at around 170 US$/ton for weak nitric acid and 1 100 US$/ton for cotton linters, the international price for nitrocellulose (100 %) will be 3 300 US$/ton.

The product value of 3 360 US$/ton is close to international price. At the difference with previous products such as ammonium nitrate and calcium nitrate, the low cost of nitric acid is a relatively low advantage for this production.

The international rate of return of the project, on the basis of 3 300 US$/ton sales price for nitrocellulose, is 12.6 % in the base case, which is acceptable.

4.5.7. Sensitivity Analysis. Conclusions

The main influing factor is the **variation of the investment.** A 15 % decrease on the total investment would decrease the product value down to 3 090 US$/ton.

Another influing factor is the **price of cotton linters.** Recently on the international market the prices fluctuated seriously. An increase of the linters price up to 1 500 US$/ton would increase the product value up to 3 640 US$/ton.

With a further evaluation of the risks, particularly for the availability and cost of cotton linters, this project appears justified.

FIGURE 6

MANUFACTURING DIAGRAM

NITROCELLULOSE PRODUCTION

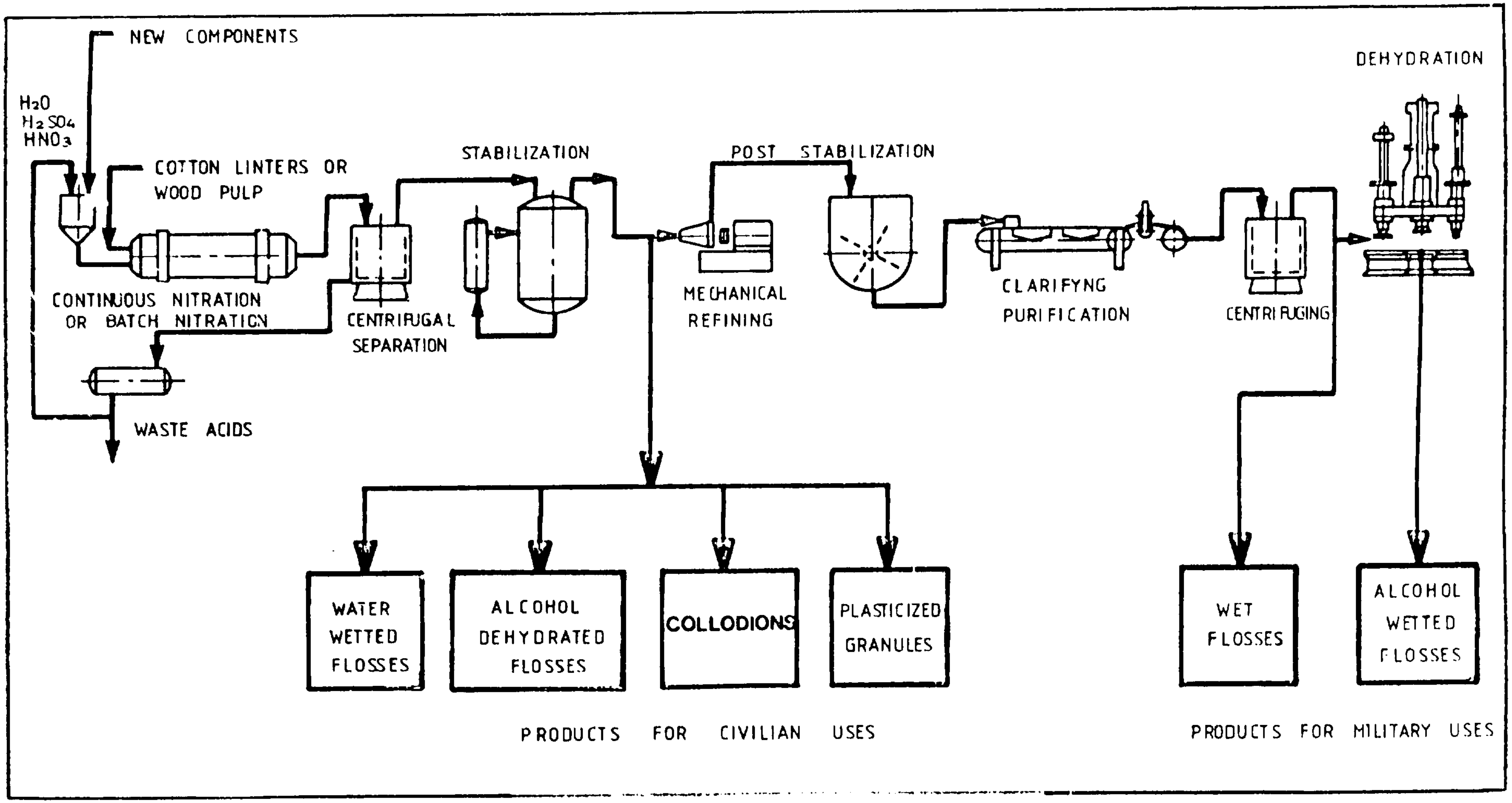

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Table 14

NITROCELLULOSE

2000 tons/year (100 % basis)

TOTAL INVESTMENT COST

	In 10^3 US$
Total battery limits	8 000
Off-sites	3 200
Erected cost in Indonesia	**11 200**
Pre-operating expenses	1 700
Fixed investment cost	12 900
Interests during the construction	1 200
Total fixed investment cost	**14 100**
Working capital	1 100
TOTAL INVESTMENT COST	15 200

Table 15

NITROCELLULOSE

2000 tons/year (100 % basis)

TECHNICAL REQUIREMENTS

Raw Materials and By-Products		Per unit Ton / Ton	Annual (in tons)
Nitric acid		1 125	2 250
Sulfuric acid		0.600	1 200
Linters		0.700	1 400
Utilities consumption		Per ton	Annual
Power	in kWh	1 400	2 800 000
Cooling water	in m^3		
Process water	in m^3	700	1 400 000
Steam	in 10^6 Kcal	5.85	11 700

Manpower	Number	Cost per person	Annual cost in US$
	25	2 500	62 500

Table 16

NITROCELLULOSE

2000 tons/year (100 % basis)

PRODUCTION COST AND PRODUCT VALUE

RAW MATERIALS	
Nitric acid	304 000
Sulfuric acid	144 000
Linters	1 540 000
VARIABLE CHARGES	
Utilities	1 071 000
Packaging	40 000
FIXED CHARGES	
Labour	62 500
Maintenance	423 000
Overhead expenses	274 000
Insurance, taxes	53 000
Interests on working capital	110 000
DEPRECIATION	1 290 000
COST OF PRODUCTION (US$)	**5 311 500**
ROI	1 410 000
TOTAL SALES	6 721 500
PRODUCT VALUE (US$/ton)	**3 360**

4.6. Toluene Diisocyanate

4.6.1. Technical Description and Definition of Plant Facilities

Toluene diisocyanate is conventionally produced by the reaction of toluene diamine and phosgene. The diamine is produced by the catalytic reduction of dinitrotoluene which, in turn, is produced by the nitration of toluene.

a) Technical Description

a.1. Dinitrotoluene production

Dinitrotoluene is manufactured by the two stage nitration of toluene. In the initial step, fresh toluene is fed to agitated reactors operated in series. The toluene reacts with a mixture of aqueous nitric and sulfuric acid. Exothermic heat of reaction is removed through internal cooling coils. The products of the mononitration step are phase separated.

The organic products from this first step react with fresh mixed acids for the conversion of mononitrotoluene to dinitrotoluene. The reactors are similar in design and cooling systems to those used in the first step. Products from the dinitration step pass to a separator. Crude dinitrotoluene is sent to a series of neutralisers/washers to remove the acids and their resulting salts. Washed dinitrotoluene is then transfered to a separator where product is removed.

a.2. Toluene diamine production

Dinitrotoluene, methanol and catalyst are blended in the feed preparation tank. The mixture is fed as slurry to the high pressure reactors. Reaction conditions are about 80 bars and 170°C. Hydrogen is supplied under pressure control. The reactor effluent

is cooled down and sent to a vessel where hydrogen and the liquid phase are separated. The liquid phase is transferred to a product receiver. The product is then separated from the catalyst, a part is recycled and the main stream is stored in a tank for subsequent purification.
The purification section consists of methanol and dehydration columns, a flash reboiler, strippers for toluene diamine and residue.

a.3. Toluene diisocyanate production

Toluenediisocyanate is obtained by the phosgenation of toluene diamine in orthodichlorobenzene. The reaction mixture enters several phosgenators.
The reaction products contained in orthodichlorobenzene enter an absorber-stripper which is used to remove HCl and excess phosgene. Gaseous phosgene and HCl leave the top of the absorber-stripper.
The bottoms from the absorber stripper contain TDI. The stream is fed to the phosgene stripper. The bottoms are transferred to the purification section which consists of crude product flasher and preconcentrator and distillation columns.
The phosgene required for the reaction is produced from carbon monoxide and chlorine in the phosgene reactor over activated carbon.

b) Definition of Plant Facilities

The plant facilities include all the equipment required by the processes described above, plus the electricity distribution system, the steam system, the cooling water system and all the general services and buildings.

4.6.2. Total Investment

The nominal capacity of the production unit is 10 000 tons per year.

The battery limits investment in Europe is estimated at US$ 28 000 000, investment figure based on the process presented previously, and including the concentration of nitric acid.

The erected cost in Indonesia is estimated at US$ 39 200 000 and the total fixed investment cost including pre-operating costs and interests during the construction amounts to US$ 49 400 000.

The detailed investment cost is presented in table 17.

4.6.3. Technical Requirements

The technical requirements include the consumptions of raw materials and utilities, the costs of catalysts and chemicals and the costs of operating manpower.

In the utility costs the cooling water costs are derived from equivalent electricity and raw water expenses.

Technical requirements are presented in table 18.

4.6.4. Production Cost and Product Value

The production cos and product value are calculated according to the basis presented in the methodology related to the calculation of variable charges, fixed charges and depreciation.

The results are presented in table 19.

This table lets appear the most important part taken by the investment-related charges or return (fixed charges, depreciation, ROI) which constitutes nearly 55 % of the product value.

In the basic case, no credit value is considered for HCl produced in the reaction.

4.6.5. Economic Results. Comparison with international prices

The international price of TDI is taken at 2 200 US$/ton. The product value of 2 170 US$/ton is comparable with international price and the internal rate of return (14 % in the base case for the 2 200 US$/ton international price) can be considered as acceptable .

The share of nitric acid cost in the total product value is relatively low and the impact of this low cost on the total product value is small compared to the influence of the investment cost.

4.6.6. Sensitivity Analysis. Conclusions

Main influing factors are possible variations in investment cost and in the valorization of by-product HCl :

- a 10 % increase on the investment would lead to an increase of 120 US$/ton of the product value, i.e. a total product value of 2 291 US$/ton

- a valorization of HCl at 50 US$/ton would lead to a decrease of 147 US$/ton of the product value, i.e. a total product value of 2 024 US$/ton

On the only evaluation of profitability this project, at a minimum 10 000 tpa size, appears justified. Should be recalled **all critical problems relating to raw materials - availability, cost, environment - and to high investment requirements.**

Table 17

TOLUENE DIISOCYANATE

10 000 tons/year

TOTAL INVESTMENT COST

	In 10^3 US$
Total battery limits	28 000
Off-sites	11 200
Erected cost in Indonesia	**39 200**
Pre-operating expenses	5 900
Fixed investment cost	45 100
Interests during the construction	4 300
Total fixed investment cost	**49 400**
Working capital	3 600
TOTAL INVESTMENT COST	53 000

Table 18

TOLUENE DIISOCYANATE

10 000 tons/year

TECHNICAL REQUIREMENTS

Raw Materials and By-Products	Per unit Ton / Ton	Annual (in tons)
Toluene	0.66	6 600
Nitric acid	0.95	9 500
Hydrogen	0.11	11 000
Chlorine	0.96	9 600
Carbon monoxide	0.43	4 300
HCl	(2.94)	(29 400)

Utilities consumption		Per ton	Annual
Power	in kWh	1 490	14 900 000
Cooling water	in m^3	1 620	16 200 000
Steam	in 10^6 Kcal	8.65	86 500
Fuel	in 10^6 Kcal	0.55	5 500

Catalysts and chemicals	Per ton in US$	Annual in US$
	65	650 000

Manpower	Number	Cost per person	Annual cost in US$
	50	2 500	125 000

Table 19

TOLUENE DIISOCYANATE

10 000 tons/year

PRODUCTION COST AND PRODUCT VALUE

RAW MATERIALS AND BY-PRODUCTS	
Toluene	1 980 000
Nitric acid	1 282 500
Hydrogen	1 320 000
Chlorine	1 440 000
Carbon monoxide	860 000
HCl	0
VARIABLE CHARGES	
Utilities	1 710 000
Catalysts and chemicals	650 000
FIXED CHARGES	
Labour	125 000
Maintenance	1 482 000
Overhead expenses	866 000
Insurance, taxes	185 300
Interests on working capital	360 000
DEPRECIATION	4 510 000
COST OF PRODUCTION (US$)	**14 770 800**
ROI	4 940 000
TOTAL SALES	21 710 000
PRODUCT VALUE (US$/ton)	**2 170**

4.7. Nitrochlorobenzenes

4.7.1. Technical Description and Definition of Plant Facilities

Orthonitrochlorobenzene and Paranitrochlorobenzene are produced by nitration of monochlorobenzene.

The upstream production of monochlorobenzene by chlorination of benzene in liquid phase is described but not included for the purpose of prefeasibility evaluation ; this has no significant effect on the conclusions of such evaluation.

a) Technical Description

a.1. Monochlorobenzene production

Production of chlorobenzene is based upon liquid-phase chlorination of benzene in the presence of a catalyst. Benzene used in the process should be free of paraffinic impurities and thoroughly dried. Chlorine gas has to be supplied dry. Since the reactants are dry, the chlorinator is constructed of iron or steel in the form of deep tank or horizontal vessel. Ferric chloride is usually used as catalyst. The chlorinator is charged with benzene and chlorine gas. The desired reaction temperature (about 40°C for chlorobenzene) is maintained by circulation of the liquid through the external cooler.

The degree of chlorination is determined by density measurements ; the chlorinated product is withdrawn continuously to the neutralizer.

The HCl gas coming from the chlorinator is sent to a scrubber. In the neutralizer, dissolved HCl is reacted with caustic solution and maintained slightly alkaline to protect downstream equipment from corrosion.

After neutralization the mixture of caustic solution and organic phase is sent to a decanter where the aqueous and organic phases are separated.

The organic phase from the decanter is sent to a flash drum where benzene and monochlorobenzene are taken off overhead. The overhead from the flash drum goes to benzene column and chlorobenzene column where chlorobenzene product is taken off overhead.

a.2. Nitrochlorobenzene production

The chlorobenzene is nitrated continuously by a mixed acid containing 35 % HNO_3, 53 % H_2SO_4 and H_2O in an agitated reactor with cooling coils. The reaction product is decanted in a special decanter. The nitrated product is washed several times. The nitrochlorobenzene obtained is a mixture of 65 % ortho and 34 % para.

The mixture is cooled to a temperature slightly above its freezing point and a large portion of the para isomer slowly crystallizes and is separated from the mother liquor.

The liquid mixture of isomers is separated by a combination of fractionnal distillation and crystallization.

The o-chloronitrobenzene coming from the separation column is evaporated in a special evaporator. Chlorobenzene is recycled and the spent acid is concentrated to recover the sulfuric acid.

b) <u>Definition of Plant Facilities</u>

The plant facilities include the equipment required by the processes described above, plus the electricity distribution system, the steam system, the cooling water system and all the general services and buildings.

For the purpose of prefeasibility evaluation, the chlorination section (transformation from benzene to monochlorobenzene) is not included.

4.7.2. Total investment

The nominal capacity of the nitrochlorobenzene production unit is 5 000 tons/year.

The battery limits investment in Europe is estimated at US$ 5 900 000, investment figure based on the process presented previously, and including the concentration of nitric acid.

The erected cost in Indonesia is estimated at US$ 8 250 000 and the total fixed investment cost including pre-operating costs and interests during the construction amounts to US$ 10 400 000.

The detailed investment cost is presented in table 20.

4.7.3. Technical Requirements

The technical requirements include the consumptions of raw materials and utilities, the costs of catalysts and chemicals and the costs of operating manpower.

In the utility costs the cooling water costs are derived from equivalent electricity and raw water expenses.

Technical requirements are presented in table 21.

4.7.4. Production Cost and Product Value

The production cost and product value are calculated according to the basis presented in the methodology related to the calculation of variable charges, fixed charges and depreciation.

The results are presented in table 22.

This table lets appear the most important part taken by the cost of raw materials, especially monochlorobenzene intervening for nearly 55 % of the total product value. Effect of investment is still valuable but not to a too large extent (around 32 % of the product value).

4.7.5. Economic Results. Comparison with International Prices

The international prices for both ortho and para-nitrochlorobenzene lie between 1 550 and 1 650 US$/ton. A 1 600 US$/ton price is taken for the product, as a compromise between the price of product rendered in Indonesia and the export price, since a large part of p-nitrochlorobenzene will have to be exported.

The product value of 1 560 US$/ton is comparable with the international price and the internal rate of return (14.4 % in the base case for the 1 600 US$/ton international price) can be considered as acceptable.

4.7.6. Sensitivity analysis. Conclusions

Main influing factors are variations in **monochlorobenzene price and investment evaluation :**

- a monochlorobenzene of 1 265 US$/ton instead of 1 150 (i.e. 10 % increase) would increase the product value of 85 US$/ton, i.e. up to 1 645 US$/ton

- a 20 % increase of the investment would increase the product value of 100 US$/ton, i.e. up to 1 660 US$/ton.

The project at this size appears thus justified.

Table 20

O- and P-NITROCHLOROBENZENES

5000 tons/year

TOTAL INVESTMENT COST

	In 10^3 US$
Total battery limits	5 900
Off-sites	2 350
Erected cost in Indonesia	**8 250**
Pre-operating expenses	1 250
Fixed investment cost	9 500
Interests during the construction	900
Total fixed investment cost	**10 400**
Working capital	1 350
TOTAL INVESTMENT COST	11 750

Table 21

O- and P-NITROCHLORONITROBENZENES

5 000 tons/year

TECHNICAL REQUIREMENTS

Raw Materials and By-Products	Per unit Ton / Ton	Annual (in tons)
Monochlorobenzene	0.74	3 700
Nitric acid	0.43	2 150
Sulphuric acid	0.03	150

Utilities consumption		Per ton	Annual
Power	in kWh	450	2 250 000
Cooling water	in m^3	100	500 000
Steam	in 10^6 Kcal	3.6	18 000
Fuel	in 10^6 Kcal	0.3	1 500

Manpower	Number	Cost per person	Annual cost in US$
	30	2 500	75 000

Table 22

O- and P-NITROCHLOROBENZENES

5 000 tons/year

PRODUCTION COST AND PRODUCT VALUE

RAW MATERIALS	
Monochlorobenzene	4 255 000
Nitric acid	290 300
Sulphuric acid	18 000
VARIABLE CHARGES	
Utilities	447 00
FIXED CHARGES	
Labour	75 000
Maintenance	312 000
Overhead expenses	231 000
Insurance, taxes	39 000
Interests on working capital	135 000
DEPRECIATION	950 000
COST OF PRODUCTION (US$)	**6 752 300**
ROI	1 040 000
TOTAL SALES	7 792 300
PRODUCT VALUE (US$/ton)	**1 560**

4.8. Cyclohexylamine

4.8.1. Technical Description and Definition of Plant Facilities

a) Technical Description

Cyclohexylamine is obtained by hydrogenation of aniline. The hydrogenation reaction (T°=230°C, P=60 atm) is highly exothermic, the reaction heat usually being removed by steam generation.

Aniline and hydrogen-rich gas are fed to a liquid-phase reactor. Overheads are sent to a fixed bed finishing reactor where Raney-type catalysts convert the remaining aniline. The concentration gradient across the second reactor is such that over 100 per cent conversion can be obtained. Effluent from the second reactor is cooled and separated in a high pressure drum. Gas from the drum can be partially recycled depending on the purity of the original hydrogen stream, the residual amount being sent to fuel. Product is then fractionated in a stabilizer, pure cyclohexylamine being drawn off from the bottom of the column.

Product purity is dependent on high purity aniline feed. Hydrogen feed needs to have low sulphur and carbon oxide levels.

b) Definition of plant facilities

The plant facilities include all the equipment required by the process described above, plus the electricity distribution system, the steam system, the cooling water system and all the general services and buildings.

4.8.2. Total Investment

The nominal capacity of the cyclohexylamine production unit is 2000 tons/year.

The battery limits investment in Europe is estimated at US$ 2 000 000, investment figure based on the process presented previously.

The erected cost in Indonesia is estimated at US$ 2 800 000 and the total fixed investment cost including pre-operating costs and interests during the construction amounts to US$ 3 550 000.

The detailed investment cost is presented in table 23.

4.8.3. Technical Requirements

The technical requirements include the consumptions of raw materials and utilities, the costs of catalysts and chemicals and the costs of operating manpower.

In the utility costs the cooling water costs are derived from equivalent electricity and raw water expenses.

Technical requirements are presented in table 24.

4.8.4. Production Cost and Product Value

The production cost and product value are calculated according to the basis presented in the methodology related to the calculation of variable charges, fixed charges and depreciation.

The results are presented in table 25.

This table lets appear the major part taken by the cost of raw materials, which constitutes nearly 70 % of the total product value.

The effect of investment cost is limited but still appreciable (around 25 % of the product value).

4.8.5. Economic Results. Comparison with international prices

International prices for cyclohexylamine are comprised between 1 700 and 1 800 US$/ton. A 1 800 US$/ton price is taken for the product rendered in Indonesia.

The product value of about 1 700 US$/ton is attractive as compared with the international price. Similarwise the internal rate of return of the project, on the basis of a 1 800 US$/ton sales price for cyclohexylamine is relatively attractive : 17 % in the base case.

4.8.6. Sensitivity analysis

Main influing factors are variations in **aniline price or investment cost**

- an aniline price of 1 210 US$/ton instead of 1 100 US$ (10 % increase) would increase the product value of 108 US$/ton, i.e. up to a total of 1 806 US$/ton

- a 20 % increase on the investment would increase the product value of 85 US$/ton, i.e. up to a total of 1 783 US$/ton

Would be this 2000 tpa size of production installed for meeting sure market requirements, the project appears justified.

A smaller size at say 500 tpa would yield an increase of the investment cost per ton of about 50 %, thus leading to a product value over 1900 US$/ton or an IRR below 10 %.

Table 23

CYCLOHEXYLAMINE

2 000 tons/year

TOTAL INVESTMENT COST

In 10^3 US$

Total battery limits	2 000
Off-sites	700
Erected cost in Indonesia	**2 800**
Pre-operating expenses	450
Fixed investment cost	3 250
Interests during the construction	300
Total fixed investment cost	**3 550**
Working capital	570
TOTAL INVESTMENT COST	4 120

Table 24

CYCLOHEXYLAMINE

2 000 tons/year

TECHNICAL REQUIREMENTS

Raw Materials and By-Products		Per unit Ton / Ton	Annual (in tons)
Aniline		0.98	1 960
Hydrogen		0.085	170

Utilities consumption		Per ton	Annual
Power	in kWh	90	180 000
Cooling water	in m^3	100	200 000
Process water	in m^3	1	2 000
Steam	in 10^6 Kcal	0.4	800

Catalysts and chemicals	Per ton in US$	Annual in US$
	3	6 000

Manpower	Number	Cost per person	Annual cost in US$
	20	2 500	50 000

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Table 25

CYCLOHEXYLAMINE

2 000 tons/year

PRODUCTION COST AND PRODUCT VALUE

RAW MATERIALS	
Aniline	2 156 000
Hydrogen	204 000
VARIABLE CHARGES	
Utilities	19 300
Catalysts and chemicals	6 000
FIXED CHARGES	
Labour	50 000
Maintenance	106 500
Overhead expenses	103 300
Insurance, taxes	13 300
Interests on working capital	57 000
DEPRECIATION	325 000
COST OF PRODUCTION (US$)	**3 040 100**
ROI	355 000
TOTAL SALES	3 395 100
PRODUCT VALUE (US$/ton)	**1 698**

4.9. Aniline

Aniline can be obtained either by reduction of mononitrobenzene or by ammonalysis of phenol.
The selected route is the reduction of mononitrobenzene by hydrogen.

4.9.1. Technical Description and Definition of Plant Facilities

a) Technical Description

a.1. Nitrobenzene production

A mixed acid stream containing sulphuric and nitric acids is charged to the nitration reactor. Weak nitric acid can be used, consequently a fairly high rate of 96 per cent sulphuric acid will be necessary. The nitration vessels are conventional stirred-tank type reactors equipped with internal cooling coils. The number of nitration reactors varies among producers, however the current number is comprised between 2 and 4.

The mixed acid-organic flow is arranged so that the strongest acid contacts the solution containing the highest concentration of nitrobenzene. The emulsion leaving the last nitrator enters the decanter where it is separated by gravity.

The nitrobenzene from the decanter is next washed with a dilute soda ash solution and water to remove residual amounts of entrained and dissolved acid.

The acid-free nitrobenzene from the last washer is heated and then sent to the nitrobenzene flasher. The liquid phase from the flasher is nitrobenzene sent to storage.

a.2. Aniline production

Nitrobenzene and hydrogen are sent to a vaporizer which is a tower equipped with sieve trays and a reboiler. The gas mixture is then sent to the bottom of reactor. The gas passes through a porous distributor plate, and then enters the fluidized bed of catalyst. Reaction temperature and pressure are controlled. The heat of reaction is removed via an adequate sytem. The catalyst is slowly deactivated due to deposition of organic materials. Hence, it is necessary to regenerate the catalyst about every three months. The aniline and water in the gaseous effluent from the reactor are condensed in the product gas condenser. The hydrogen stream, after a short treatment, is compressed and recycled to the reaction system.

The water-aniline stream is separated by gravity in a separator. The water rich phase is fed to the water removal column. The organic phase is sent to a recovery column. Aniline product is taken overhead from the refining column and sent to storage.

b) Definition of Plant Facilities

The plant facilities include all the equipment required by the processes described above, plus the electricity distribution system, the steam system, the cooling water system and all the general services and buildings.

4.9.2. Total Investment

The nominal capacity of the production unit is 5 000 tons/year.

The battery limits investment in Europe is estimated at US$ 7 800 000, investment figure based on the process presented previously.

The erected cost in Indonesia is estimated at US$ 10 600 000 and the total fixed investment cost including pre-operating costs and interests during the construction amounts to US$ 13 350 000.

The detailed investment cost is presented in table 26.

4.9.3. Technical Requirements

The technical requirements include the consumptions of raw materials and utilities, the costs of catalysts and chemicals and the costs of operating manpower.

In the utility costs the cooling water costs are derived from equivalent electricity and raw water expenses.

Technical requirements are presented in table 27.

4.9.4. Production Cost and Product Value

The production cost and product value are calculated according to the basis presented in the methodology related to the calculation of variable charges, fixed charges and depreciation.

The results are presented in table 28.

This table lets appear the important part taken by the investment-related charges or return (fixed charges, depreciation, ROI) which intervene for over 50 % of the total product value.

4.9.5. Economic Results. Comparison with International Prices. Conclusions

In accordance with medium-term international prices at around 450 $/ton for benzene, the international prices for aniline will be around 1 100 $/ton.

The product value of nearly 1 300 $/ton appears relatively high. The IRR of 5.9 %, calculated on the 1 100 $/ton value, confirms the bad economic results for such a project.

It mainly comes from the **effect of low capacity size :** an acceptable IRR range between 10 and 12 % would be obtained for a minimum size of 40 000 - 50 000 tpa, all other costs being maintained.

In the light of economic results this project of aniline does not appear justified in the short and medium term.

Table 26

ANILINE

5 000 tons/year

TOTAL INVESTMENT COST

	In 10^3 US$
Total battery limits	7 800
Off-sites	2 800
Erected cost in Indonesia	**10 600**
Pre-operating expenses	1 600
Fixed investment cost	12 200
Interests during the construction	1 150
Total fixed investment cost	**13 350**
Working capital	1 100
TOTAL INVESTMENT COST	14 450

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Table 27

ANILINE

5 000 tons/year

TECHNICAL REQUIREMENTS

Raw Materials and By-Products		Per unit Ton / Ton	Annual (in tons)
Benzene		0.88	4 400
Nitric acid		0.73	3 650
Hydrogen		0.066	330

Utilities consumption		Per ton	Annual
Power	in kWh	90	450 000
Cooling water	in m^3	360	1 800 000
Steam	in 10^6 Kcal	0.59	2 950
Fuel	in 10^6 Kcal	0.40	2 000

Catalysts and chem[illegible]als	Per ton in US$	Annual in US$
	7	35 000

Manpower	Number	Cost per person	Annual cost in US$
	35	2 500	87 500

Table 28

ANILINE

5 000 tons/year

PRODUCTION COST AND PRODUCT VALUE

RAW MATERIALS	
Benzene	1 980 000
Nitric acid	492 800
Hydrogen	396 000
VARIABLE CHARGES	
Utilities	71 100
Catalysts and chemicals	35 000
FIXED CHARGES	
Labour	87 500
Maintenance	400 500
Overhead expenses	287 800
Insurance, taxes	50 100
Interests on working capital	110 000
DEPRECIATION	1 220 000
COST OF PRODUCTION (US$)	**5 130 800**
ROI	1 335 000
TOTAL SALES	6 465 800
PRODUCT VALUE (US$/ton)	**1 293**

4.10. Rubber Chemicals - MBT

4.10.1. Technical Description and Definition of Plant Facilities

2-Mercaptobenzothiazole (MBT) is produced by heating aniline with carbon disulphide, sulphur and caustic soda at over 200°C according to the following equation :

$$\text{Aniline} + CS_2 + S \xrightarrow{NaOH} \text{MBT Na} + H2S$$

By-product hydrogen sulphide is usually converted back to sulphur in a Claus plant but for economic reasons is rather neutralized with caustic soda to obtain sodium sulphhydrate to be disposed off as such.

The sodium salt of mercaptobenzothiazole can be neutralized with hydrogen chloride to form MBT itself which is used as such as a rubber accelerator.

The plant facilities include the equipment required by the process described above, plus the electricity distribution system, the steam system, the cooling water system and all the general services and buildings.

4.10.2. Total Investment

The nominal capacity of the MBT production unit is 1 000 tons/year.

The battery limits investment in Europe is estimated at US$ 1 800 000, investment figure based on the process presented previously.

The erected cost in Indonesia is estimated at US$ 2 500 000 and the total fixed investment cost including pre-operating costs and interests during the construction amounts to US$ 3 200 000.

The detailed investment cost is presented in table 29.

4.10.3. Technical Requirements

The technical requirements include the consumptions of raw materials and utilities, the costs of catalysts and chemicals and the costs of operating manpower.

In the utility costs the cooling water costs are derived from equivalent electricity and raw water expenses.

Technical requirements are presented in table 30.

4.10.4. Production Cost and Product Value

The production cost and product value are calculated according to the basis presented in the methodology related to the calculation of variable charges, fixed charges and depreciation.

The results are presented in table 31.

This table lets appear the important parts taken by the investment-related charges or return (fixed charges, depreciation and ROI) and the costs of raw materials, respectively 54 % and 35 %.

4.10.5. Economic results. Comparison with International Prices

International price for MBT is estimated at 2 400 US$/ton, product rendered in Indonesia.

The product value of 2 200 US$/ton can be considered as attractive as compared with the international price. Similarwise, the internal rate of return of the project, on the basis of a 2 400 US$/ton sales price for MBT is considered as attractive : 17.8 % in the base case.

4.10.6. Sensitivity Analysis. Conclusions

Main influing factors are variations in raw materials prices and investment cost:

- a 10 % increase of raw materials would increase the product value of 119 US$/ton, i.e. up to a total of 2 319 US$/ton

- a 20 % increase on the investment would increase the product value of 154 US$/ton, i.e. up to a total of 2 354 US$/ton

After market requirements for rubber chemicals having been met by producing plants, this MBT project appears justified.

Table 29

MBT

1 000 tons/year

TOTAL INVESTMENT COST

	In 10^3 US$
Total battery limits	1 800
Off-sites	700
Erected cost in Indonesia	**2 500**
Pre-operating expenses	400
Fixed investment cost	2 900
Interests during the construction	300
Total fixed investment cost	**3 200**
Working capital	400
TOTAL INVESTMENT COST	3 600

Table 30

MBT

1 000 tons/year

TECHNICAL REQUIREMENTS

Raw Materials and By-Products		Per unit Ton / Ton	Annual (in tons)
Aniline		0.59	590
Carbon disulphide		0.54	540
Sulphur		0.21	210
Caustic soda		0.5	500
Hydrochloric acid		0.22	220
Utilities consumption		Per ton in US$	Annual in US$
All included		70	70 000
Manpower	Number	Cost per person	Annual cost in US$
	25	2 500	62 500

Table 31

MBT

1 000 tons/year

PRODUCTION COST AND PRODUCT VALUE

RAW MATERIALS	
Aniline	649 000
Carbon disulphide	378 000
Sulphur	25 200
Caustic soda	125 000
Hydrochloric acid	11 000
VARIABLE CHARGES	
Utilities	70 000
Packaging	10 000
FIXED CHARGES	
Labour	62 500
Maintenance	96 000
Overhead expenses	110 500
Insurance, taxes	12 000
Interests on working capital	40 000
DEPRECIATION	290 000
COST OF PRODUCTION (US$)	**1 879 200**
ROI	320 000
TOTAL SALES	2 199 200
PRODUCT VALUE (US$/ton)	**2 200**

4.11. Integrated Complex for Nitric Acid, Ammonium Nitrate and Calcium Nitrate Productions

4.11.1 Technical Definition and Requirements. Investment and Operating Requirements

As given above the definition of the three individual plants - nitric acid, ammonium nitrate, calcium nitrate - is based on the integration of these units together on a same site with a common infrastructure and offsite / utilities system.

Hence the technical definition and requirements for the integrated complex correspond to the only addition of inputs from each of the three individual plants sized at 40,000 tons/year for nitric acid, 26,000 tons/year for ammonium nitrate and 12,000 tons/year for calcium nitrate, e.g. resulting in yearly requirements of about 17,000 tons of ammonia and 8,000 tons of limestone at full capacity.

The same applies to investment and operating requirements, resulting in the following estimates:

- US$ 15,000,000 for the battery limits investment on European basis
- US$ 20,250,000 for the total erected cost in Indonesia
- US$ 22,860,000 for the total fixed investment cost, including pre-operating costs but excluding interests during construction
- US$ 353,500 for the yearly cost of utilities at full capacity
- 105 people for the operating manpower.

4.11.2 Methodology and Bases for Economic - Financial Evaluation

This evaluation is performed through the analysis of various profitability and financial ratios established according to a computer model, where the **following results** are issued:

- Internal rate of return on the project (on gross cash flow)
- After tax cash flow on total investment
- Return on equity (as cash available)
- Net income statement
- Balance sheet

Approach and wording for the main inputs/outputs of the evaluation are illustrated in figures in Appendix. They refer to the statement for economic evaluation or financial income and to the yearly balance sheet.

Bases concern the following main items:

- **Investments costs**

  They are constituted as in the evaluation of individual projects, with the following schedule of disbursement:

  20% of erected cost, in 1988

  45% of erected cost, in 1989

  35% of erected cost + preoperating expenses, in 1990.

  Interests during the construction are capitalized at the end of investment period in 1990.

- **Working capital**

It is constituted by inventories (for raw materials, products, spare parts, catalysts and chemicals), operating cash, accounts receivable (1 month of sales) and accounts payable (1 month of raw materials).

- **Equity and loan bases**

The initial equity/debt ratio is taken at 30/70. With interests during construction being paid on equity this ratio becomes about 1/3-2/3.

On a current inflated basis in Indonesia and starting from world prevailing conditions (maximum 9% prime rate), the loan conditions have been appreciated as follows:

. 7 years of reimbursement for the long term loans, with a grace period corresponding to the initial year of reimbursement for the 1st year of operation (1991)

. overall rate of interests of 18% per year.

This high rate of interest reflects to a great part the effect of inflation differential between currencies. As, for a better comprehension of results, our financial evaluation is made on a constant basis, a coherent rate of interest (in line with the world rates) would lie in a 10-12% range, this latter figure of 12% being adopted in the evaluation.

In other terms the 18% rate of interest is justified in a financial evaluation in current terms where a minimum 6-7% inflation is taken into account as a differential between the local and the international currencies.

- **Depreciation - Taxes**

A double declining balance is adopted, with a 25% rate of depreciation.

Taxes apply on the gross cash flow from which are deducted the depreciation and the interests on loans, with a 35% rate.

- **Costs for Fixed and Variable Charges**

As indicated above they are the sum of constituents in the evaluation of each of the three individual projects of production for nitric acid, ammonium nitrate and calcium nitrate:

- **Operating Rate**

In the base case, as retained in the evaluation of individual projects the following schedule is retained;

80% of nominal capacity in the 1st year of operation (1991)

90% of nominal capacity in the 2nd year of operation (1992)

100% of nominal capacity in the 3rd year of operation (1993) and following years.

In the sensitivity analysis a more pessimistic case which takes into account constraints on market and operation is as follows:

60% in the 1st year of operation

70% in the 2nd year of operation

80% in the 3rd year of operation

90% in the 4th year of operation

95% in the 5th year of operation (1995) and following years

- **Lifetime**

Lifetime of the project is taken at 15 years, up to year 2005.

- **Prices of raw materials and products**

As given and justified in the evaluation of individual projects the following prices are taken in 1987 US$/ton, for:

ammonia	110	(high price 170)
limestone	30	(high price 40)
nitric acid	170	(low price 150)
ammonium nitrate	230	(low price 210)
calcium nitrate	240	(low price 220)

where the prices between brackets are taken in alternate cases in the sensitivity study.

4.11.3. Results (see computer tables in Appendix)

In the **base case** (basic costs and prices for raw materials and products, operating rate as evaluated for the individual projects) the main results are:

. a return on gross cash flow (or Internal Rate of Return) of 20.5%

. a return on after tax cash flow of 17.0%

. a return or cash available on equity of 20.5% (financial income generated by the project included)

. a net operating profit from the 3rd year of operation, after reimbursement and payment of interests on loans.

In the **sensitivity analysis** the variations of main influing factors are evaluated.

Resulting profitability results given in Appendix show the effect of such variations with a significant decrease for the various returns.

Table 32 sums up the main results for different alternate cases which correspond to plausible and more pessimistic estimates:

- increase of raw material prices, 170 $/ton for ammonia instead of 110 $/ton (in line with expected world prices in the medium term) and higher price of limestone (40 $/ton instead of 30 $/ton)
- decrease of product prices by 20 $/ton
- lower operating rate with figures varying between 60% and 95% of nominal capacity in 5 years of operation, instead of 80% to 100% in 3 years.

In each case the rates of return are lowered by about 3.5% for the internal rate of return on gross cash flow and about 6% for the return on equity, as given in table 32.

Figures 8 and 9 illustrate the sensitivity to main influing factors, i.e. according to variations on prices of raw materials and products and on operating rates.

4.11.4 Conclusions

The evaluation of the integrated complex confirms the economic and financial results obtained with the individual units.

All discounted cash flow returns lie in a quite acceptable or even attractive range: between 14 and 20% for the internal rate of return of the whole project and between 7 and 20% for the return on equity, in constant terms.

The **project is thus justified and rather attractive in economic and financial terms,** even with the incorporation of a relatively less profitable unit - calcium nitrate productio into account possible worsening conditions either for prices of products (or costs of ammonia/limestone) or for operating rates lower than expected.

Table 32

NITRIC ACID INTEGRATED COMPLEX

PROFITABILITY RESULTS

	Rates of return		
	On gross cash flow (IRR)	On after tax cash flow	On equity (incl.non operating income)
Base Case	20.5 %	17.0%	20.5%
Raw materials (1) more costly	16.8 %	14.4 %	13.9 %
Cheaper products (2)	17.2 %	14.6 %	14.8 %
Lower operating rate	17.2 %	14.8 %	14.2 %
Lower operating rate and raw materials more costly	13.9 %	12.5 %	8.0 %

(1) Ammonia at 170 $/ton, limestone at 40 $/ton

(2) Nitric acid sold at 150 $/ton
Ammonium nitrate at 210 $/ton
Calcium nitrate at 220 $/ton

Figure 8

EVALUATION OF NITRIC ACID INTEGRATED COMPLEX

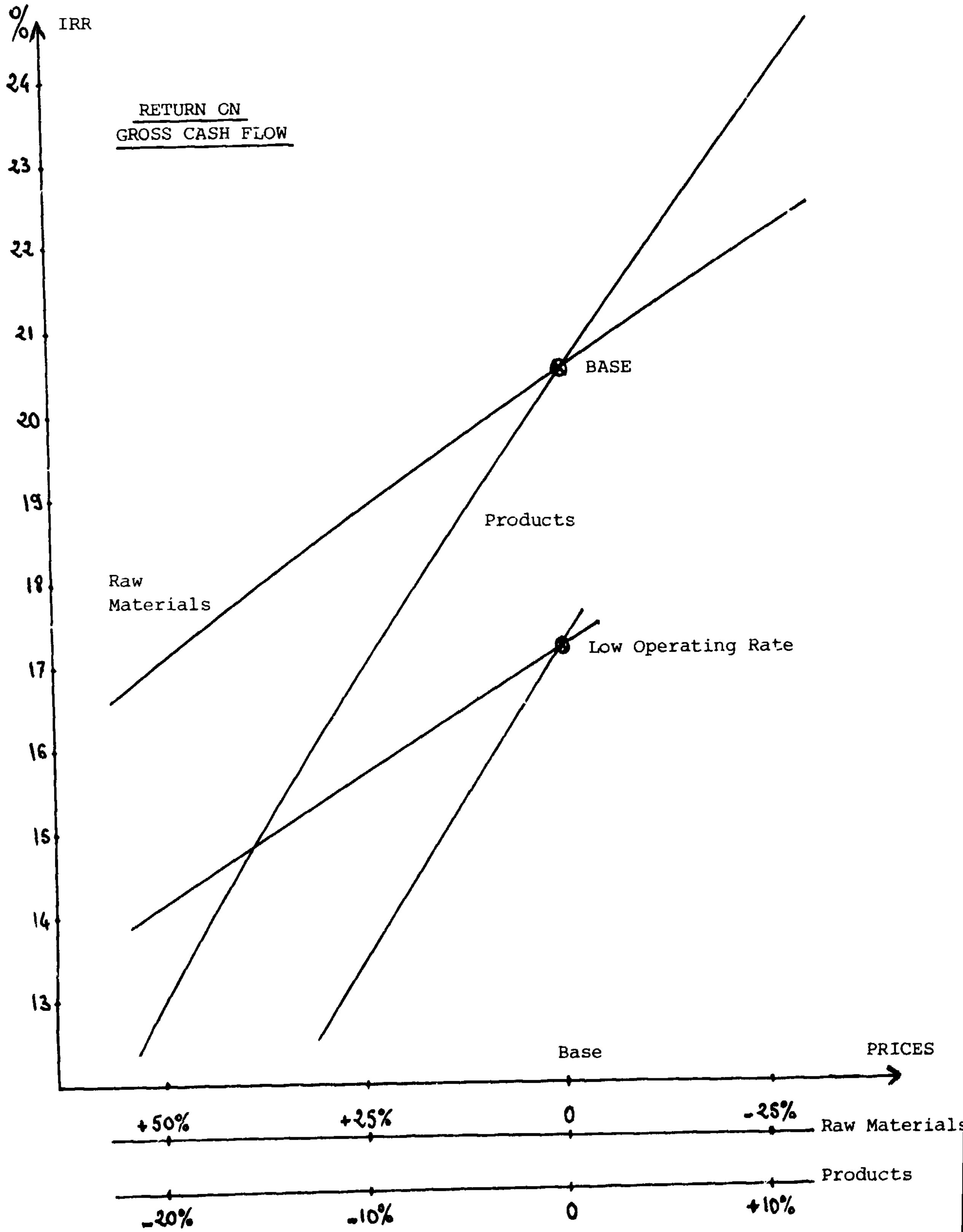
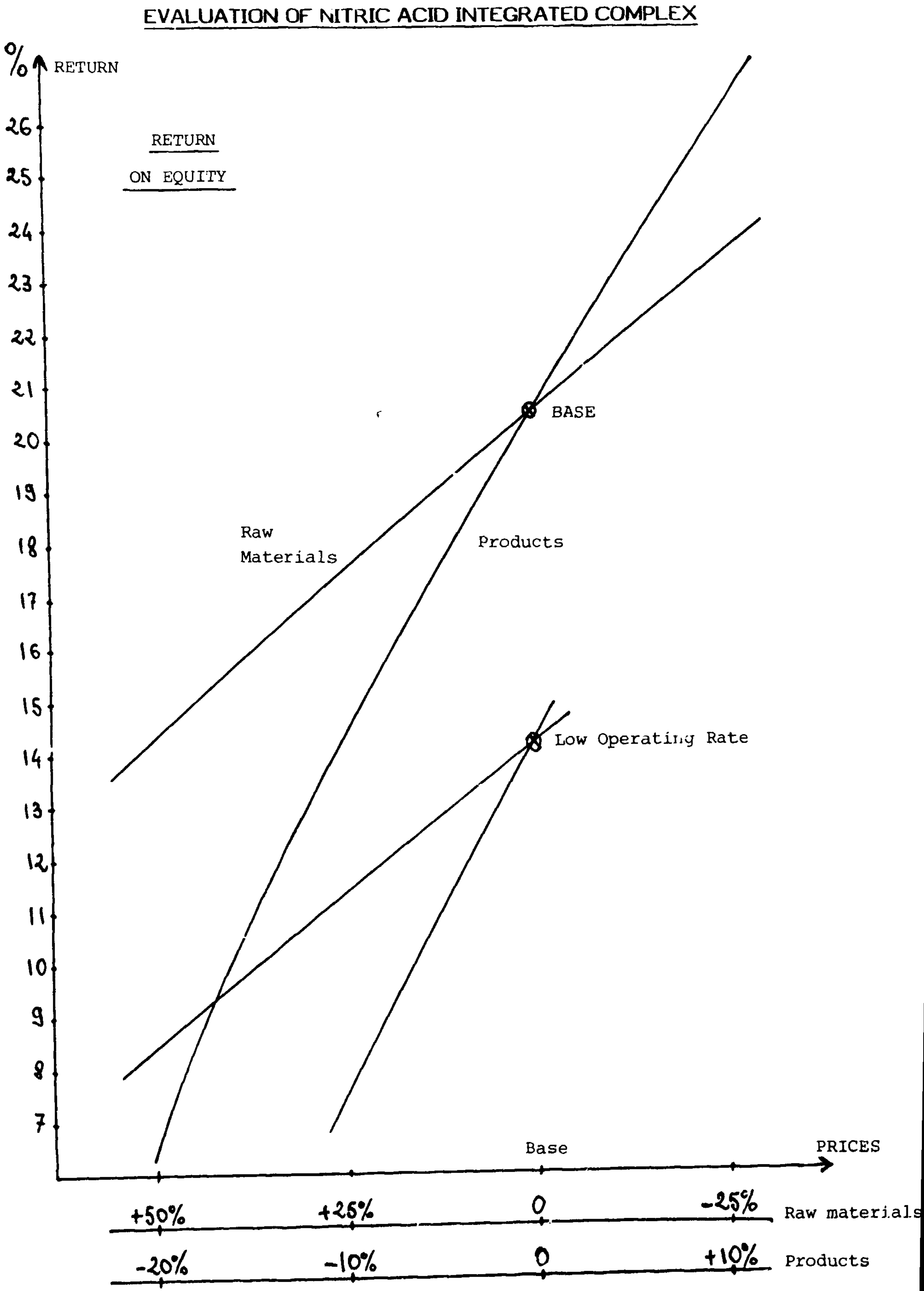


Figure 9


EVALUATION OF NITRIC ACID INTEGRATED COMPLEX
% RETURN
26
25
24
23
22
21
20
19
18
17
16
15
14
13
12
11
10
9
8
7
RETURN
ON EQUITY
BASE
Raw
Materials
Products
Low Operating Rate
Base
PRICES
+50%
+25%
0
-25%
Raw materials
-20%
-10%
0
+10%
Products

CONCLUSIONS - MASTER PLAN FOR THE INDUSTRY

1. CONCLUSIONS ON THE PREFEASIBILITY OF PROJECTS

1.1. Criteria

The main criteria intervening in the feasibility of the projects evaluated relate to:

- **market risks** which should be minimized, which is generally the case where domestic consumption is already significant and indeed likely to extend due to the expected sustained development of the related industrial sector ; the exports for such productions remain at marginal levels mainly in view of ensuring a more profitable rate of production

- **easy access to technology** or at least no drastic impedement to obtain for some specific productions the external technology or even the investment from well known major companies

- **limited** order of magnitude for the **investment** required, in line with local means either from public investments or from foreign/local private companies as regards the borrowing capacity

- **economic competitivity** of the production, due to:
  - . minimum cost in relation to the choice of the capacity at a sufficient size level
  - . easy availability of raw materials at competitive prices or costs
  - . benefit from an existing infrastructure with attractive costs for auxiliary requirements (utilities, handling, distribution)

Should all these conditions be fulfilled the feasibility of projects is obviously quite acceptable. If only a part is fulfilled the feasibility becomes questionable and even not recommendable if one of the first two conditions is not met (domestic market size, access to technology).

1.2. Conclusions on the Projects

According to the listing and evaluation of above criteria, a ranking can be made for the various projects investigated, by increasing order of interest.

a) Projects to be **discarded,** after prefeasibility evaluation

Firstly it concerns productions which were discarded at the **prescreening stage**

- either due to obviously unsufficient size of market:

  Potassium nitrate and ammonium nitrate, such as fertilizers
  MDI, as isocyanate intermediate for rigid polyurethane foams
  Fenitrothion and new productions of cyclamates
  Intermediates (aromatic amines) for dyestuffs

- or for other reasons, like the high level of investment or a rather difficult access to the technology:

  Complete chain of production leading to sulphamides
  Complete chain of production leading to pyrazolone products and the pyrazolone products themselves

After that, at the actual stage of prefeasibility evaluation, the demand requirements appear definitely too low for the **aniline** production, with a forecast consumption of 3 000 - 4 000 tons/year at a 10 year horizon from now.

This is illustrated by the profitability results for a 5 000 tpa plant:
- Product value 15 to 20 % higher than the international price
- Too low internal rate of return of the project, at about 6 %

Under prevailing conditions an aniline project would be hardly acceptable below a 40 000 tpa size.

b) Projects which require either **more detailed feasibility investigation** or **direct contacts** with a few number of **licensing / producing firms** in the field.

It mainly concerns projects benefiting from an important added value, but where no plant can be set up without passing through a restricted number of potential firms:

. **rubber chemicals** (and consequently the upstream project of production of the main intermediate - mercaptobenzothiazole or MBT - which can be set up only at a later second step after confirmation of a minimum 1 000 tpa market)

. **sulpha drugs**

It concerns also the project of **TDI** (toluene diisocyanate), as raw material for flexible polyurethane foams, at the chosen minimum size of 10,000 tpa.

This unit would have to overpass several constraints :

- complexity of various productions for the raw materials requirements (chlorine ; hydrogen ; carbon monoxide)
- environmental problems in the production/handling of chlorine and phosgene
- difficult access to a very few number of licensing companies
- high investment cost

It should be recalled that the demand (both domestic and export) is not expected to reach the 10 000 tpa mark before 1998 which may lead, according to assumptions of prices taken for raw materials and by-products, to a competitive price for TDI.

The **cyclohexylamine** project can also be ranked in this category for further detailed investigation, since its setting up depends only on the decisions to be taken in the development of sodium cyclamate market and more generally sugar or sugar substitutes market. A much lower demand for this product, at about 500 tpa for instance with moreover the uncertainty to justify the production in the longer term, would definitely discard such a project, with:

- Product value becoming at least 10 % higher than the international price, instead of competitive price for a 2000 tpa plant
- Too low internal rate of return, below 10 % instead of 17 % for a minimum 2000 tpa plant

c) **Projects** which, practically justified after preafeasibility evaluation, require **a few years before being set up.**

This leaves time to evaluate again the main components of the future decision, in the light of:

- evolution of domestic and international markets along the trends expected
- updating of feasibility evaluation
- preliminary contacts with licensing / producing companies

It concerns the project of **nitrochlorobenzenes** which can only be justified when market requirements reach a minimum 5 000 tpa level, thus in the medium term only and provided further outlets are found on the export market of p-nitrochlorobenzene.

This is illustrated by the just acceptable profitability of such a unit having to export nearly half of p-nitrochlorobenzene production:

- Product values just below the international prices
- Internal rate of return in the range of 12-13 %

Besides the fact that an export market has to be found, the most sensitive factor on such production is the availability and cost of monochlorobenzene as raw material.

d) Projects which can be decided and precised from now in view of **setting-up in the near future.**

It firstly concerns the basic production of **nitric acid** and the other ammonia - based production, **ammonium nitrate for explosives,** since these two productions can enjoy all the advantages of market, raw materials, technology and infrastructure.

Profitability figures evaluated for these two units stay in a good range after taking into account all the sensitivity analysis:

- Product values below the international prices
- Internal rate of return at a quite acceptable range of 20-25 %

It also concerns the production of **nitrocellulose for coatings,** insofar as linters as raw materials are procured at competitive costs.

Here again the product value and the internal rate of return (at about 12 %) support such a positive decision.

In technical terms only - safety aspects, process possibilities - a production of nitrocellulose for explosives could be advantageously coupled in the same plant; this, without considering national policy and ownership problems as well as the quite different types of market and industry (civilian/militar).

Although to a less certain extent, the production of **nitrate calcium** is ranked in the same category of projects. Reserves come from the relatively low level of capacity, 12 000 tpa, as compared with worldsize plants, as well as from uncertainties on the ready availability of good quality limestone.

Even with low nitric acid costs which intervene for 1/3 of the final product value such a unit being individually implemented would not be fully justified in economic and financial terms.

However it involves an additional requirement of a minimum of 8,000 tons/year of nitric acid at full capacity, which justifies to a large extent the choice of production size for nitric acid. Hence, as a second client of nitric acid after ammonium nitrate, it participates to the attractive profitability of an integrated complex for nitric acid, ammonium nitrate and calcium nitrate productions.

2. MASTER PLAN FOR THE NITRIC ACID-BASED INDUSTRY

2.1. General

The **master plan** development for such an industry consists of:

. establishing priorities for decisions and actions to be taken

. setting-up projects with maximum interrelation

. recommending sequential development phases between projects during the present and next three 5-year plans (Repelitas IV, V and VI)

Emphasis should be put on the necessary **interdependence of projects** and, if possible, the **maximum integration** when it definitely presents important economic advantages (infrastructure, utility and offsites costs, direct transfer prices for nitric acid or for other raw materials having to bear high transport costs).

The whole industry should be built through two approaches:

- starting from the conception of a nitric acid production, if justified at the beginning, and developing in the course of time downstream productions in the various sectors of application

- starting from the production of final products and developing upstream productions of intermediate materials and finally nitric acid

In the particular case of this nitric acid-based industry, both approaches are valid and converge together to an harmonious development within the next 10 or 15 years.

2.2. Present Status and Projects Already Planned

An embryonic **nitric acid-based industry already exists** with downstream productions of paracetamol by PT RIA SIMA ABADI (soon to be extended by the production of para-aminophenol, its raw material) and sodium cyclamate by at least five companies.

Moreover **different projects have been applied for** and are at a more or less advanced stage before final decision of setting-up:

- carbofuran production (joint project by several companies)
- nitrocellulose production (two projects)

complemented with the intention of several companies to develop the industry in specific sectors of application (dyestuffs productions, rubber chemicals plant).

Finally the foundation stone for this industry, the **PUPUK KUJANG project** of nitric acid and ammonium nitrate productions at the Cikampek site, is already in the files and can thus be soon decided.

These existing units (paracetamol and soon paraaminophenol, sodium cyclamate) are quite justified and their sizes are adapted to the market requirements in the short and medium term (unfortunately to a lesser extent for sodium cyclamate, due to the trends in a new policy against the development of this particular industry). It also appears to be the case for the planned carbofuran production.

Sizes of these other contemplated and mentioned projects are told to be:

- a maximum 1 500 tons/year for each nitrocellulose (100 % basis) project
- 100 tons/day or 33 000 tons/year for the nitric acid plant
- 26 000 tons/year for the ammonium nitrate plant

2.3. Market and Technical Considerations for Sizing the Plants

Sizes of plants to be implemented in the near and medium term should comply with two constraints:

- large enough to meet the market requirements as long as possible over the coming years, thus coping with the concept of minimum economic sizes

- at a level which optimizes the technical operating conditions, particularly for the first years of production

Following the market and prefeasibility findings the core of the nitric acid-based industry, in terms of volume of nitric acid and derivates requirements, is constituted by:

- ammonium nitrate production
- calcium nitrate production
- direct uses for nitric acid

to which might be added, but to a much less probable extent, a TDI production not before 8-10 years time.

By 1998 the demand for these 3 main outlets on both **the domestic and export markets** will amount to:

- 21 000 to 25 000 tons/year of ammonium nitrate which require 17 500 to 20 750 tons of nitric acid, at the most
- 15 000 tons/year of calcium nitrate which require 11 250 tons of nitric acid (12,000 tons/year by 1993-1995 which require 9 000 tons of nitric acid, at the most)
- 5 000 tons of nitric acid for direct uses

or all together between 31 500 and 37 000 tons/year of nitric acid (100% basis).

A nominal capacity of **40 000 tons/year for the nitric acid plant** thus appears quite well adapted to **meet the market** by that horizon, say **10 years from now,** moreover after taking into account the outlets in less consuming downstream productions of:

- nitrocellulose (2 500 tpa market by 1998 which, if fulfilled, requires 1 700 tons/year of nitric acid)
- nitrochlorobenzenes (7 500 tpa market which, if fulfilled, requires 3 300 tons/year of nitric acid)

Such a size, combined with the right sizes for the mentioned downstream units, will meet the 1998 market requirements.

In the case of an advanced, but less probable, decision to set-up a TDI production, the 1998 requirements of nitric acid would be increased by 9 000 tons/year. In other terms, should this last decision be taken, the 40 000 tpa nitric acid unit would meet the 1996-1997 market, with the following possibilities:

- all ammonium nitrate and calcium nitrate requirements being met
- most of other downstream requirements (nitrocellulose, nitrochlorobenzenes, TDI) being met
- some temporary imports of nitric acid being achieved, particularly for supplying the direct uses.

Investment cost considerations play in favour of sizes chosen at the high point of ranges where variations in investment are almost negligible, which is the case of:

- nitric acid production for which a 120 tons/day plant costs about the same as a 90 or 100 tons/day plant
- ammonium nitrate production, for which the investment costs vary slightly for capacities between 60 and 80 tons/day

For this latter unit, the investment cost considerations as well as some possibilities of finding exceptional export markets through country-to-country deals, play in favour of choosing a 80 tons/day capacity (or about 26 000 tpa).

On the other hand, **technical and operational considerations** lead to carefully take account of minimum production rates in the first years of operation and market development.

This applies to the ammonium nitrate and calcium nitrate plants and more critically to the nitric acid plant, for which it is preferred and at least not too uneconomical to run at a minimum 60% rate.

For the ammonium nitrate production this constraint may be achieved by specific export deals which would add annual volumes of 5 000 to 10 000 tons/year, thus leading to a total of 15 000 - 20 000 tons/year.

For the nitric acid production, the downstream productions of ammonium nitrate, calcium nitrate and nitrocellulose completed at the same time and complemented by direct nitric acid sales would ensure a sufficient rate of production (60% to 70% of nominal capacity), with a total of 24 000 - 28 000 tons/year to be produced at the start-up or for the first two years of production:

- minimum 3 000 tons/year as direct uses
- 12 500 to 16 500 tons/year for feeding a 15 000 - 20 000 tpa production of ammonium nitrate
- 7 500 tons/year for feeding a 10 000 tpa production of calcium nitrate
- 1 000 tons/year for feeding a 1 500 tpa production of nitrocellulose

For memory the **restricted availability of 47 tons/day (or 15 500 tpa) of ammonia** would lead to run the ammonium nitrate plant at 20 000 tpa if the whole capacity of nitric acid plant (40 000 tpa) is utilized. In other words, for running the ammonium nitrate at its full capacity of 26 000 tpa the nitric acid plant would be able to produce up to 35 000 tpa.

2.4. Sizing - Schedule for Setting-Up

Following the market findings and all the above considerations for sizing the units, different steps for building the nitric acid-based incustry would be recommended.

In the short term or after a decision to be taken very soon, an integrated complex should be installed near an ammonia location, like the PUPUK KUJANG plant.

This integrated complex would comprise the following core units:

- a nitric acid plant with a 40 000 tpa or 120 tons/day capacity (100% basis)
- an ammonium nitrate (explosive grade) plant with a 26 000 tpa or 80 tons/day capacity
- a calcium nitrate plant with a 12 000 tpa capacity

In the same location or another location, since the economics can support the transport of nitric acid, a nitrocellulose plant of 2 000 tpa capacity (100% basis) would complete the 1st phase of projects implementation, in view of coating resins (to be completed or not at this stage with an additional production for explosive requirements).

Still in this 1st phase the following should be recalled or mentioned:

- start-up of paraaminophenol production
- confirmation and setting up of the carbofuran project
- decisions and actions for the setting up of productions of
  - rubber chemicals
  - sulpha drugs
- decision for the setting up, or not, of the cyclohexylamine production which should be installed at a 2000 tpa size only in the case of continuing to a large extent the downstream sodium cyclamate production

In the medium term, say 3-4 years from now, at the time or just after the start-up of 1st phase projects, a second phase of development would include:

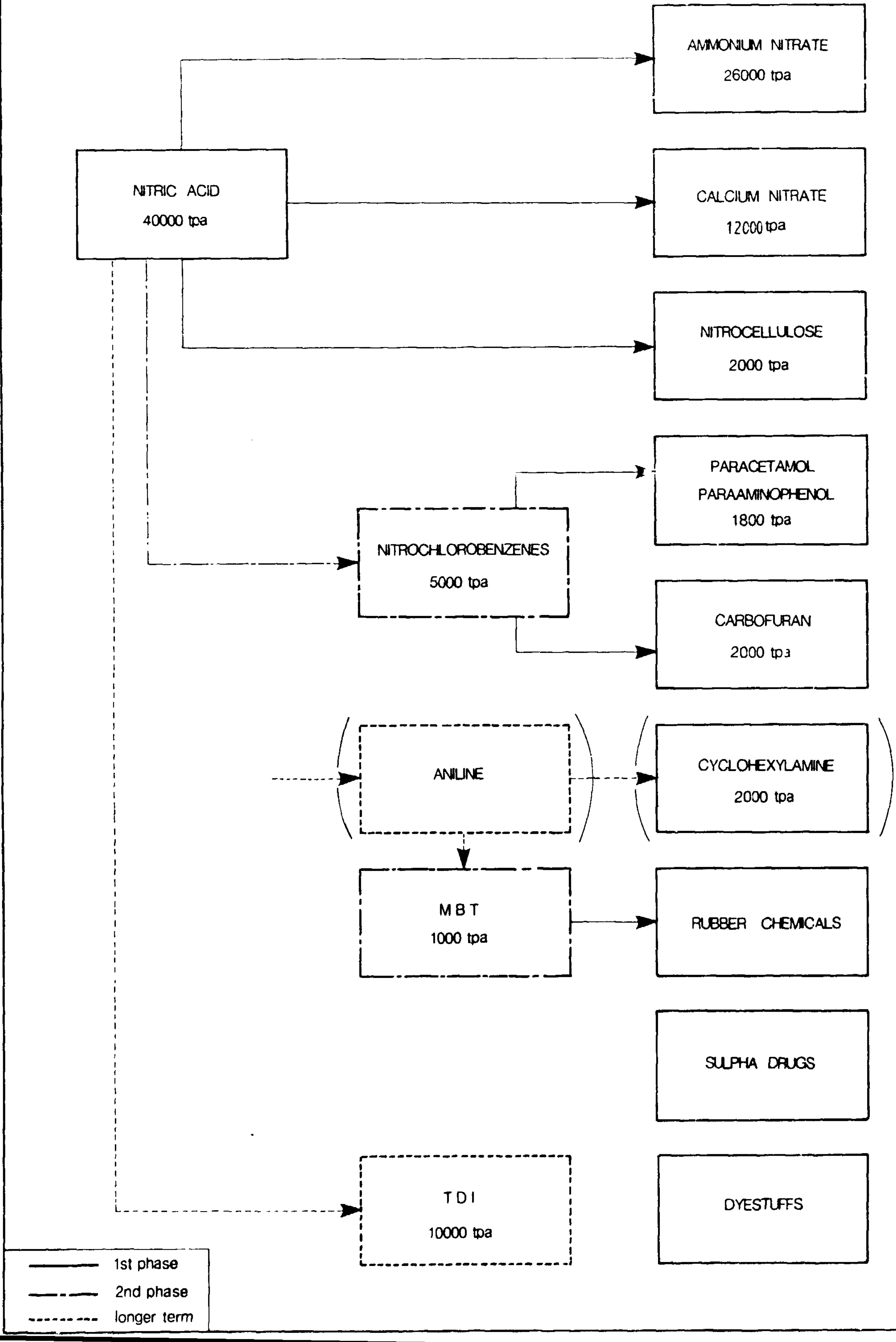
- confirmation, decision and setting-up of the nitrochlorobenzenes capacity at 5 000 tpa, in the case of the carbofuran production having already been set up in addition to the paraaminophenol existing plant at that time
- reevaluation of market and prefeasibility of longer term production projects of
  - TDI, in view of a possible setting up after the mid 90's
  - MBT, this latter presenting more probability obviously in the case of a sufficient size of production of rubber chemicals having already been set up

In the longer term, say after the mid-90's, the time will come for evaluating the new trends of the market and for updating decisions for new plants or for extension of existing plants, such as for instance:

- evaluation of market and prefeasibility of an aniline project
- study of possibilities in raw materials and infrastructure for extending later some units or productions from the 1st phase step

The following scheme (Figure 7) illustrates the two phases of development for the nitric acid-based industry in the near and medium terms.

PHASING FOR NITRIC ACID-BASED INDUSTRY



3. FURTHER STEPS AND ACTIONS

Further actions will have to be undertaken at least at two different horizons or progressively in the course of time, firstly in the short term for decisions to be taken very soon to build up the industry and later in the medium term to strengthen and develop that industry.

3.1. In the Short Term

Four types of concerted actions are identified and would ensure a solid ground for the nitric acid-based industry.

For the planned projects of production of **nitrocellulose for coating resins** and **carbofuran** the final confirmation or green light should be achieved and incentive facilities for their setting up, if needed, should be conceded.

Specific consideration should be given to the opportunity or not of coupling a production of nitrocellulose for explosives in the same nitrocellulose plant.

In the frame of an overall market evaluation and economic analysis of the sugar and sugar substitute industry, a thorough analysis of the future development of sodium cyclamate industry should be performed soon. One of its main objectives will be to conclude on the persistence or not of **cyclohexylamine** requirements which may justify or not setting up a plant in the near future.

Contacts with the few licensing / producing firms in the field should be initiated, if not yet done, and actively pursued up to the conclusion for the setting up of :

rubber chemicals	production
sulpha drugs	production
dyestuffs	production

The PUPUK KUJANG project or a project of similar conception should be soon promoted, starting from ready and cheap availability of ammonia as raw material.

In view of building this integrated complex with a 40 000 tpa **nitric acid** plant, a 26 000 tpa **ammonium nitrate** plant (for explosives) and a 12 000 tpa **calcium nitrate** plant, the following actions should be achieved :

- detailed technical definition and basic design for the scheme of integration with the existing plants and infrastructure
- selection of licences for the three technologies involved on the basis of both technical and commercial offers from licensors
- tender writing and emission in view of selecting contractors (foreign and local) to build the plants and the complex
- financing study and preliminary financing arrangements.

3.2. In the Medium Term

Medium-term actions will be undertaken in the light of recent and expected developments of market and industry for the concerned products and sectors of application.

They will probably occur after the start-up of the first phase of projects described above, and particularly after the beginning of production in the integrated complex.

Market evaluation and feasibility study will be carried out for :

- the early setting up of a **nitrochlorobenzenes** production (both ortho- and para-products), obviously in the case of downstream paraaminophenol and carbofuran productions having started to require nitrochlorobenzenes as raw material with sufficient volumes
- the investigation for a later setting-up of a **MBT** (2-mercaptobenzothiazole) production, obviously in the case of rubber chemicals production requiring sufficient volume of MBT as raw material, and in a longer term of a **TDI** (toluene diisocyanate) production.

Only at a later horizon will the evaluation of future projects like **aniline, intermediates for dyestuffs** be carried out, as well as the updating for extension or debottlenecking of existing productions which have been built during the 1st phase of development.

APPENDIX

EVALUATION OF NITRIC ACID INTEGRATED COMPLEX

Approach and Results

CONTENT

- **Figures illustrating approach and wording for:**

  Financial evaluation statement
  Financial income statement
  Balance sheet

- **Results from the computer model**

  Base case

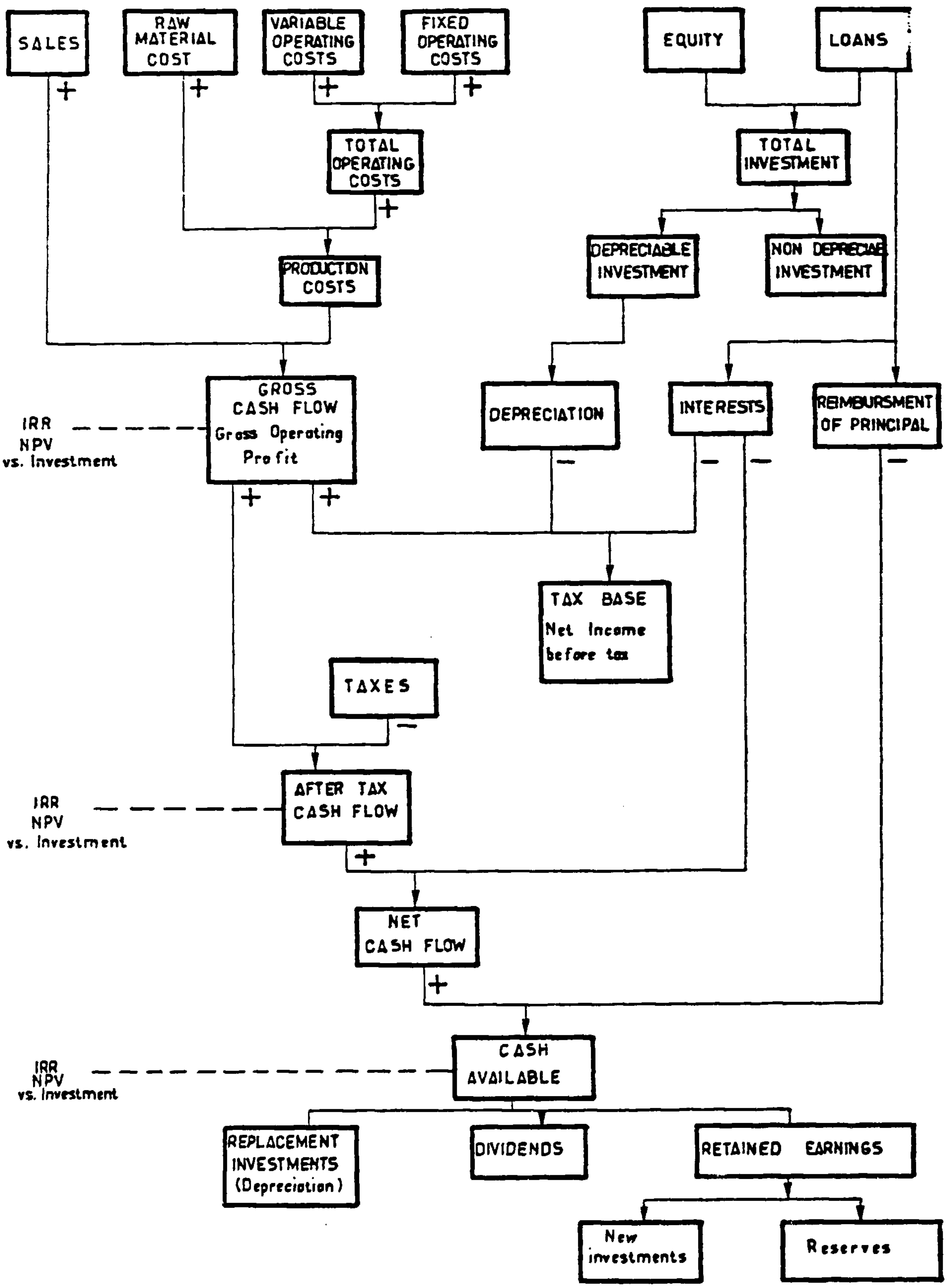
  Schedule of investments
  Working capital requirements
  Summary for the net income statement
  Cash flow series for IRR and NPV calculations
  Profitability results and ratios
  Source and use of cash
  Pro forma balance sheet
  Pro forma income statement

  For each **Alternate case**

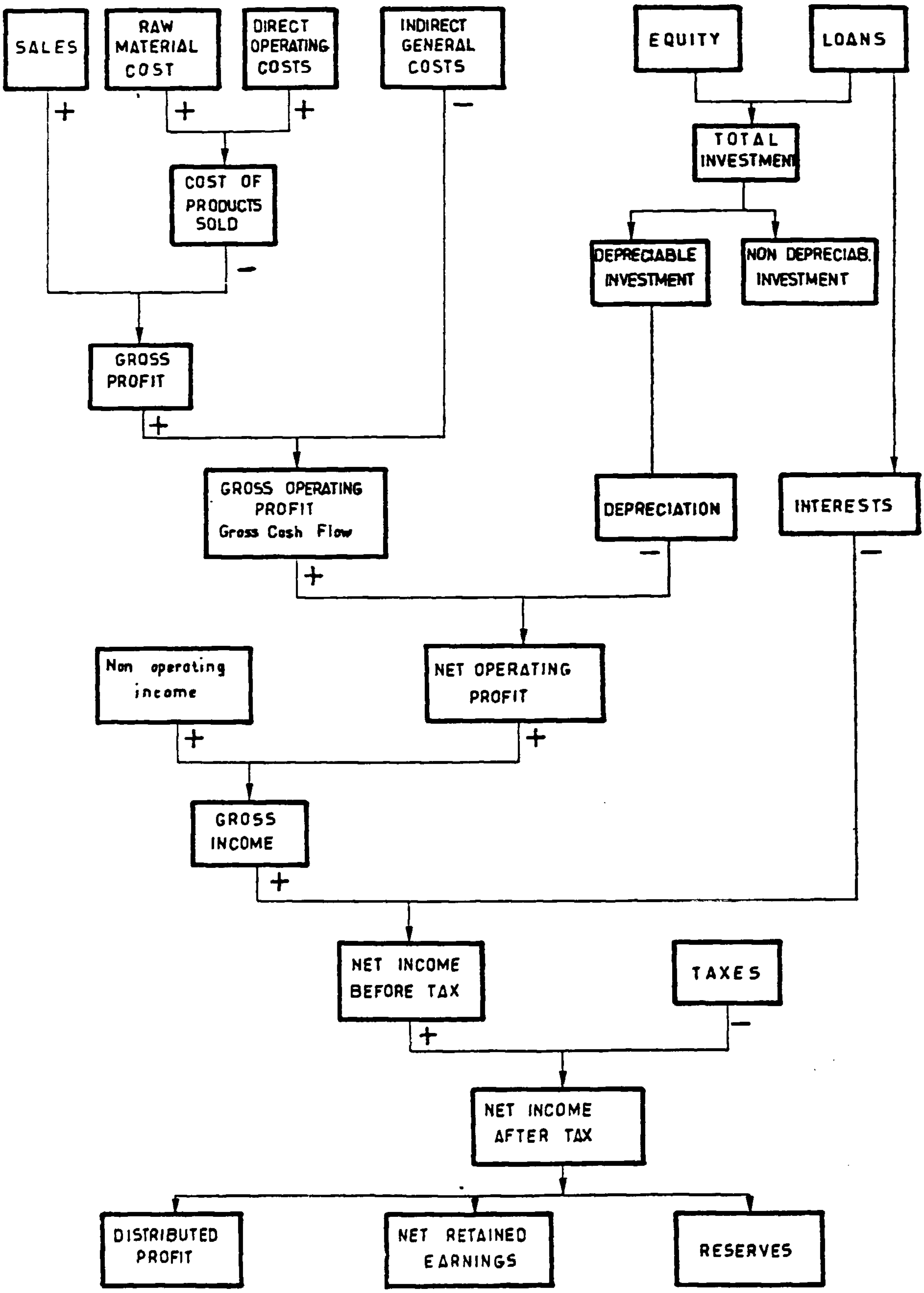
  Summary for the net income statement
  Profitability results and ratios

  for Raw Materials more costly
  Products cheaper
  Lower operating rate
  Lower operating rate and raw materials more costly

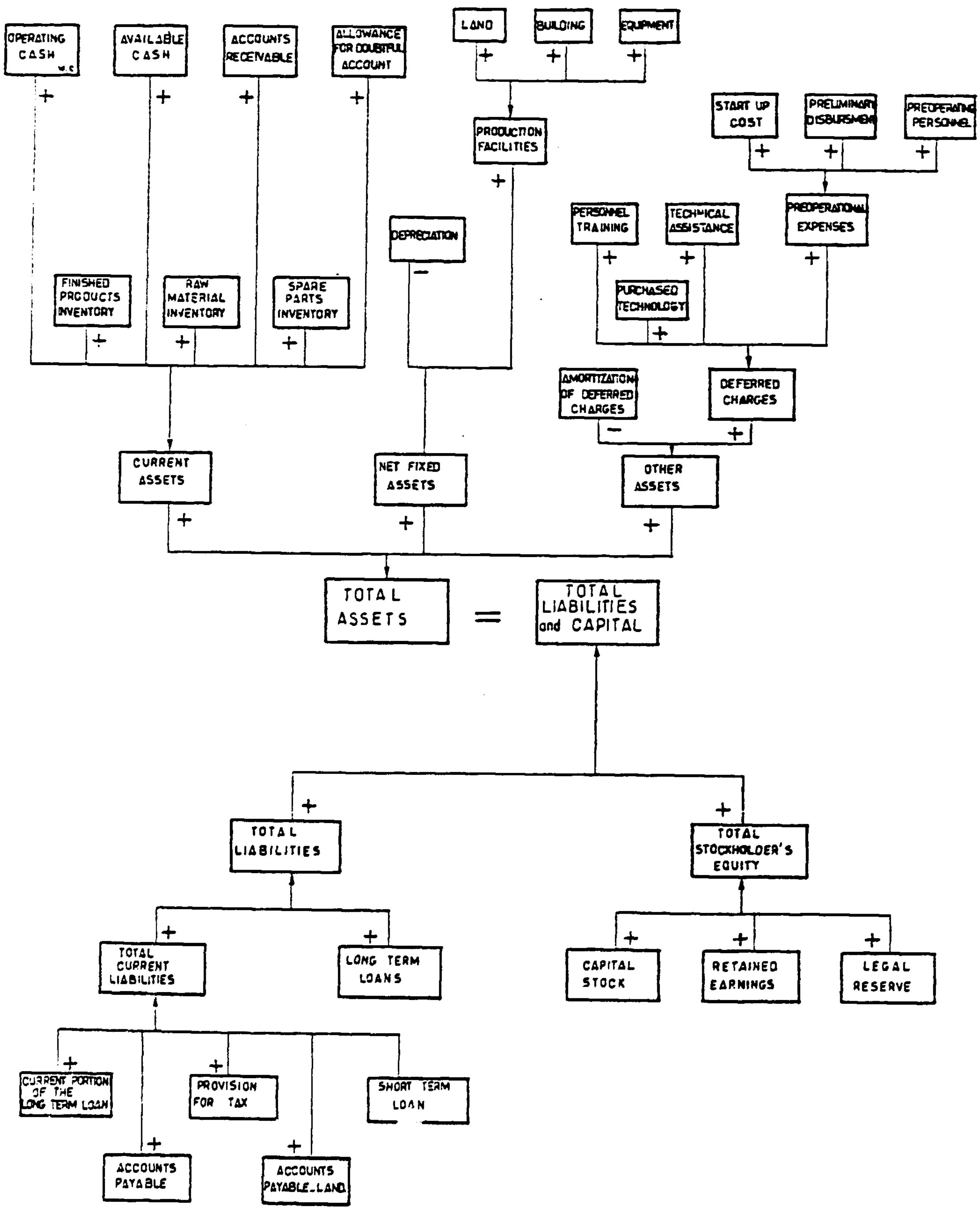
FINANCIAL EVALUATION STATEMENT



FINANCIAL INCOME STATEMENT



BALANCE SHEET



PHASING OF EXPENDITURES AND FINANCING BEFORE 1987

	1988	1989	1990	TOTAL
Process units	3000.0	6750.0	5250.0	15000.0
Off-Sites	1050.0	2360.0	1840.0	5250.0
Preoper. Exp.	0.0	0.0	2610.0	2610.0
	0.0	0.0	0.0	0.0
T O T A L CONSTRUCTION COST BASIC	4050.0	9110.0	9700.0	22860.0
ESCALATED	4050.0	9110.0	9700.0	22860.0
INTEREST DURING CONSTRUCTION	177.6	770.1	1662.3	2609.9
NEED FOR WORKING CAPITAL	0.0	0.0	1042.1	1042.1
T O T A L P R O J E C T COST	4227.6	9880.1	12404.4	26512.0
EQUITY	1268.3	2964.0	3408.7	7641.0
Commercial Credit 1988	2959.3	0.0	0.0	2959.3
Commercial Credit 1989	0.0	6916.1	0.0	6916.1
Commercial Credit 1990	0.0	0.0	7953.6	7953.6
CAPITALIZED INTERESTS	0.0	0.0	0.0	0.0
SHORT TERM LOANS	0.0	0.0	1042.1	1042.1
T O T A L D E B T	2959.3	6916.1	8995.7	18871.0
T O T A L F I N A N C I N G	4227.6	9880.1	12404.4	26512.0
INCL. ANTICIP. FINANCING	0.0	0.0	0.0	0.0
EQUITY / INVEST. R A T I O	0.30	0.30	0.30	0.33

- NITRIC ACID INTEGRATED COMPLEX - Case : BASE

INV:BASE *-* Raws *-* Products * *

W O R K I N G   C A P I T A L   R E Q U I R E M E N T S

MONETARY UNIT = THOUSAND 1987 $

DATE : 31-AUG-87

N.	YEAR	OPERATING CASH	ACCOUNTS RECEIVAB.	FINISHED PRODUCTS INVENTORY	WORK IN PROCESS	RAW MATERIAL INVENTORY	SPARE PARTS INVENTORY	CATALYST CHEMICAL INVENTORY	OPERATING CURRENT ASSETS	ACCOUNTS PAYABLE	NEED FOR WORKING CAPITAL	NEED FOR WOR. CAP INCREASE
-2	1988	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
-1	1989	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0	1990	0.	0.	0.	0.	138.	800.	104.	1042.	0.	1042.	1042.
1	1991	121.	660.	720.	0.	138.	800.	104.	2543.	138.	2405.	1363.
2	1992	128.	803.	810.	0.	155.	800.	104.	2800.	155.	2644.	240.
3	1993	135.	893.	900.	0.	173.	800.	104.	3004.	173.	2831.	187.
4	1994	135.	900.	900.	0.	173.	800.	104.	3011.	173.	2839.	7.
5	1995	135.	900.	900.	0.	173.	800.	104.	3011.	173.	2839.	0.
6	1996	135.	900.	900.	0.	173.	800.	104.	3011.	173.	2839.	0.
7	1997	135.	900.	900.	0.	173.	800.	104.	3011.	173.	2839.	0.
8	1998	135.	900.	900.	0.	173.	800.	104.	3011.	173.	2839.	0.
9	1999	135.	900.	900.	0.	173.	800.	104.	3011.	173.	2839.	0.
10	2000	135.	900.	900.	0.	173.	800.	104.	3011.	173.	2839.	0.
11	2001	135.	900.	900.	0.	173.	800.	104.	3011.	173.	2839.	0.
12	2002	135.	900.	900.	0.	173.	800.	104.	3011.	173.	2839.	0.
13	2003	135.	900.	900.	0.	173.	800.	104.	3011.	173.	2839.	0.
14	2004	135.	900.	900.	0.	173.	800.	104.	3011.	173.	2839.	0.
15	2005	135.	900.	900.	0.	173.	800.	104.	3011.	173.	2839.	0.

NET INCOME STATEMENT (SUMMARY)

MONETARY UNIT = THOUSAND 1987 $

DATE : 31-AUG-87

N.	YEAR	SALES	RAW MATERIAL	OPERATING COST	GROSS OPERATING PROFIT	DEPRECIATION	NET OPERATING PROFIT	INTERESTS	NET INCOME BEF. TAXES	TAXES	NET INCOME AFT. TAXES	CUMULATED NET INCOME
1	1991	7923.	1658.	2429.	4557.	6367.	-1810.	2286.	-4097.	0.	-4097.	-4097.
2	1992	9635.	1866.	2512.	5348.	4776.	572.	2079.	-1507.	0.	-1507.	-5604.
3	1993	10715.	2073.	2594.	6138.	3582.	2556.	1716.	841.	0.	841.	-4764.
4	1994	10805.	2073.	2594.	6138.	2686.	3452.	1271.	2181.	0.	2181.	-2583.
5	1995	10805.	2073.	2594.	6138.	2015.	4123.	966.	3221.	258.	2964.	381.
6	1996	10805.	2073.	2594.	6138.	1511.	4627.	660.	4308.	1508.	2800.	3181.
7	1997	10805.	2073.	2594.	6138.	1133.	5005.	354.	5283.	1849.	3434.	6615.
8	1998	10805.	2073.	2594.	6138.	850.	5288.	125.	6008.	2103.	3905.	10520.
9	1999	10805.	2073.	2594.	6138.	0.	6138.	125.	7100.	2485.	4615.	15135.
10	2000	10805.	2073.	2594.	6138.	0.	6138.	125.	7671.	2685.	4986.	20121.
11	2001	10805.	2073.	2594.	6138.	0.	6138.	125.	8225.	2879.	5346.	25467.
12	2002	10805.	2073.	2594.	6138.	0.	6138.	125.	8823.	3088.	5735.	31202.
13	2003	10805.	2073.	2594.	6138.	0.	6138.	125.	9464.	3313.	6152.	37354.
14	2004	10805.	2073.	2594.	6138.	0.	6138.	125.	10153.	3553.	6599.	43953.
15	2005	10805.	2073.	2594.	6138.	0.	6138.	125.	10891.	3812.	7079.	51032.

NET INCOME BEF. TAXES INCLUDES 'NON OPERATING INCOME' (INTERESTS EARNED ON SECURITIES OR BONDS)
NET INCOME BEFORE TAXES = NET OPER. PROFIT + NON OPER. INC. - INTEREST
BONDS ARE ASSUMED TO PURCHASED AT BEGINNING OF YEAR N IN THE AMOUNT OF X P.CENT OF YEAR N-1'S NIAT
INTERESTS ARE CALCULATED ON LONG TERM AND SHORT TERM LOANS
NET INCOME AFTER TAXES = NET INCOME BEFORE TAXES - TAXES

- NITRIC ACID INTEGRATED COMPLEX - Case : BASE   INV:BASE *-* Raws *-* Products *-*

CASH FLOW SERIES FOR I.R.R AND N.P.V CALCULATIONS

MONETARY UNIT = THOUSAND 1987 $ DATE : 31-AUG-87

N.	YEAR	TOTAL INVEST.	LOANS	EQUITY	INVESTMENT CASH FLOW	GROSS CASH FLOW	TAXES	AFTER TAX CASH FL	TOTAL INTEREST	NET CASH FLOW 1	FINANCIAL INCOME	NET CASH FLOW 2
-2	1988	4050.	2959.	1268.	1268.	0.	0.	0.	0.	0.	0.	0.
-1	1989	9110.	6916.	2964.	2964.	0.	0.	0.	0.	0.	0.	0.
0	1990	9700.	7954.	3409.	3409.	0.	0.	0.	0.	0.	0.	0.
1	1991	0.	0.	0.	3910.	4557.	0.	4557.	2286.	2271.	0.	2271.
2	1992	0.	0.	0.	2787.	5348.	0.	5348.	2079.	3268.	0.	3268.
3	1993	0.	0.	0.	2734.	6138.	0.	6138.	1716.	4422.	0.	4422.
4	1994	0.	0.	0.	2554.	6138.	0.	6138.	1271.	4867.	0.	4867.
5	1995	0.	0.	0.	2547.	6138.	258.	5880.	966.	4915.	64.	4978.
6	1996	0.	0.	0.	2547.	6138.	1508.	4630.	660.	3970.	341.	4311.
7	1997	0.	0.	0.	2547.	6138.	1849.	4289.	354.	3935.	633.	4568.
8	1998	0.	0.	0.	0.	6138.	2103.	4035.	125.	3910.	845.	4755.
9	1999	0.	0.	0.	0.	6138.	2485.	3653.	125.	3528.	1087.	4615.
10	2000	0.	0.	0.	0.	6138.	2585.	3453.	125.	3328.	1658.	4986.
11	2001	0.	0.	0.	0.	6138.	2879.	3259.	125.	3134.	2212.	5346.
12	2002	0.	0.	0.	0.	6138.	3088.	3050.	125.	2925.	2810.	5735.
13	2003	0.	0.	0.	0.	6138.	3313.	2825.	125.	2700.	3451.	6152.
14	2004	0.	0.	0	0.	6138.	3553.	2585.	125.	2460.	4140.	6599.
15	2005	-4575.	0.	0.	-4575.	6138.	3812.	2326.	125.	2201.	4878.	7079.

TOTAL INVEST. INCLUDES INTERIM INTERESTS PAID WITH EQUITY AND WORKING CAPITAL
INVEST. CASH FLOW INCLUDES : EQUITY + PRINCIPAL PAYMENT (LONG AND SHORT TERM LOANS) + WORKING CAPITAL INCREASE
NET CASH FLOW 1 = AFTER TAX CASH FLOW - INTERESTS (TOTAL)
NET CASH FLOW 2 INCLUDES 'NON OPERATING INCOME' (NCF1+NON OPER.INC.)

- NITRIC ACID INTEGRATED COMPLEX - Case ASE   INV:BASE *-* Raws   *-* Products *-*

MONETARY UNIT = THOUSAND 1987 $ DATE : 31-AUG-87

	GROSS CASH FLOW / INVESTMENT		AFTER TAX CASH FLOW / INVESTMENT		CASH AVAILABLE / EQUITY		CASH AVAILABLE (1) / EQUITY	
I R R (CURRENT MONEY) P.CENT	20.5		17.0		16.5		20.5	
I R R (CONSTANT MONEY) P.CENT	20.5		17.0		16.5		20.5	
D I S C O U N T R A T E	0.	15.	0.	15.	0.	15.	0.	15.
NET PRESENT VALUE (*)	71.	9.	44.	3.	29.	1.	51.	5.
CASH FLOW ANNUITY (*)	6.	6.	4.	5.	3.	4.	5.	4.
INVESTMENT ANNUITY (*)	2.	4.	2.	4.	2.	4.	2.	4.
PROFIT ANNUITY (*)	5.	2.	3.	1.	2.	1.	3.	2.
PAY OUT PERIOD	4.1	8.0	4.1	10.3	6.7	13.1	6.3	10.3
NPV PER UNIT OF INVEST.	3.1	0.4	1.9	0.1	1.1	0.1	1.9	0.3
AVERAGE RATE OF RETURN	20.8	8.7	12.8	4.5	7.1	4.3	12.5	7.7

(1) CASH AVAILABLE INCLUDING FINANCIAL INCOME   (*) MONETARY UNIT DIVIDED BY 1000

AVERAGE VALUES	
SALES (internal)	10529.
SALES (export)	0.
RAW MATERIAL	2031.
OPERATING COST	2578.
GROSS CASH FLOW	5980.
DEPRECIATION	1528.
INTEREST	535.
LOAN REIMBURST	1189.
FINANC. INCOME	1475.
NET INC. B. TAX	5238.
TAXES	1835.
AFT. TAX CASH F.	4144.
NET INC. A. TAX	3402.

PROJECT LIFE (Y)	15.
CONSTRUCT. COST	22860.
INTERIM INTEREST	2610.
WK. CAP 1ST CALL	1042.
TOT. INVESTMENT	26512.
WK. CAP AV. NEED	120.
INITIAL EQUITY	7641.
LOANS	18871.
EQUITY/INV PCENT	33.
DIVID/NIAT PCENT	0.
DIVIDENDS (CUM.)	0.
DIVID /INV PCENT	0.
FINAL CASH	11654.
FINAL SECURITIES	47248.
FINAL NETWORTH	63248.

FINANCIAL RATIOS	1992	2000	2005
CURRENT RATIO	1.	18.	41.
INVENTORY TO WORKG CAP.	0.	10.	4.
L.T. DEBT TO NETWORTH	83.	0.	0.
DEBT TO TOTAL ASSETS	123.	4.	2.
TIMES INTEREST EARNED	0.	62.	88.
FIXED ASSETS TO NETWORTH	703.	9.	4.
GROSS OPERATING MARGIN	56.	57.	57.
SALES MARGIN	0.	46.	66.
RETURN ON NET FIXED ASSETS	3.	200.	283.
RETURN ON NETWORTH	0.	18.	11.
INVENTORY TURNOVER	5.	5.	5.
TOTAL ASSETS TURNOVER	1.	0.	0.
SALES TO NETWORTH	5.	0.	0.
SALES TO WORKG CAPITAL	0.	1.	0.

INDONESIA   PRODUCT PRICES (/TON)-

*Nitric Aci 170. *Ammon.Nitr 230. *Calcium Ni 240. *

NITRIC ACID INTEGRATED COMPLEX   Case : BASE   INV:BASE *-* Raws *-* Products *-*

S O U R C E   A N D   U S E   O F   C A S H

MONETARY UNIT = THOUSAND 1987 $ DATE : 31-AUG-87

	1988	1989	1990	1991	1992	1993	1994	1995
I N I T I A L C A S H	0.	0.	0.	0.	121.	128.	666.	2447.
SURPLUS CASH REINVESTED	0.	0.	0.	0.	0.	0.	0.	0.
NET OPERATING PROFIT	0.	0.	0.	-1810.	572.	2556.	3452.	4123.
NON OPERATING INCOME	0.	0.	0.	0.	0.	0.	0.	64.
GROSS INCOME	0.	0.	0.	-1810.	572.	2556.	3452.	4187.
DEPRECIATION	0.	0.	0.	6367.	4776.	3582.	2686.	2015.
ACCOUNTS PAYABLE INCREASE	0.	0.	0.	138.	17.	17.	0.	0.
SALES OF SECURITIES	0.	0.	0.	0.	0.	0.	0.	0.
SHORT TERM LOAN	0.	0.	1042.	1639.	0.	0.	0.	0.
EQUITY INCREASE	1268.	2964.	3409.	0.	0.	0.	0.	0.
LONG TERM LOAN	2959.	6916.	7954.	0.	0.	0.	0.	0.
S O U R C E O F C A S H	4228.	9880.	12404.	6334.	5365.	6155.	6138.	6202.
TAX PAYMENT	0.	0.	0.	0.	0.	0.	0.	258.
INVENTORIES INCREASE	0.	0.	1042.	720.	107.	107.	0.	0.
ACCOUNTS RECEIVABLE INCREASE	0.	0.	0.	660.	143.	90.	7.	0.
FINANCIAL ASSETS INCREASE	0.	0.	0.	0.	0.	0.	531.	2312.
PRINCIPAL REIMBURSMENT								
SHORT TERM	0.	0.	0.	0.	482.	1157.	0.	0.
LONG TERM	0.	0.	0.	2547.	2547.	2547.	2547.	2547.
INTERESTS ON SHORT TERM LOANS	0.	0.	0.	223.	322.	264.	125.	125.
INTERESTS ON LONG TERM LOANS	178.	770.	1662.	2063.	1757.	1452.	1146.	841.
PAID OUT PROFITS(DIVIDENDS)	0.	0.	0.	0.	0.	0.	0.	0.
WORKERS FUND	0.	0.	0.	0.	0.	0.	0.	0.
INVESTMENTS	4050.	9110.	9700.	0.	0.	0.	0.	0.
U S E O F C A S H	4228.	9880.	12404.	6213.	5358.	5617.	4357.	6083.
CASH BALANCE(YEARLY)	0.	0.	0.	121.	7.	538.	1781.	119.
ACTUAL CASH RESERVES	0.	0.	0.	121.	128.	666.	2447.	2566.
MINIMUN CASH REQUIREMENT	0.	0.	0.	121.	128.	135.	135.	135.
C A S H S U R P L U S	0.	0.	0.	0.	0.	531.	2312.	2431.

NITRIC ACID INTEGRATED COMPLEX - Case : BASE   INV:BASE *-* Raws *-* Products * *

S O U R C E   A N D   U S E   O F   C A S H

MONETARY UNIT = THOUSAND 1987 $ DATE : 31-AUG-87

	1996	1997	1998	1999	2000	2001	2002	2003
I N I T I A L C A S H	2566.	1899.	2155.	4890.	4750.	512 .	5481.	5869.
SURPLUS CASH REINVESTED	0.	0.	0.	0.	0.	0.	0.	0.
NET OPERATING PROFIT	4627.	5005.	5288.	6138.	6138.	6138.	6138.	6138.
NON OPERATING INCOME	341.	633.	845.	1087.	1658.	2212.	2810.	3451.
GROSS INCOME	4968.	5638.	6133.	7225.	7796.	8350.	8948.	9589.
DEPRECIATION	1511.	1133.	850.	0.	0.	0.	0.	0.
ACCOUNTS PAYABLE INCREASE	0.	0.	0.	0.	0.	0.	0.	0.
SALES OF SECURITIES	0.	0.	0.	0.	0.	0.	0.	0.
SHORT TERM LOAN	0.	0.	0.	0.	0.	0.	0.	0.
EQUITY INCREASE	0.	0.	0.	0.	0.	0.	0.	0.
LONG TERM LOAN	0.	0.	0.	0.	0.	0.	0.	0.
S O U R C E O F C A S H	6479.	6771.	6983.	7225.	7796.	8350.	8948.	9589.
TAX PAYMENT	1508.	1849.	2103.	2485.	2685.	2879.	3038.	3313.
INVENTORIES INCREASE	0.	0.	0.	0.	0.	0.	0.	0.
ACCOUNTS RECEIVABLE INCREASE	0.	0.	0.	0.	0.	0.	0.	0.
FINANCIAL ASSETS INCREASE	2431.	1764.	2021.	4755.	4615.	4986.	5346.	5735.
PRINCIPAL REIMBURSMENT								
SHORT TERM	0.	0.	0.	0.	0.	0.	0.	0.
LONG TERM	2547.	2547.	0.	0.	0.	0.	0.	0.
INTERESTS ON SHORT TERM LOAN	125.	125.	125.	125.	125.	125.	125.	125.
INTERESTS ON LONG TERM LOANS	535.	229.	0.	0.	0.	0.	0.	0.
PAID OUT PROFITS(DIVIDENDS)	0.	0.	0.	0.	0.	0.	0.	0.
WORKERS FUND	0.	0.	0.	0.	0.	0.	0.	0.
INVESTMENTS	0.	0.	0.	0.	0.	0.	0.	0.
U S E O F C A S H	7146.	6515.	4248.	7365.	7425.	7990.	8559.	9172.
CASH BALANCE(YEARLY)	-667.	256.	2734.	-140.	371.	360.	389.	417.
ACTUAL CASH RESERVES	1899.	2155.	4890.	4750.	5121.	5481.	5869.	6286.
MINIMUM CASH REQUIREMENT	135.	135.	135.	135.	135.	135.	135.	135.
C A S H S U R P L U S	1764.	2021.	4755.	4615.	4986.	5346.	5735.	6152.

- NITRIC ACID INTEGRATED COMPLEX - Case : BASE   INV-BASE   Raws   *-* Products *-*

SOURCE AND USE OF CASH

MONETARY UNIT = THOUSAND 1987 $ DATE : 31-AUG-87

	2004	2005
INITIAL CASH	6286.	6734.
SURPLUS CASH REINVESTED	0.	0.
NET OPERATING PROFIT	6138.	6138.
NON OPERATING INCOME	4140.	4878.
GROSS INCOME	10278.	11016.
DEPRECIATION	0.	0.
ACCOUNTS PAYABLE INCREASE	0.	0.
SALES OF SECURITIES	0.	0.
SHORT TERM LOAN	0.	0.
EQUITY INCREASE	0.	0.
LONG TERM LOAN	0.	0.
SOURCE OF CASH	10278.	11016.
TAX PAYMENT	3553.	3812.
INVENTORIES INCREASE	0.	0.
ACCOUNTS RECEIVABLE INCREASE	0.	0.
FINANCIAL ASSETS INCREASE	6152.	6599.
PRINCIPAL REIMBURSMENT		
SHORT TERM	0.	0.
LONG TERM	0.	0.
INTERESTS ON SHORT TERM LOAN	125.	125.
INTERESTS ON LONG TERM LOANS	0.	0.
PAID OUT PROFITS(DIVIDENDS)	0.	0.
WORKERS FUND	0.	0.
INVESTMENTS	0.	-4575.
USE OF CASH	9830.	5961.
CASH BALANCE(YEARLY)	447.	5055.
ACTUAL CASH RESERVES	6734.	11788.
MINIMUM CASH REQUIREMENT	135.	135.
CASH SURPLUS	6599.	11654.

- NITRIC ACID INTEGRATED COMPLEX - Case : BASE   INV:BASE *-* Raws   *-* Products *-*

P R O F O R M A   B A L A N C E   S H E E T

MONETARY UNIT = THOUSAND 1987 $ DATE : 31-AUG-87

	1988	1989	1990	1991	1992	1993	1994	1995
MARKETABLE SECURITIES	0.	0.	0.	0.	0.	0.	531.	2844.
MINIMUM CASH REQUIREMENT	0.	0.	0.	121.	128.	135.	135.	135.
ACCOUNTS RECEIVABLE	0.	0.	0.	660.	803.	893.	900.	900.
INVENTORIES	0.	0.	1042.	1762.	1870.	1977.	1977.	1977.
C U R R E N T A S S E T S	0.	0.	1042.	2543.	2800.	3004.	3543.	5855.
ACCUMULATED CASH SURPLUS	0.	0.	0.	0.	0.	531.	2312.	2431.
Process units	3000.	9750.	15000.	15000.	15000.	15000.	15000.	15000.
Off-Sites	1050.	3410.	5250.	5250.	5250.	5250.	5250.	5250.
Preoper. Exp.	178.	948.	5220.	5220.	5220.	5220.	5220.	5220.
	0.	0.	0.	0.	0.	0.	0.	0.
TOTAL F I X E D A S S E T S	4228.	14108.	25470.	25470.	25470.	25470.	25470.	25470.
ACCUMULATED DEPRECIATION	0.	0.	0.	6367.	11143.	14725.	17411.	19426.
NET F I X E D A S S E T S	4228.	14108.	25470.	19102.	14327.	10745.	8059.	6044.
T O T A L A S S E T S	4228.	14108.	26512.	21645.	17127.	14280.	13914.	14330.
ACCOUNTS PAYABLE	0.	0.	0.	138.	155.	173.	173.	173.
CUR. PORTION(LT.LOAN)	0.	0.	2547.	2547.	2547.	2547.	2547.	2547.
SHORT TERM LOAN	0.	0.	1042.	2681.	2199.	1042.	1042.	1042.
TOTAL CURRENT LIABILITIES	0.	0.	3589.	5366.	4902.	3762.	3762.	3762.
LONG TERM LOANS	2959.	9875.	15282.	12735.	10188.	7641.	5094.	2547.
TOTAL L I A B I L I T I E S	2959.	9875.	18871.	18101.	15090.	11403.	8856.	6309.
EQUITY	1268.	4232.	7641.	7641.	7641.	7641.	7641.	7641.
RETAINED EARNINGS	0.	0.	0.	-4097.	-5604.	-4764.	-2583.	381.
(DIVIDENDS)	0.	0.	0.	0.	0.	0.	0.	0.
RESERVE (LEGAL OR EXC.)	0.	0.	0.	0.	0.	0.	0.	0.
TOTAL STOCKHOLDER'S EQUITY	1268.	4232.	7641.	3544.	2037.	2877.	5058.	8022.
TOTAL LIABILITY AND CAPITAL	4228.	14108.	26512.	21645.	17127.	14280.	13914.	14330.

NITRIC ACID INTEGRATED COMPLEX - Case : BASE   INV:BASE *-* Raws   *-* Products *-*

P R O F O R M A   B A L A N C E   S H E E T

MONETARY UNIT = THOUSAND 1987 $ DATE : 3[illegible]-AUG 87

	1996	1997	1998	1999	2000	2001	2002	2003
MARKETABLE SECURITIES	5275.	7039.	9060.	13815.	18430.	23410.	28752.	34497.
MINIMUM CASH REQUIREMENT	135.	135.	135.	135.	135.	135.	135.	135.
ACCOUNTS RECEIVABLE	900.	900.	900.	900.	900.	900.	900.	900.
INVENTORIES	1977.	1977.	1977.	1977.	1977.	1977.	1977.	1977.
C U R R E N T A S S E T S	8286.	10051.	12071.	16826.	21441.	26427.	31773.	37508.
ACCUMULATED CASH SURPLUS	1764.	2021.	4755.	4615.	4986.	5346.	5735.	6152.
Process units	15000.	15000.	15000.	15000.	15000.	15000.	15000.	15000.
Off-Sites	5250.	5250.	5250.	5250.	5250.	5250.	5250.	5250.
Preoper. Exp.	5220.	5220.	5220.	5220.	5220.	5220.	5220.	5220.
	0.	0.	0.	0.	0.	0.	0.	0.
TOTAL F I X E D A S S E T S	25470.	25470.	25470.	25470.	25470.	25470.	25470.	25470.
ACCUMULATED DEPRECIATION	20937.	22070.	22920.	22920.	22920.	22920.	22920.	22920.
NET F I X E D A S S E T S	4533.	3400.	2550.	2550.	2550.	2550.	2550.	2550.
T O T A L A S S E T S	14584.	15471.	19376.	23991.	28977.	34323.	40058.	46210.
ACCOUNTS PAYABLE	173.	173.	173.	173.	173.	173.	173.	173.
CUR. PORTION(LT.LOAN)	2547.	0.	0.	0.	0.	0.	0.	0.
SHORT TERM LOAN	1042.	1042.	1042.	1042.	1042.	1042.	1042.	1042.
TOTAL CURRENT LIABILITIES	3762.	1215.	1215.	1215.	1215.	1215.	1215.	1215.
LONG TERM LOANS	0.	0.	0.	0.	0.	0.	0.	0.
TOTAL L I A B I L I T I E S	3762.	1215.	1215.	1215.	1215.	1215.	1215.	1215.
EQUITY	7641.	7641.	7641.	7641.	7641.	7641.	7641.	7641.
RETAINED EARNINGS	3181.	6615.	10520.	15135.	20121.	25467.	31202.	37354.
(DIVIDENDS)	0.	0.	0.	0.	0.	0.	0.	0.
RESERVE (LEGAL OR EXC.)	0.	0.	0.	0.	0.	0.	0.	0.
TOTAL STOCKHOLDER'S EQUITY	10822.	14256.	18161.	22776.	27762.	33108.	38843.	44995.
TOTAL LIABILITY AND CAPITAL	14584.	15471.	19376.	23991.	28977.	34323.	40058.	46210.

NITRIC ACID INTEGRATED COMPLEX -- Case : BASE   INV:BASE *-* Raws   *-* Products *-*

P R O F O R M A   B A L A N C E   S H E E T

MONETARY UNIT = THOUSAND 1987 $ DATE : 31-AUG-87

	2004	2005
MARKETABLE SECURITIES	40648.	47248.
MINIMUM CASH REQUIREMENT	135.	135.
ACCOUNTS RECEIVABLE	900.	900.
INVENTORIES	1977.	1977.
C U R R E N T A S S E T S	43660.	50259.
ACCUMULATED CASH SURPLUS	6599.	11654.
Process units	15000.	15000.
Off Sites	5250.	5250.
Preoper. Exp.	5220.	5220.
	0.	0.
TOTAL F I X E D A S S E T S	25470.	25470.
ACCUMULATED DEPRECIATION	22920.	22920.
NET F I X E D A S S E T S	2550.	2550.
T O T A L A S S E T S	52809.	64463.
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ACCOUNTS PAYABLE	173.	173.
CUR. PORTION(LT.LOAN)	0.	0.
SHORT TERM LOAN	1042.	1042.
TOTAL CURRENT LIABILITIES	1215.	1215.
LONG TERM LOANS	0.	0.
TOTAL L I A B I L I T I E S	1215.	1215.
EQUITY	7641.	12216.
RETAINED EARNINGS	43953.	51032.
(DIVIDENDS)	0.	0.
RESERVE (LEGAL OR EXC.)	0.	0.
TOTAL STOCKHOLDER'S EQUITY	51594.	63248.
TOTAL LIABILITY AND CAPITAL	52809.	64463.
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NITRIC ACID INTEGRATED COMPLEX - Case : BASE   INV CASE *-* Raws *-* Products *-*

P R O F O R M A   I N C O M E   S T A T E M E N T

MONETARY UNIT = THOUSAND 1987 $ DATE : 31-AUG-87

	1991	1992	1993	1994	1995	1996	1997	1998
INDONESIA	7923.	9635.	10715.	10805.	10805.	10805.	10805.	10805.
T O T A L S A L E S	7923.	9635.	10715.	10805.	10805.	10805.	10805.	10805.
PRODUCTS INVENTORY INCREASE	720.	90.	90.	0.	0.	0.	0.	0.
R A W M A T E R I A L S	1658.	1866.	2073.	2073.	2073.	2073.	2073.	2073.
Manpower	263.	263	263.	263.	263.	263.	263.	263.
Maintenance	764.	764.	764.	764.	764.	764.	764.	764.
Insurance	96.	96.	96.	96.	96.	96.	96.	96.
Gen. Overheads	645.	645.	645.	645.	645.	645.	645.	645.
FIXED OPERATING COSTS	1767.	1767.	1767.	1767.	1767.	1767.	1767.	1767.
Catalysts & & Chems	166.	187.	208.	208.	208.	208.	208.	208.
Utilities	283.	318.	354.	354.	354.	354.	354.	354.
Packaging	213.	239.	266.	266.	266.	266.	266.	266.
VARIABLE OPERATING COSTS	662.	745.	828.	828.	828.	828.	828.	828.
TOTAL OPERATING COSTS	2429.	2512.	2594.	2594.	2594.	2594.	2594.	2594.
P R O D U C T I O N C O S T	4087.	4377.	4667.	4667.	4667.	4667.	4667.	4667.
G R O S S C A S H F L O W	4557.	5348.	6138.	6138.	6138.	6138.	6138.	6138.
D E P R E C I A T I O N	6367	4776.	3582.	2686.	2015.	1511.	1133.	850.
N E T O P E R. P R O F I T	-1810.	572.	2556.	3452.	4123.	4627.	5005.	5288.
NON OPERATING INCOME	0.	0.	0.	0.	64.	341.	633.	845.
G R O S S I N C O M E	1810.	572.	2556.	3452.	4187.	4968.	5638.	6133.
SHORT TERM INTEREST	223.	322.	264.	125.	125.	125.	125.	125.
LONG TERM INTEREST (CURRENT)	.2063.	1757.	1452.	1146.	841.	535.	229.	0.
LONG TERM INTEREST PAID	2063.	1757.	1452.	1146.	841.	535.	229.	0.
NET INCOME BEFORE TAX	-4097.	-1507.	841.	2181.	3221.	4308.	5283.	6008.
WORKERS FUND	0.	0.	0.	0.	0.	0.	0.	0.
T A X B A S E	-3999.	-1507.	0.	0.	737.	4308.	5283.	6008.
T A X E S (PAID)	0.	0.	0.	0.	258.	1508.	1849.	2103.
NET INCOME AFTER TAX	4097.	-1507.	841.	2181.	2964.	2800.	3434.	3905.
(DIVIDENDS)	0.	0.	0.	0.	0.	0.	0.	0.
RESERVE (LEGAL OR EXC.)	0.	0.	0.	0.	0.	0.	0.	0.
RETAINED EARNINGS (CUMUL.)	-4097.	-5604.	-4764.	-2583.	381.	3181.	6615.	10520.

NITRIC ACID INTEGRATED COMPLEX   Case : BASE   INV:BASE *-* Raws *-* Products *-*

P R O F O R M A   I N C O M E   S T A T E M E N T

MONETARY UNIT = THOUSAND 1987 $ DATE : 31-AUG-87

	1999	2000	2001	2002	2003	2004	2005
INDONESIA	10805.	10805.	10805.	10805.	10805.	10805.	10805.
T O T A L S A L E S	10805.	10805.	10805.	10805.	10805.	10805.	10805.
PRODUCTS INVENTORY INCREASE	0.	0.	0.	0.	0.	0.	0.
R A W M A T E R I A L S	2073.	2073.	2073.	2073.	2073.	2073.	2073.
Manpower	263.	263.	263.	263.	263.	263.	263.
Maintenance	764.	764.	764.	764.	764.	764.	764.
Insurance	96.	96.	96.	96.	96.	96.	96.
Gen. Overheads	645.	645.	645.	645.	645.	645.	645.
FIXED OPERATING COSTS	1767.	1767.	1767.	1767.	1767.	1767.	1767.
Catalysts & & Chems	208.	208.	208.	208.	208.	208.	208.
Utilities	354.	354.	354.	354.	354.	354.	354.
Packaging	266.	266.	266.	266.	266.	266.	266.
VARIABLE OPERATING COSTS	828.	828.	828.	828.	828.	828.	828.
TOTAL OPERATING COSTS	2594.	2594.	2594.	2594.	2594.	2594.	2594.
P R O D U C T I O N C O S T	4667.	4667.	4667.	4667.	4667.	4667.	4667.
G R O S S C A S H F L O W	6138.	6138.	6138.	6138.	6138.	6138.	6138.
D E P R E C I A T I O N	0.	0.	0.	0.	0.	0.	0.
N E T O P E R. P R O F I T	6138.	6138.	6138.	6138.	6138.	6138.	6138.
NON OPERATING INCOME	1087.	1658.	2212.	2810.	3451.	4140.	4878.
G R O S S I N C O M E	7225.	7796.	8350.	8948.	9589.	10278.	11016.
SHORT TERM INTEREST	125.	125.	125.	125.	125.	125.	125.
LONG TERM INTEREST (CURRENT)	0.	0.	0.	0.	0.	0.	0.
LONG TERM INTEREST PAID	0.	0.	0.	0.	0.	0.	0.
NET INCOME BEFORE TAX	7100.	7671.	8225.	8823.	9464.	10153.	10891.
WORKERS FUND	0.	0.	0.	0.	0.	0.	0.
T A X B A S E	7100.	7671.	8225.	8823.	9464.	10153.	10891.
T A X E S (PAID)	2485.	2685.	2879.	3088.	3313.	3553.	3812.
NET INCOME AFTER TAX	4615.	4986.	5346.	5735.	6152	6599.	7079.
(DIVIDENDS)	0.	0.	0.	0.	0.	0.	0.
RESERVE (LEGAL OR EXC.)	0.	0.	0.	0.	0.	0.	0.
RETAINED EARNINGS (CUMUL.)	15135.	20121.	25467.	31202.	37354.	43953.	51032.

- NITRIC ACID INTEGRATED COMPLEX - Case : RAW MAT. HIGH   INV:BASE *-* Raws   *-* Products *-*

NET INCOME STATEMENT (SUMMARY)

MONETARY UNIT = THOUSAND 1987 $ DATE : 31-AUG-87

N.	YEAR	SALES	RAW MATERIAL	OPERATING COST	GROSS OPERATING PROFIT	DEPRECIATION	NET OPERATING PROFIT	INTERESTS	NET INCOME BEF. TAXES	TAXES	NET INCOME AFT. TAXES	CUMULATED NET INCOME
1	1991	7923.	2530.	2429.	3684.	6367.	-2683.	2347.	-5030.	0.	-5030.	-5030.
2	1992	9635.	2848.	2512.	4366.	4776.	-410.	2230.	-2640.	0.	-2640.	-7670.
3	1993	10715.	3163.	2594.	5047.	3582.	1465.	1964.	-498.	0.	-498.	-8168.
4	1994	10805.	3163.	2594.	5047.	2686.	2361.	1616.	745.	0.	745.	-7423.
5	1995	10805.	3163.	2594.	5047.	2015.	3032.	1205.	1827.	0.	1827.	-5596.
6	1996	10805.	3163.	2594.	5047.	1511.	3536.	744.	2792.	0.	2792.	-2804.
7	1997	10805.	3163.	2594.	5047.	1133.	3914.	363.	3551.	328.	3223.	420.
8	1998	10805.	3163.	2594.	5047.	850.	4197.	134.	4199.	1470.	2729.	3149.
9	1999	10805.	3163.	2594.	5047.	0.	5047.	134.	5266.	1843.	3423.	6572.
10	2000	10805.	3163.	2594.	5047.	0.	5047.	134.	5695.	1993.	3702.	10273.
11	2001	10805.	3163.	2594.	5047.	0.	5047.	134.	6106.	2137.	3969.	14242.
12	2002	10805.	3163.	2594.	5047.	0.	5047.	134.	6550.	2293.	4258.	18500.
13	2003	10805.	3163.	2594.	5047.	0.	5047.	134.	7027.	2459.	4567.	23067.
14	2001	10805.	3163.	2594.	5047.	0.	5047.	134.	7538.	2638.	4899.	27967.
15	2005	10805.	3163.	2594.	5047.	0.	5047.	134.	8086.	2830.	5256.	33222.

NET INCOME BEF. TAXES INCLUDES 'NON OPERATING INCOME' (INTERESTS EARNED ON SECURITIES OR BONDS)
NET INCOME BEFORE TAXES = NET OPER. PROFIT + NON OPER. INC. - INTEREST
BONDS ARE ASSUMED TO PURCHASED AT BEGINNING OF YEAR N IN THE AMOUNT OF X P.CENT OF YEAR N-1'S NIAT
INTERESTS ARE CALCULATED ON LONG TERM AND SHORT TERM LOANS
NET INCOME AFTER TAXES = NET INCOME BEFORE TAXES - TAXES

NITRIC ACID INTEGRATED COMPLEX - Case : RAW MAT. HIGH   INV:BASE *-* Raws   *-* Products *-*

MONETARY UNIT = THOUSAND 1987 $ DATE : 31-AUG-87

	GROSS CASH FLOW / INVESTMENT		AFTER TAX CASH FLOW / INVESTMENT		CASH AVAILABLE / EQUITY		CASH AVAILABLE (1) / EQUITY	
I R R (CURRENT MONEY) P.CENT	16.8		14.4		11.3		13.9	
I R R (CONSTANT MONEY) P.CENT	16.8		14.4		11.3		13.9	
D I S C O U N T R A T E	0.	15.	0.	15.	0.	15.	0.	15.
NET PRESENT VALUE (*)	55.	3.	37.	0.	22.	0.	34.	0.
CASH FLOW ANNUITY (*)	5.	5.	4.	4.	3.	3.	4.	3.
INVESTMENT ANNUITY (*)	2.	4.	2.	4.	2.	4.	2.	4.
PROFIT ANNUITY (*)	4.	1.	2.	1.	1.	0.	2.	1.
PAY OUT PERIOD	4.9	11.9	4.9	****	8.4	****	8.3	****
NPV PER UNIT OF INVEST.	2.4	0.1	1.6	0.0	0.8	0.0	1.2	0.0
AVERAGE RATE OF RETURN	16.2	4.6	10.9	2.2	5.3	0.8	8.2	2.5

(1) CASH AVAILABLE INCLUDING FINANCIAL INCOME   (*) MONETARY UNIT DIVIDED BY 1000

AVERAGE VALUES	
SALES (internal)	10529.
SALES (export)	0.
RAW MATERIAL	3100.
OPERATING COST	2578.
GROSS CASH FLOW	4911.
DEPRECIATION	1528.
INTEREST	535.
LOAN REIMBURST	1189.
FINANC. INCOME	801.
NET INC. B. TAX	3414.
TAXES	1199.
AFT. TAX CASH F.	3712.
NET INC. A. TAX	2215.

PROJECT LIFE (Y)	15.
CONSTRUCT. COST	22860.
INTERIM INTEREST	2610.
WK. CAP 1ST CALL	1115.
TOT. INVESTMENT	26585.
WK. CAP AV. NEED	115.
INITIAL EQUITY	7641.
LOANS	18944.
EQUITY/INV PCENT	33.
DIVID/NIAT PCENT	0.
DIVIDENDS (CUM.)	0.
DIVID /INV PCENT	0.
FINAL CASH	9830.
FINAL SECURITIES	31334.
FINAL NETWORTH	45438.

FINANCIAL RATIOS	1992	2000	2005
CURRENT RATIO	0.	9.	25.
INVENTORY TO WORKG CAP.	0.	18.	6.
L.T. DEBT TO NETWORTH	100.	0.	0.
DEBT TO TOTAL ASSETS	170.	8.	3.
TIMES INTEREST EARNED	0.	44.	61.
FIXED ASSETS TO NETWORTH	0.	14.	6.
GROSS OPERATING MARGIN	45.	47.	47.
SALES MARGIN	0.	34.	49.
RETURN ON NET FIXED ASSETS	0.	150.	211.
RETURN ON NETWORTH	****	21.	12.
INVENTORY TURNOVER	5.	5.	5.
TOTAL ASSETS TURNOVER	1.	1.	0.
SALES TO NETWORTH	0.	1.	0.
SALES TO WORKG CAPITAL	0.	1.	0.

-INDONESIA   PRODUCT PRICES (/TON)
*Nitric Aci 170. *Ammon.Nitr 230. *Calcium Ni 240. *

- NITRIC ACID INTEGRATED COMPLEX - Case : PRODUCTS LOW   INV:BASE *-* Raws *-* Products *-*

NET INCOME STATEMENT (SUMMARY)

MONETARY UNIT = THOUSAND 1987 $

DATE : 31-AUG-87

N.	YEAR	SALES	RAW MATERIAL	OPERATING COST	GROSS OPERATING PROFIT	DEPRE- CIATION	NET OPERATING PROFIT	INTERESTS	NET INCOME BEF. TAXES	TAXES	NET INCOME AFT. TAXES	CUMULATED NET INCOME
1	1991	7198.	1658.	2429.	3766.	6367.	-2601.	2329.	-4930.	0.	-4930.	-4930.
2	1992	8753.	1866.	2512.	4458.	4776.	-318.	2194.	-2512.	0.	-2512.	-7443.
3	1993	9734.	2073.	2594.	5149.	3582.	1567.	1919.	-351.	0.	-351.	-7794.
4	1994	9816.	2073.	2594.	5149.	2686.	2463.	1551.	912.	0.	912.	-6882.
5	1995	9816.	2073.	2594.	5149.	2015.	3134.	1120.	2014.	0.	2014.	-4868.
6	1996	9816.	2073.	2594.	5149.	1511.	3638.	660.	2978.	0.	2978.	-1890.
7	1997	9816.	2073.	2594.	5149.	1133.	4016.	354.	3685.	688.	2997.	1107.
8	1998	9816.	2073.	2594.	5149.	850.	4299.	125.	4430.	1551.	2880.	3986.
9	1999	9816.	2073.	2594.	5149.	0.	5149.	125.	5470.	1915.	3556.	7542.
10	2000	9816.	2073.	2594.	5149.	0.	5149	125.	59'8.	2071.	3846.	11388.
11	2001	9816.	2073.	2594.	5149.	0.	5149.	125.	6344.	2221.	4124.	15512.
12	2002	9816.	2073.	2594.	5149.	0.	5149.	125.	6806.	2382.	4424.	19936.
13	2003	9816.	2073.	2594.	5149.	0.	5149.	125.	7301.	2555.	4745.	24682.
14	2004	9816.	2073.	2594.	5149.	0.	5149.	125.	7832.	2741.	5091.	29772.
15	2005	9816.	2073.	2594.	5149.	0.	5149.	125.	8401.	2940.	5461.	35233.

NET INCOME BEF. TAXES INCLUDES 'NON OPERATING INCOME' (INTERESTS EARNED ON SECURITIES OR BONDS)
NET INCOME BEFORE TAXES = NET OPER. PROFIT + NON OPER. INC. - INTEREST
BONDS ARE ASSUMED TO PURCHASED AT BEGINNING OF YEAR N IN THE AMOUNT OF X P.CENT OF YEAR N-1'S NIAT
INTERESTS ARE CALCULATED ON LONG TERM AND SHORT TERM LOANS
NET INCOME AFTER TAXES = NET INCOME BEFORE TAXES - TAXES

NITRIC ACID INTEGRATED COMPLEX - Case : PRODUCTS LOW   INV:BASE *-* Raws   *-* Products * *

MONETARY UNIT = THOUSAND 1987 $ DATE : 31-AUG-87

	GROSS CASH FLOW / INVESTMENT		AFTER TAX CASH FLOW / INVESTMENT		CASH AVAILABLE / EQUITY		CASH AVAILABLE (1) / EQUITY	
I R R (CURRENT MONEY) P.CENT	17.2		14.6		12.0		14.8	
I R R (CONSTANT MONEY) P.CENT	17.2		14.6		12.0		14.8	
D I S C O U N T R A T E	0.	15.	0.	15.	0.	15.	0.	15.
NET PRESENT VALUE (*)	57.	3.	38.	0.	22.	0.	36.	0.
CASH FLOW ANNUITY (*)	5.	5.	4.	4.	3.	3.	4.	3.
INVESTMENT ANNUITY (*)	2.	4.	2.	4.	2.	3.	2.	3.
PROFIT ANNUITY (*)	4.	1.	3.	1.	1.	0.	2.	1.
PAY OUT PERIOD	4.8	11.3	4.8	****	8.2	****	8.1	****
NPV PER UNIT OF INVEST.	2.5	0.1	1.7	0.0	0.8	0.0	1.3	0.0
AVERAGE RATE OF RETURN	16.6	5.0	11.0	2.4	5.5	1.3	8.8	3.2

(1) CASH AVAILABLE INCLUDING FINANCIAL INCOME   (*) MONETARY UNIT DIVIDED BY 1000

AVERAGE VALUES	
SALES (internal)	9565.
SALES (export)	0.
RAW MATERIAL	2031.
OPERATING COST	2578.
GROSS CASH FLOW	5011.
DEPRECIATION	1528.
INTEREST	535.
LOAN REIMBURST	1189.
FINANC. INCOME	879.
NET INC. B. TAX	3620.
TAXES	1271.
AFT. TAX CASH F.	3740.
NET INC. A TAX	2349.

PROJECT LIFE (Y)	15.
CONSTRUCT. COST	22860.
INTERIM INTEREST	2610.
WK. CAP 1ST CALL	1042.
TOT. INVESTMENT	26512.
WK. CAP AV. NEED	109.
INITIAL EQUITY	7641.
LOANS	18871.
EQUITY/INV PCENT	33.
DIVID/NIAT PCENT	0.
DIVIDENDS (CUM.)	0.
DIVID /INV PCENT	0.
FINAL CASH	10036.
FINAL SECURITIES	33231.
FINAL NETWORTH	47449.

FINANCIAL RATIOS	1992	2000	2005
CURRENT RATIO	0.	11.	30.
INVENTORY TO WORKG CAP.	0.	15.	5.
L. T. DEBT TO NETWORTH	98.	0.	0.
DEBT TO TOTAL ASSETS	162.	6.	3.
TIMES INTEREST EARNED	0.	48.	68.
FIXED ASSETS TO NETWORTH	****	13.	5.
GROSS OPERATING MARGIN	51.	52.	52.
SALES MARGIN	0.	39.	56.
RETURN ON NET FIXED ASSETS	0.	156.	219.
RETURN ON NETWORTH	0.	20.	12.
INVENTORY TURNOVER	5.	5.	5.
TOTAL ASSETS TURNOVER	1.	0.	0.
SALES TO NETWORTH	44.	1.	0.
SALES TO WORKG CAPITAL	0.	1.	0.

-INDONESIA   PRODUCT PRICES (/TON)-
*Nitric Aci 150. *Ammon.Nitr 210. *Calcium Ni 220. *

- NITRIC ACID INTEGRATED COMPLEX - Case : OPER. RATE LOW   INV:BASE *-* Raws *-* Products *-*

NET INCOME STATEMENT (SUMMARY)

MONETARY UNIT = THOUSAND 1987 $ DATE : 31-AUG-87

N.	YEAR	SALES	RAW MATERIAL	OPERATING COST	GROSS OPERATING PROFIT	DEPRE-CIATION	NET OPERATING PROFIT	INTERESTS	NET INCOME BEF.TAXES	TAXES	NET INCOME AFT.TAXES	CUMULATED NET INCOME
1	1991	5942.	1243.	2263.	2976.	6367.	-3391.	2362.	-5754.	0.	-5754.	-5754.
2	1992	7474.	1451.	2346.	3767.	4776.	-1009.	2314.	-3323.	0.	-3323.	-9077.
3	1993	8554.	1658.	2429.	4557.	3582.	975.	2104.	-1129.	0.	-1129.	-10206.
4	1994	9635.	1866.	2512.	5348.	2686.	2661.	1816.	846.	0.	846.	-9360.
5	1995	10220.	1969.	2553.	5743.	2015.	3729.	1414.	2314.	0.	2314.	-7046.
6	1996	10265.	1969.	2553.	5743.	1511.	4232.	906.	3326.	0.	3326.	-3720.
7	1997	10265.	1969.	2553.	5743.	1133.	4610.	350.	4260.	285.	3975.	255.
8	1998	10265.	1969.	2553.	5743.	850.	4893.	121.	4796.	1679.	3118.	3373.
9	1999	10265.	1969.	2553.	5743.	0.	5743.	121.	5954.	2084.	3870.	7242.
10	2000	10265.	1969.	2553.	5743.	0.	5743.	121.	6430.	2250.	4179.	11422.
11	2001	10265.	1969.	2553.	5743.	0.	5743.	121.	6894.	2413.	4481.	15903.
12	2002	10265.	1969.	2553.	5743.	0.	5743.	121.	7396.	2588.	4807.	20710.
13	2003	10265.	1969.	2553.	5743.	0.	5743.	121.	7933.	2777.	5157.	25866.
14	2004	10265.	1969.	2553.	5743.	0.	5743.	121.	8510.	2979.	5532.	31398.
15	2005	10265.	1969.	2553.	5743.	0.	5743.	121.	9129.	3195.	5934.	37332.

NET INCOME BEF. TAXES INCLUDES 'NON OPERATING INCOME' (INTERESTS EARNED ON SECURITIES OR BONDS)
NET INCOME BEFORE TAXES = NET OPER. PROFIT + NON OPER. INC. - INTEREST
BONDS ARE ASSUMED TO PURCHASED AT BEGINNING OF YEAR N IN THE AMOUNT OF X P.CENT OF YEAR N-1'S NIAT
INTERESTS ARE CALCULATED ON LONG TERM AND SHORT TERM LOANS
NET INCOME AFTER TAXES = NET INCOME BEFORE TAXES - TAXES

- NITRIC ACID INTEGRATED COMPLEX - Case : OPER. RATE LOW   INV:BASE *-* Raws *-* Products *-*

MONETARY UNIT = THOUSAND 1987 $ DATE : 31-AUG-87

	GROSS CASH FLOW / INVESTMENT		AFTER TAX CASH FLOW / INVESTMENT		CASH AVAILABLE / EQUITY		CASH AVAILABLE (1) / EQUITY	
I R R (CURRENT MONEY) P.CENT	17.2		14.8		11.7		14.2	
I R R (CONSTANT MONEY) P.CENT	17.2		14.8		11.7		14.2	
D I S C O U N T R A T E	0.	15.	0.	15.	0.	15.	0.	15.
NET PRESENT VALUE (*)	62.	4.	41.	0.	25.	0.	38.	0.
CASH FLOW ANNUITY (*)	5.	5.	4	4.	3.	3.	4.	3.
INVESTMENT ANNUITY (*)	2.	4.	2.	4.	2.	3.	2.	3.
PROFIT ANNUITY (*)	4.	1.	3.	1.	2.	0.	3.	1.
PAY OUT PERIOD	5.1	11.4	5.1	****	8.3	****	8.2	****
NPV PER UNIT OF INVEST.	2.7	0.1	1.8	0.0	0.9	0.0	1.4	0.0
AVERAGE RATE OF RETURN	17.9	5.2	12.0	2.4	6.1	0.9	9.2	2.7

(1) CASH AVAILABLE INCLUDING FINANCIAL INCOME   (*) MONETARY UNIT DIVIDED BY 1000

AVERAGE VALUES	
SALES (internal)	9632.
SALES (export)	0.
RAW MATERIAL	1858.
OPERATING COST	2509.
GROSS CASH FLOW	5322.
DEPRECIATION	1528.
INTEREST	535.
LOAN REIMBURST	1189.
FINANC. INCOME	861.
NET INC. B. TAX	3839.
TAXES	1350.
AFT. TAX CASH F.	3972.
NET INC. A. TAX	2489.

PROJECT LIFE (Y)	15.
CONSTRUCT. COST	22860.
INTERIM INTEREST	2610.
WK. CAP 1ST CALL	1008.
TOT. INVESTMENT	26477.
WK. CAP AV. NEED	116.
INITIAL EQUITY	7641.
LOANS	18836.
EQUITY/INV PCENT	33.
DIVIDENIAT PCENT	0.
DIVIDENDS (CUM.)	0.
DIVID /INV PCENT	0.
FINAL CASH	10509.
FINAL SECURITIES	34751.
FINAL NETWORTH	49548.

FINANCIAL RATIOS	1992	2000	2005
CURRENT RATIO	0.	12.	32.
INVENTORY TO WORKG CAP.	0.	16.	5.
L.T. DEBT TO NETWORTH	116.	0.	0.
DEBT TO TOTAL ASSETS	207.	6.	2.
TIMES INTEREST EARNED	0.	54.	77.
FIXED ASSETS TO NETWORTH	0.	13.	5.
GROSS OPERATING MARGIN	50.	56.	56.
SALES MARGIN	0.	41.	58.
RETURN ON NET FIXED ASSETS	0.	169.	237.
RETURN ON NETWORTH	231.	22.	12.
INVENTORY TURNOVER	5.	5.	5.
TOTAL ASSETS TURNOVER	0.	1.	0.
SALES TO NETWORTH	0.	1.	0.
SALES TO WORKG CAPITAL	0.	1.	0.

-INDONESIA   PRODUCT PRICES ($/TON)-

*Nitric Aci 170. *Ammon.Nitr 230. *Calcium Ni 240. *

- NITRIC ACID INTEGRATED COMPLEX - Case : OPER. RATE LOW/ RAW HIGH   INV:BASE *-* Raws   *-* Products *-*

NET INCOME STATEMENT   (SUMMARY)

MONETARY UNIT = THOUSAND 1987 $

DATE : 31-AUG-87

N.	YEAR	SALES	RAW MATERIAL	OPERATING COST	GROSS OPERATING PROFIT	DEPRE-CIATION	NET OPERATING PROFIT	INTERESTS	NET INCOME BEF.TAXES	TAXES	NET INCOME AFT.TAXES	CUMULATED NET INCOME
1	1991	5942.	1897.	2263.	2322.	6367.	-4046.	2408.	-6453.	0.	-6453.	-6453.
2	1992	7474.	2215.	2346.	3003.	4776.	-1773.	2452.	-4225.	0.	-4225.	-10678.
3	1993	8554.	2530.	2429.	3684.	3582.	103.	2365.	-2262.	0.	-2262.	-12940.
4	1994	9635.	2848.	2512.	4366.	2686.	1679.	2176.	-497.	0.	-497.	-13437.
5	1995	10220.	3005.	2553.	4707.	2015.	2693.	1903.	789.	0.	789.	-12648.
6	1996	10265.	3005.	2553.	4707.	1511.	3196.	1579.	1618.	0.	1618.	-11030.
7	1997	10265.	3005.	2553.	4707.	1133.	3574.	1204.	2370.	0.	2370.	-8660.
8	1998	10265.	3005.	2553.	4707.	850.	3857.	860.	2998.	0.	2998.	-5662.
9	1999	10265.	3005.	2553.	4707.	0.	4707.	398.	4309.	0.	4309.	-1352.
10	2000	10265.	3005.	2553.	4707.	0.	4707.	127.	4580.	1293.	3287.	1934.
11	2001	10265.	300[illegible]	2553.	4707.	0.	4707.	127.	4827.	1689.	3[illegible]37.	5071.
12	2002	10265.	3005.	255[illegible]	4707.	0.	4707.	127.	5221.	1827.	3394.	8465.
13	2003	10265.	3005.	2553.	4707.	0.	4707.	127.	5597.	1959.	3638.	12103.
14	2004	10265.	3005.	2553.	4707.	0.	4707.	127.	6005.	2102.	3903.	16006.
15	2005	10265.	3005.	2553.	4707.	0.	4707.	127.	6441.	2254.	4187.	20193.

NET INCOME BEF. TAXES INCLUDES 'NON OPERATING INCOME' (INTERESTS EARNED ON SECURITIES OR BONDS)
NET INCOME BEFORE TAXES = NET OPER. PROFIT + NON OPER. INC. - INTEREST
BONDS ARE ASSUMED TO PURCHASED AT BEGINNING OF YEAR N IN THE AMOUNT OF X P.CENT OF YEAR N-1'S NIAT
INTERESTS ARE CALCULATED ON LONG TERM AND SHORT TERM LOANS
NET INCOME AFTER TAXES = NET INCOME BEFORE TAXES - TAXES

- NITRIC ACID INTEGRATED COMPLEX - Case : OPER. RATE LOW/ RAW HIGH   INV:BASE *-* Raws *-* Products *-*

MONETARY UNIT = THOUSAND 1987 $ DATE : 31-AUG-87

	GROSS CASH FLOW / INVESTMENT		AFTER TAX CASH FLOW / INVESTMENT		CASH AVAILABLE / EQUITY		CASH AVAILABLE (1) / EQUITY	
I R R (CURRENT MONEY) P.CENT	13.9		12.5		6.7		8.0	
I R R (CONSTANT MONEY) P.CENT	13.9		12.5		6.7		8.0	
D I S C O U N T R A T E	0.	15.	0.	15.	0.	15.	0.	15
NET PRESENT VALUE (*)	47.	0.	36.	0.	15.	0.	21.	0.
CASH FLOW ANNUITY (*)	4.	4.	4.	4.	3.	2.	3.	2.
INVESTMENT ANNUITY (*)	2.	4.	2.	4.	2.	3.	2.	3.
PROFIT ANNUITY (*)	3.	0.	2.	0.	1.	0.	1.	0.
PAY OUT PERIOD	6.0	****	6.0	****	10.8	****	10.7	****
NPV PER UNIT OF INVEST.	2.1	0.0	1.6	0.0	0.6	0.0	0.8	0.0
AVERAGE RATE OF RETURN	13.7	1.6	10.4	0.3	5.8	0.0	5.0	0.0

(1) CASH AVAILABLE INCLUDING FINANCIAL INCOME   (*) MONETARY UNIT DIVIDED BY 1000

AVERAGE VALUES	
SALES (internal)	9632.
SALES (export)	0.
RAW MATERIAL	2836.
OPERATING COST	2509.
GROSS CASH FLOW	4344.
DEPRECIATION	1528.
INTEREST	535.
LOAN REIMBURST	1189.
FINANC. INCOME	346.
NET INC. B. TAX	2088.
TAXES	742.
AFT. TAX CASH F.	3602.
NET INC. A. TAX	1346.

PROJECT LIFE (Y)	15.
CONSTRUCT COST	22860.
INTERIM INTEREST	2610.
WK. CAP 1ST CALL	1062.
TOT. INVESTMENT	26532.
WK. CAP AV. NEED	112.
INITIAL EQUITY	7641.
LOANS	18891.
EQUITY/INV PCENT	33.
DIVID/NIAT PCENT	0.
DIVIDENDS (CUM.)	0.
DIVID /INV PCENT	0.
FINAL CASH	6762.
FINAL SECURITIES	19414.
FINAL NETWORTH	32409.

FINANCIAL RATIOS	1992	2000	2005
CURRENT RATIO	0.	4.	17.
INVENTORY TO WORKG CAP.	0.	54.	10.
L.T. DEBT TO NETWORTH	142.	0.	0.
DEBT TO TOTAL ASSETS	277.	14.	4.
TIMES INTEREST EARNED	0.	37.	52.
FIXED ASSETS TO NETWORTH	0.	27.	8.
GROSS OPERATING MARGIN	40.	46.	46.
SALES MARGIN	0.	32.	41.
RETURN ON NET FIXED ASSETS	0.	134.	169.
RETURN ON NETWORTH	139.	34.	13.
INVENTORY TURNOVER	4.	5.	5.
TOTAL ASSETS TURNOVER	0.	1.	0.
SALES TO NETWORTH	0.	1.	0.
SALES TO WORKG CAPITAL	0.	3.	0.

INDONESIA   PRODUCT PRICES (/TON)-
*Nitric Aci 170. *Ammon.Nitr 230. *Calcium Ni 240. *