VI.3 Basic Product-mix

What can be said from the results derived from the last para. is that this project is poor in profitability, when only bulk intermediate fertilizer products are produced, so that it must be concluded to ship such finished fertilizer products in bag as desired by the each ASEAN countries.

It is evident that manufacturing only NPK/NP makes more benefits, but it seems too much in volume from market point of view. So the basis of product-mix is manufacturing ammonium sulfate and NPK/NP mainly.

As for ammonium sulfate production, its shortage in ASEAN market is fairly large, and possibly allows more production than what is projected in the case study. But there are two uncertain questions in ammonium sulfate, as given below. It is, therefore, deemed that its production capacity should not be so big, and around 100 - 150 thous. tons/y is an appropriate size to produce.

i) Today, most of ammonium sulfate is manufactured by using waste ammonium and/ or waste sulfuric acid, and very few from virgin raw materials. Under such circumstances there exists some possibility of rapid price fall, depending upon the market situation. It is, therefore, recommended that its production ratio should not be so big, not to suffer so much when such case has happened.

ii) Though ammonium sulfate has a unique feature (SO_4 gives good effects on crop growth), it is also true that its price is higher than urea per unit weight of nitrogen. Till now, the tendency of being replaced with urea is not so much noticeable, but its consumption may probably decrease, when price gap between these two becomes larger.

In the previous para., it is concluded that it is more profitable if this project has no phosphoric acid concentrating plant, and no phosphoric acid is shipped. Therefore, Case 10, having no shipment of phosphoric acid, is recommended as the basic case.

On the contrary, a plant to manufacture TSP with imported phosphoric acid has been completed in Indonesia and is about to start its operation. From this, possibility assumedly exists that Indonesia may desire to buy phosphoric acid from this project. But, as there is a plan in Indonesia to produce phosphoric acid, the cases to ship phosphoric acid from this project are excluded.

Henceforth, detail study in this report will be carried out only for one case, Case 10, which excludes production of intermediate fertilizer products having characteristics of international bulky commodity, such as DAP, TSP and phosphoric acid, while include ammonium sulfate as well as NPK/NP fertilizers all in bag.

Further, note should be taken that all the assumptions used in this Chapter for the computation of internal rate of return are not always used in the subsequent study hereafter.

CHAPTER VII

DESCRIPTIONS AND COMPARISON OF MANUFACTURING PROCESSES

VII. DESCRIPTIONS AND COMPARISON OF MANUFACTURING PROCESSES

VII.1 Phosphoric Acid

1. Phosphoric Acid Manufacturing Processes

Phosphoric acid is basically produced by putting ground phosphate rock into the mixture of sulfuric acid and partially recycled phosphoric acid, decomposing the rock into phosphoric acid and calcium sulfate (dihydrate of this is gypsum), and separating phosphoric acid product and gypsum through filtration. The chemical reaction equation is quite complicated to write down, but can be simplified as follows:

$Ca_{10}F_2(PO_4)_6$	+ $10H_2SO_4$	+ $\overset{n}{0.1}$ H_2O →	$10[CaSO_4 \cdot nH_2O]$	+ $2HF$	+ $6H_3PO_4$
Phosphate rock	Sulfuric acid		Calcium sulfate	Hydrogen fluoride	Phosphoric acid

"n" is either 2 or 0.5 in the above equation. And, "HF" is recovered as H_2SiF_6 which is formed with "Si" existing in phosphate rock.

In normal manufacturing process of phosphoric acid, product is obtained as liquid of 30%-P_2O_5 concentration. In case that more concentrated phosphoric acid liquid is required, depending upon the subsequent use, it is concentrated generally to 54%-P_2O_5 liquid by means of vacuum concentration.

2. Kinds of Processes

There are many kinds of processes for phosphoric acid manufacturing, but afore-mentioned basic principle are same for all. Depending upon reaction condition, "n" in the above equation takes 0.5 or 2, i.e. calcium sulfate hemi-hydrate or calcium sulfate dihydrate, respectively. The amount of phosphoric acid remaining in by-product gypsum may vary with difference of the crystal form of calcium sulfate.

Generally speaking, calcium sulfate dihydrate is stable at around 70°C of decompositional reaction temperature, while calcium sulfate hemi-hydrate at around 80°C - 100°C.

The processes are classified as follows, depending upon the calcium sulfate form with which the decomposition reaction is taken place:

Dihydrate process:	Prayon process, Rhone-Poulenc process, Dorr-Oliver process, Nissan Chemical D-process, and others
Hemi-dihydrate process:	Nissan Chemical H-process, Mitsubishi Chemical Industries process, and Nippon Kokan process
Di-hemihydrate process:	Central-Prayon process
Hemihydrate process:	Fisons HH process, and Occidental process
Modified hemi-dihydrate process:	Fisons HDH process and Nissan Chemical C-process

Features of these processes are described hereunder.

3. Descriptions of Process Characteristics

i) Dihydrate process:

Decomposition of phosphate rock with sulfuric acid and partially recycled phosphoric acid is taken place under temperature of 70 – 80°C, stable range for dihydrate. Resultant slurry is filtrated and approx. 30% phosphoric acid and gypsum are obtained. Owing to a gentle and consistent condition, the process is quite simple, and this principle is adopted by a majority of phosphoric acid process in the world.

Because of its simpleness, plant construction cost required is relatively low, but recovery rate of P_2O_5 from phosphate rock is as low as 90 - 95%, and P_2O_5 contained in by-product gypsum is rather high. This causes some problems in respect of utilization or disposal of by-product gypsum.

Therefore, absolute advantage of dihydrate process can no longer be committed, depending upon conditions.

As introduced above, there are many well known processes in which this principle is applied. Difference among these processes mainly exists in engineering matters, such as structure of digester (multi-tank type, comparted square tank type, comparted round tank type, etc.), filter type (belt filter, tilting pan-filter, etc.), cooling method, and others. They all have both merits and demerits, and it is difficult to say which process is best.

As reference, recent performance list of dihydrate process is given in Annex VII-1. The list may contain some error, because complete information is not available.

ii) Hemi-dihydrate process:

This is a process primarily developed in Japan. Phosphate rock is first decomposed with phosphoric acid and sulfuric acid under temperature of 90°C – 100°C, stable range for calcium sulfate hemihydrate, resultant slurry is then reacted under a condition of 50°C – 65°C in temperature and hemihydrate recrystalizes into calcium sulfate dihydrate.

This process is more complicated than the dihydrate process, and requires a little higher construction cost, while recovery rate of P_2O_5 from rock is as high as 97.5 – 98.5%, and accordingly less P_2O_5 is contained in by-product gypsum making it possible to utilize by-product gypsum for gypsum board manufacturing. Namely, this is a process better suitable for such conditions as no domestic sources of phosphate rock is available, imported rock is expensive, and utilization of by-product gypsum is desired from lack of natural gypsum.

About 30 plants have been constructed all over the world with Nissan Chemical H-process, among which maximum production capacity is 600 T-P_2O_5/D.

Actual applications of both Nippon Kokan process and Mitsubishi Chemical Industries process are limited only within Japan, each having just a few and small plants.

Annex VII-2 shows the performance list of hemi-dihydrate process.

iii) Di-hemihydrate process:

Phosphate rock is decomposed with sulfuric acid under the condition of 70°C – 80°C in temperature, where dihydrate is kept stable, and resultant slurry is simply separated into gypsum and product phosphoric acid of about 30% concentration by means of a centrifuge or others. Gypsum is again treated with sulfuric acid at higher temperature where hemihydrate is more stable. Resultant calcium sulfate hemihydrate is filtered out, and liquid is recycled for phosphate rock decomposition.

P_2O_5 recovery is as high as 97 - 98%. The biggest feature of this process is that calcium sulfate is obtainable in the form of α-type hemihydrate (in case of immediate drying), which is quite beneficial in case that all of by-product gypsum is utilized like in Japan. If all of gypsum is not utilized, difficulties arise in disposal of by-product gypsum in piling it up on an open area, as it promptly hardens.

Some plants using Central Prayon process are in Japan, and several in other countries in the world.

iv) Hemihydrate process:

Phosphate rock is first decomposed with sulphuric acid and phosphoric acid under the condition of hemihydrate stable range, and resultant crystalized hemihydrate is filtered as it is, obtaining product phosphoric acid. Crystals of calcium sulfate hemihydrate are hard to be filtered, and requires larger filtration area than that for dihydrate process.

It is one of features of this process that higher concentration phosphoric acid of 40 - 50% is obtainable, while phosphoric acid recovery rate is as small as 90 - 94%, and by-product gypsum is also inadequate for utilization.

As for actual performances, Fisons Co. has licensed one plant and Occidental Chemical Co. owns one plant by himself.

v) Modified hemi-dihydrate process:

This is the newest process improved the low recovery of P_2O_5 and difficulty in utilization of by-product gypsum in hemihydrate process. The process is exactly same with hemihydrate process up to where phosphate rock is decomposed with sulfuric acid and phosphoric acid under hemihydrate stable condition and crystalized hemihydrate is filtered as it is, resulting in high concentration product phosphoric acid of 40 - 50%. From this step on, calcium sulfate hemihydrate separated from the slurry is again treated with acid under temperature condition of 50 - 60°C to recrystalizing it to dihydrate and again filtered to obtain better quality by-product gypsum and high P_2O_5 recovery rate.

This process requires two filters, which gives higher construction cost than those for other processes. However; if a concentrating plant is not required, its total construction cost may become lower than that for hemi-dihydrate process, and additionally, a higher P_2O_5 recovery rate of 97.5 - 98.5% and very good quality of by-product gypsum would come to the result.

A plant of 160 T-P_2O_5/D adopting Fisons HDH-process is now being operated in Yugoslavia, and in addition, it is reported that two of such plants are now under construction in some other countries.

100 T-P_2O_5/D and 40 T-P_2O_5/D capacity plants of Nissan Chemical C-process are now running in Japan.

Please refer to Annex VII-3 for the performance data.

4. Comparison of Processes

Characteristics of each process have been described in the previous para., which are summarized in the following Table VII-1.

Table VII-1 reveals that the process having less construction cost invested obtains lower P_2O_5 recovery rate (higher phosphate rock consumption rate). Therefore, let's briefly study here to see whether, in the Philippines, the process with less construction cost and higher phosphate rock consumption is better or vice versa, taking dihydrate process and hemi-dihydrate process as example.

First, supposing that the estimated construction cost required for dihydrate process is 85% of that for hemi-dihydrate process, and that the construction cost of a 250 T-P_2O_5/D capacity hemi-dihydrate plant is estimated to be about 13.5 million US dollars for the battery limit of only phosphoric acid manufacturing plant, the difference of construction cost between these two processes would be:

$$13.5 \text{ Mil. US\$} \times (1 - 0.85) = 2.03 \text{ Mil. US\$}$$

The difference in the fixed cost per annum, subject to 12 years depreciation of this construction cost and 4% of interest rate, would be:

$$2.03 \text{ Mil. US\$} \div 12 + 2.03 \text{ Mil. US\$} \times 0.04 = 0.25 \text{ Mil. US\$/year}$$

The hemi-dihydrate process requires 0.25 Mil. US$/year more than the dihydrate process as fixed cost.

Table VII-1. Comparison of Phosphoric Acid Process

Principle	Process Name	P_2O_5 Recovery	Product Concentration	Gypsum Quality	Investment Index
Dihydrate process	Prayon, Rhone-Poulenc Don-Oliver, Nissan D	90 - 95%	30% P_2O_5	medium	85
Hemi-dihydrate process	Nissan H., Mitsubishi Chemical Nippon Kokan	97.5 - 98.5%	30%	good	100
Di-hemihydrate process	Central-Prayon	97 - 98%	30%	good	105
Hemihydrate process	Fisons HH, Occidental	90 - 94%	40 - 50%	bad	90
Modified hemi-dihydrate process	Fisons HDH, Nissan C	97.5 - 98.5%	40 - 50%	good	120

1) Investment cost comparison is only for dilute phosphoric acid manufacturing plant and concentrating plant is not included.

2) High P_2O_5 recovery rate in hemi-dihydrate process will compensate high investment cost.

3) High product concentration in modified hemi-dihydrate process will compensate high investment when concentrated acid is necessary.

On the other hand, phosphate rock consumption is required more in dihydrate process by 5% in general.

Supposing that P_2O_5 recovery rate is 98% and P_2O_5 concentration in phosphate rock is 33%, phosphate rock consumption in dihydrate process would be 3.092 T/T-P_2O_5. Subject to such phosphate rock price in the Philippines of 44 US$/T and operation for 330 days per annum at 250 T/Y, the difference in the variable cost per annum would be:

$$250\ T/D \times 330\ D/Y \times 3.092\ T/T\text{-}P_2O_5 \times 0.05 \times 44\ US\$/T$$
$$= 0.56\ Mil.\ US\$/Y$$

The dihydrate process requires 0.56 Mil. US$/Y more in terms of variable cost than the hemi-dihydrate process.

With these two results computed above, the hemi-dihydrate process is better lucrative than the other, even though its construction cost requires more.

From these results, dihydrate process may be favorable for the countries where phosphate rock is produced and its price is about half of that in importing countries. But in the phosphate rock importing countries such as Japan or the Philippines, hemi-dihydrate process with high P_2O_5 recovery rate is favorable even if it requires more in construction cost. Furthermore, it is another important point that by-product gypsum has better quality suitable for utilization of disposal.

Next, a comparison between modified hemi-dihydrate process, with which high concentration phosphoric acid is obtainable, and conventional hemi-dihydrate process is made below.

Regarding these two, P_2O_5 recovery rate is almost same, but an estimated construction cost is approx. 17.7 Mil. US$ for the modified process and 15.3 Mil. US$ for the conventional process, subject to construction of a phosphoric acid manufacturing plant with 250 T-P_2O_5/D capacity and a concentrating plant with 90 T-P_2O_5/D capacity. (Note that construction cost for the conventional one is cheaper up to the step of obtaining 45% or 30% concentration phosphoric acid while construction cost for the modified one can be saved because concentrating plant is smaller owing to the higher concentration of dilute phosphoric acid.) If this variance is converted into difference in terms of fixed cost per annum likely as done before, subject to 12 years depreciation and 4% of interest rate, the result would be:

$$(17.7 - 15.3) \text{ Mil. US\$} \div 12 + (17.7 - 15.3) \text{ Mil. US\$} \times 0.04$$
$$= 0.30 \text{ Mil. US\$/Y}$$

The conventional one requires less construction cost than the other by the amount resulted as above.

On the contrary, an estimated volume of steam required for concentration from 30% to 54% is about 2.4 T/T-P_2O_5, and from 45% to 54% is about 1.0 T/T-P_2O_5.

In case of Case 9 under the product-mix case study, concentrated phosphoric acid of 30,000 T-P_2O_5/Y is planned to be shipped, so that, subject to the steam cost of 15 US$/T, a variance in terms of variable cost per annum would be:

$$(2.4 - 1.0) \text{ T/T-}P_2O_5 \times 30{,}000 \text{ T/Y} \times 15 \text{ US\$/T} = 0.62 \text{ Mil. US\$/Y}$$

The modified one requires less variable cost than the other by the amount resulted as above.

In summary, therefore, even if concentrating only about one-third of initially produced phosphoric acid, the modified one is much more beneficial than the conventional one. Consequently, the adoption of modified hemi-dihydrate process, with which phosphoric acid of higher concentration is obtainable, is more lucrative in Case 9.

However, in the case that phosphoric acid is to be used for the purpose of manufacturing ammonium sulfate phosphate complex fertilizers such as 14-14-14, or 16-20-0, phosphoric acid of 30% concentration will be enough and 54% or 45% is not required. From these, Case 10, as previously mentioned, requires no phosphoric acid concentration process, resulting in no requirement of concentrating plant construction, i.e. conventional hemi-dihydrate process will sufficiently help, saving about 3 million US dollars in plant construction cost. The study will, from now on, use the conventional hemi-dihydrate process in Case 10, as it is much more advantageous.

Further for readers' reference, the influence of process difference upon the computed internal rate of return for both Case 9 and Case 10 on some assumptions are as follows:

	Internal Rate of Return (%)	
	Hemi-dihydrate process	Dihydrate process
Case 9	10.69 *	10.57
Case 10	14.37	14.29

* Modified hemi-dihydrate process.

You will see that I.R.R. is a little less with dihydrate process, but their variances are very small. This means that, whatever process of phosphoric acid manufacturing is selected, the influence upon the final conclusion of this study is rather small.

VII.2 Granuled Fertilizers

Since Case 10 is determined to be taken up in this study, product-mix mainly consists of various grades of ammonium sulfate phosphate NP/NPK fertilizers, but none of DAP and TSP.

In such a case, as a fertilizer granulation process, so called slurry granulation process is most suitable. This process consists of following steps: Sulfuric acid and phosphoric acid are reacted with ammonia; obtained high concentration liquid is sprayed over recycled fertilizer granular in a rotary drum; granulars are dried out in a rotary dryer; they are screened and some part of them are taken out as product.

Various grades of fertilizers are produced with one plant under switch operations by changing flow rate of raw materials and recycle rate.

All of major engineering firms have their own process developed by themselves for slurry-granulation process plant, but no substantial differences among them are seemingly recognized.

As mentioned in the previous para., in case of manufacturing fertilizers of ammonium sulfate phosphate fertilizer, such a feature exists that phosphoric acid of 30% concentration can straightly be used without further concentrating of phosphoric acid, owing to high heat of reaction incurred between sulfuric acid and ammonia, and this is not true with the case of producing DAP/TSP.

Please refer to Fig. X-5, Flow Chart, in Chapter X.

VII.3 Ammonium Sulfate

Ammonium sulfate manufacturing process is a process to blow ammonia gas into sulfuric acid and to grow the crystal size of ammonium sulfate, by taking holding time under appropriate turbulent flow.

With the purpose of making large crystal size, various measures are applied to the structure of crystalizer, but there are not so much differences among those processes.

It is advised to accept the process recommended by an engineering firm who will become the main contractor of this project.

CHAPTER VIII

BY-PRODUCT DISPOSAL

AND ENVIRONMENTAL PROTECTIONS

VIII. BY-PRODUCT DISPOSAL AND ENVIRONMENTAL PROTECTIONS

VIII.1 Gypsum

1. General

By-product gypsum is estimated to be produced about 340,000 T/Y in case 10, under this project. In general, the country where all by-product gypsum derived form phosphoric acid manufacturing industry (phospho-gypsum) is utilized is only Japan where no natural gypsum is produced in spite of big demand. By majority of countries in the world, only a part of by-product gypsum is utilized and the rest is disposed of by means of throwing into sea, piling up on open area, or filling back into holes from where phosphate rock has been mined out.

As for the way of throwing into sea, there is seemingly little problem and no substantial fish damages at the place where there is violent tide or wild waves, because by-product gypsum thrown into sea is easily dissolved, so that many of manufacturers in the world depend upon this way. However, in case of calm sea, phenomena of accumulating at the sea bottom may be observed and cause serious problems. On the other hand, phosphogypsum contains 0.3 – 0.5% of fluorine and 0.4 – 2% of P_2O_5 and some people have the opinion that these materials are harmful when they are dissolved in the sea water. From this, the way of throwing into sea tends to be reviewed.

In many instances, disposal way of piling up on open area is taken, but the biggest defect of this way is to require large area of land and to destroy natural good appearances.

Further, in case of piling up on open area, it is advisable to have a rain water treatment facility, because such contents as previously mentioned may probably be run out with rain water.

The surplus by-product gypsum under this project is tentatively determined to be disposed of over open land, and rain water is deemed to be treated in a water treatment facility within the site.

Regarding utilization pattern of phosphogypsum in Japan, its production is about 3 million tons per annum, about 35% of which is used for cement retarder, about 50% for gypsum board and about 15% for plaster. The utilization pattern in the Philippines is described below.

2. Cement Retarder Use

Cement production and gypsum consumption for cement retarder in the Philippines are shown in Table VIII-1.

Table VIII-1. Cement Production and Gypsum Requirements in the Philippines (1,000 MT)

Year	Cement Production	Gypsum Requirements
1970	2,522	102
1971	3,133	188
1972	3,167	127
1973	4,059	162
1974	3,483	139
1975	4,350	174
1976	4,085	163
1977	4,098	164
1978*	4,344	174

* estimated Source: Ministry of Industry

On the other hand, the phosphoric acid manufacturers in the Philippines, Planters Products and Atlas Fertilizer, have the plant to granulate gypsum and sell the product to cement manufacturers. The assumed actual phosphoric acid production of each manufacturer in 1978 is 29,000 T-P_2O_5/Y and 5,000 T-P_2O_5/Y, respectively, and total phospho-gypsum production is approx. 170,000 T/Y, i.e. seemingly to be slightly short, and this shortage is assumedly filled with imports from Japan (by product) or Australia (natural gypsum).

Supposing, however, that both manufacturers have fully produced phosphoric acid up to their possible maximum production capaxity, production would be 35,000 T-P_2O_5/Y and 7,500 T-P_2O_5/Y, respectively, and total phospho-gypsum production would be about 214,000 T/Y, resulting in surplus of about 30,000 T/Y which must be thrown into sea.

Cement consumption in the Philippines is increasing at a rate of about 10 per cent per annum. With use of both this rate and gypsum consumption of 174,000 T/Y in 1978, gypsum consumption is estimated over a period of 1983 – 1990, and the result is tabulated in Table VIII-2. Assuming that current gypsum production of 214,000 T/Y is kept constant, its shortage would be in the second column of Table VIII-2.

Table VIII-2. Gypsum for Cement Requirements Estimate and Balance

Year	Requirements (1,000 T/Y)	Balance (1,000 T/Y)
1983	280	66
1984	307	93
1985	337	123
1986	372	158
1987	408	194
1988	448	234
1989	493	279
1990	542	328

Judging from the shortage on this table, almost all of by-product gypsum from this project would be fully consumed in 1990 in terms of estimate basis, when case 10 is realized, and until that time, the surplus must be thrown away.

By-product gypsum to be used as cement retarder is ordinarily shipped in the form of 10 – 20 mm granular after free portion of phosphoric acid harmful to cement is neutralized with lime, as being currently processed in the Philippines. Recently, in many cases in Japan, phosphogypsum is shipped just after neutralized with lime and dried off for a while. This is seemingly because the cement manufacturers in Japan are technically advanced to accept gypsum in powdery form.

In order to granulate gypsum, dihydrate gypsum is once converted to hemihydrate gypsum by means of calcination, and granulation is made during the course of hydration to dihydrate gypsum again. To produce one ton of granular gypsum, such auxiliary materials as, 43 kg of lime, 40 kg of fuel heavy oil, 23 KWH of electricity and 35 kg of steam are required. The plant construction cost is fairly large amount of approx. 5 million US$ for the production capacity of 250,000 T/Y.

It is unforeseenable whether the cement manufacturers in the Philippines will continue to use granulated gypsum, or they will be changed to accept gypsum in a powdery form of neutralized and half dry in the future. Judging from the current situations, however, it is deemed necessary to construct about 200,000 T/Y capacity of granular gypsum manufacturing plant, but such plant is determined to be out of the scope of this fertilizer project.

Further, it should be noted that phosphogypsum is recognized as no commercial value in Japan, if it is not treated at all.

Should gypsum-based products be handled under separate projects, the value of by-product gypsum from this project can not be accounted in this project.

3. **Gypsum Board and Plaster Use**

Gypsum board is made in the following steps: calcination of by-product gypsum in kettle or rotary kiln into hemihydrate gypsum; grinding; addition of some additive agents and again some water; spreading the resultant slurry between two sheets of hard boards; hardening into dihydrate gypsum during forming; drying up. Its thickness is normally 9 - 12 mm, and there exist such grades as decorative wall board and ceiling board with decorative paper on it, and lath board on which finish mortar is applied.

Its use includes inner wall and ceiling of wooden structures, inside partitions of buildings, etc., and they are handled in the same use as plywood.

As compared with plywood, it has such features as, anti-inflammability, good stability in formed dimension, good heat insulation, good sound absorption, anti-bending, etc., while it has weak point of heavy weight per unit area and less easiness to process.

Its price in Japan is almost at the same level as plywood.

Plaster is made by calcining dihydrate gypsum into hemihydrate gypsum, and adding some additive. Some water is given at working site and trowelled. But demand in Japan is not so big.

Gypsum board is deemed not to be used at all in the Philippines for the time being, but it is expected to have a fair quantity of demand, in view of structure of common houses.

Advisable manufacturing plant capacity is around 1.5 million m^2/month, and its construction cost is about 20 million US dollars. The volume of by-product gypsum required to manufacture this volume of board is around 120,000 T/Y.

It is sure that a plenty of by-product gypsum become surplus and have to be thrown away at the commencing time of this Project, and, of course, these gypsum must be valued to be nil. As the gypsum board is cheap in price per unit weight, market exploitation depending upon product imports may cause many problems. But it is recommended to start the development plan of gypsum board in the Philippines as soon as possible in parallel to fertilizer project in order to make the volume of by-product gypsum to be thrown away as less as possible.

Further, this gypsum board manufacturing plant plan is also considered to be out of the scope of this fertilizer project.

VIII.2 Fluorine Compound

Phosphate rock containes 1.5 – 4.5% of fluorine, subject to variance by sources.

Where this fluorine goes to can not clearly be told, as it varies in accordance with phosphoric acid manufacturing process and phosphate rock quality.

Very roughly speaking, its fluorine balance in respect of Case 10 is shown as follows:

	↗ From cooling section of phosphoric acid manufacturing process	5
Phosphate rock (F = 100) →	Phosphoric acid → Fertilizer	65
	↘ By-product gypsum	30

The fluorine compound transferred into cooling air or steam can possibly be recovered in a form of silicofluoric acid solution or sodium silicofluorate, by washing such emitting gases with scrubbing water or caustic soda. While, in Case 10, it is uneconomical to recover it as silicofluoric acid or sodium silicofluorate products, because the volume of fluorine compounds evaporated is small and the concentration in liquid is low, so that emitted gas is simply washed for the purpose of environment protections.

The fluorine compound left in phosphoric acid and then transferred into fertilizer manufacturing process remains partly in the product fertilizer and is partly emitted as gas out of the fertilizer plant, from which it is washed out with scrubbing water. This scrubbing water is collected into water treatment facility, neutralized with lime, separated from resultant calcium fluoride, and discharged. But it is possible to recover the fluorine compound in phosphoric acid as sodium silicofluorate by treating the acid with caustic soda.

The fluorine compound transferred into by-product gypsum is difficult to be recovered, and even if it is attempted to recover it, such attempt won't pay economically.

In summing up above, no silicofluoric acid can be recovered in Case 10, and if sodium silicofluorate is not recovered, all fluorine are spread into fertilizers, by-product gypsum and sludge of calcium fluoride through a water treatment facility.

Should sodium silicofluorate be desired to be recovered, it can possibly be recovered by treating phosphoric acid being delivered into fertilizer manufacturing process with caustic soda.

Regarding the utilization of fluorine recovered from phosphoric acid manufacturing plant, in many cases it is used to manufacture cryolite from sodium silicofluorate. Cryolite is used in electrolysis of aluminium manufacturing. As the aluminium manufacturing industry in ASEAN region is now under planning, the possibility to recover fluoride and produce sodium silicofluoride in this project is existing. But we are of the opinion that it is too early to put this plan into practice for the time being.

Sodium silicofluorate is also used for glass manufacturing, for agricultural chemicals, etc., but the demand is rather small. Small amount of sodium silicofluorate is imported into the Philippines and it is used as additive for drinking water, a volume of which is about 600 T/Y in 1979 and estimated to be about 800 T/Y in 1984. These figures correspond to about 360 T/Y and 480 T/Y as fluorine, respectively. On the other hand, the volume of fluorine available in Case 9 is about 3,500 T/Y, a figure one place up.

Its market price is currently as cheap as about 400 US$/T, so that to construct a large scale plant in spite of low demand won't pay economically. However, it is quite easy to recover limited volume of sodium silicofluorate required in the Philippines, by using caustic soda for the washing of waste gas.

It may be of no worth discussing about this, because this is so small in sales sum, but the plan in respect of fluorine recovery to use for drinking water is determined to be out of the scope of this project, for the time being.

VIII.3 Environmental Protections

1. Air Pollution

The harmful substances that can possibly be discharged into air out of fertilizer manufacturing plant of this project are fluorine, ammonia and sulfuric acid.

In accordance with the "Rules and Regulations of the National Pollution Control Commission, 1978", each of them are restricted as follOws:

Fluorine	50 mg/m^3 as HF
Ammonia	400 mg/m^3
Sulfuric acid	1,500 mg/m^3 as SO_2

The discharging place of gas and main harmful substance contents are as follows:

Cooling air from digesters, vacuum system and others of phosphoric acid manufacturing plant	Fluorine
Discharging air from dryer of fertilizer manufacturing plant	Ammonia & Fluorine
Boiler combustion gas	SO_2

Content of fluorine in discharged air out of phosphoric acid manufacturing plant as described in the first line of above table can possibly be lowered within the restriction level, by washing it at two stages with scrubbing water. Washing water may partly be used within the system, but finally it is all treated in the water treatment facility.

Air discharged out of fertilizer manufacturing plant is first washed with acid to collect ammonia, and then washed with scrubbing water to eliminate fluorine. A part of washing water is returned with washing acid into reactor of fertilizer, while all the rest is treated in the water treatment facility. Thus, reduction within the above restriction level can easily be attained.

As for boiler combustion gas, the above restriction level can impossibly be met, if fuel heavy oil with ordinary sulfur content is used. However, we can meet the restriction with higher stack and low concentration at ground level. Construction of a stack of about several ten meters to be jointly used with other plants will suffice to solve this problem, as the volume of combustion gas is rather small.

These environment protection measures are contained in this project.

2. Water Pollution

A large volume of sea water is planned to be used as cooling water in this fertilizer manufacturing plant. Since it is not contaminated substantially, though its temperature is raised, it will be returned back into sea as it is.

Contaminated processing water is all collected from all the plants into the water treatment facility.

The contaminative substance in question are chiefly fluorine and phosphoric acid, but neither of them is restricted in the "Rules and Regulations ..... ", in the Philippines, as mentioned above, i.e. no concrete levels are standardized in the said law for Class C discharging water which should be applicable for this case.

Tolerance value for fluorine content in Japan is restricted in national level to be 15 mg/ltr, although it locally varies slightly.

Contaminated water discharged out of fertilizer manufacturing plant is in general first neutralized with lime or others to get pH = 7 - 8, forming precipitates of calcium fluoride and calcium phosphate, and solids are settled in a thickner, thereby top water is discharged out, while sludge settled at the bottom is filtered, and filtered sludge is thrown away. Thus, fluorine concentration in water can possibly be lowered down, more or less, to 40 mg/ltr.

The fluorine concentration can further be lowered down, but it is normal to discharge out by mixing it with not contaminated water, such as cooling water and others.

This study covers water treatment facility, including neutralization, settling and filtration.

3. **Solid Disposal**

As previously described in para. VIII.1, a volume of by-product gypsum have to be disposed of at the commencing time of this project. Either way of dumping in the sea or on-land pile can probably be thought of, in terms of abandonment means, but disposal of on-land pile is taken in this study. In case of piling up gypsum on land, gypsum becomes relatively hard, and also does not spread out harmful subsistences, so that there is no special problems. This way is taken in a various places of the world.

However, the more volume of gypsum is piled up, the more questions come up in terms of land use and natural beauty appearances. In this study, such piling is determined to be made in a valley just behind the plant, as all volume of by-product gypsum is possibly expected to be utilized in a few years.

Since some amount of water soluble fluorine and phosphoric acid are contained in by-product gypsum, it may cause bad affects in public, when such substances run out with rain water. It is, therefore, determined to design a system to dam such rain water at the bottom of the valley, where gypsum is thrown away and to gather all rain water flown out through such gypsum, leading it into the water treatment facility as mentioned in previous para.

Besides gypsum, sludge from the water treatment facility must also be abandoned. Such sludge is also disposed of into the same place, by mixing together with gypsum as its volume is little and looks similar with gypsum.

4. **Application to The National Environmental Protection Council, Philippines**

When planning to construct a plant, etc., in the Philippines, it is the obligation of the planning party first to submit an Initial Environmental Examination (IEE) to the National Environmental Protection Council, Ministry of Human Settlements to show what impacts such plan will affect upon environment.

Since we, the study team, are not a party to carry out this project, we are not in the position to make such documents, but for readers' references, only a check list in para. E of IEE is filled up and supplemented in Annex VIII-1.

CHAPTER IX

BASIS OF THE PLANT DESIGN

IX. BASIS OF THE PLANT DESIGN

IX.1 Scope of the Project

The scope contained in this project is summarized as follows:

1. Manufacturing plant:

   Ammonium sulfate manufacturing plant
   Phosphoric acid manufacturing plant
   Fertilizer granulation plant

2. Raw materials receiving facility:

   Port facility with unloader to receive such materials from ocean vessels, as phosphate rock, potasium chloride, ammonia, fuel heavy oil, etc.
   Storing facilities required for operation
   Sulfuric acid tank

3. Product storing, and shipping facility:

   Product bagging facility
   Storing and shipping facilities for bulk and bagged products
   Storing facility for intermediate phosphoric acid

4. Discharging water and gas treatment facility, and by-product gypsum abandonment facility:

   Please refer to para. VIII.3.

5. Utility facility:

   Boiler; Water treatment facility; Substation; Emergency-power generator; Sea-water pump; Water wells; Water piping; Instrument air system; Heavy oil supply.

6. Off-site facility:

Office building; Repair and maintenance shop; Test and laboratory room; Garage; Automobiles; Clinic; Security guard; Fire station; Air conditioner; Canteens; and all other facilities required to support plant operation.
Head office at Manila.

7. Land:

Acquisition of about 50 ha. taking account of future expansions.
Land making of about 17 ha. required in this project.

8. Road:

Construction of about 500 m of access road to the site from public road and roads within the factory.

9. Company-owned houses for management-level personnel

Major excluded Items are:

1. Sulfuric acid manufacturing plant.

2. By-product utilization plant, such as utilization of gypsum, fluorine, etc.

3. Houses for general employees.

4. All public roads, except access road.

5. Electricity transmission system up to the site.

6. Public facilities, such as hospitals, schools, etc.

IX.2 Product-mix and Plant Capacity

Ammonium sulfate:	150,000 T/Y, approx. 460 T/D All in bag per 50 kg
30% phosphoric acid:	66,400 T/Y (as P_2O_5) approx. 200 T/D
Granulated complex fertilizer:	369,000 T/Y, two trains of approx. 600 T/D All in bag per 50 kg Various grades of products, such as 12-12-12, 14-14-14, 15-15-15, 16-20-0 are produced. For the purpose of economic analyses, grades of 15-15-15 and 16-20-0 are selected, each of which is produced just a half of total annual production.

IX.3 Specifications of Raw Materials and Products

Proper specifications of main raw materials are as follows:

1. Phosphate rock: Morocco 70/72% BPL
   (This is an example used for design calculation)

P_2O_5	33.0%
CaO	52.0
SO_3	1.4
Fe_2O_3	0.17
Al_2O_3	0.45
Na_2O	0.68
K_2O	0.17
MgO	0.32
SiO_2	1.96
CO_2	4.14
Ignition loss	1.96
F	4.12

2. Sulfuric acid:

H_2SO_4	98%
Fe	max. 120 ppm
SO_2	max. 50 ppm
As	max. 0.5 ppm
Pb	max. 0.2 ppm
Hg	max. 0.1 ppm

3. Ammonia:

NH_3	min. 99.5 wt%
Moisture	max. 0.25 wt%
Oil	max. 10 ppm

4. Potassium chloride:

K_2O	min. 60%

Specifications of products are as follows:

1. Ammonium sulfate:

N	min. 21%
Moisture	max. 0.5%
Free acid	max. 0.05%

2. Granulated complex fertilizer:

N, P_2O_5 and K_2O content for each grade are guaranteed.

IX.4 Raw Material Requirements

Raw material consumption has once been shown in Table VI-4, para. 3 of Chapter VI, but a revised consumption for Case 10 is shown in Table IX-1, considering the condition that phosphoric acid process in Case 10 is different from what was previously assumed in para. 3 of Chapter VI.

Table IX-1. **Raw Material Consumption (t/t product)**
(for phosphoric acid t/t P_2O_5)

Case 10:

	30% PA	As	15-15-15	16-20-0
Phosphate rock	3.108		0.481	0.637
Sulfuric acid	2.834	0.754	0.695	0.925
Ammonia		0.263	0.151	0.202
Potassium chloride			0.256	
Urea			0.070	
Electricity KWH/T	215	33	77.7	89.3
Fuel heavy oil	0	0.012	0.039	0.043
Anti-caking agent			0.01	0.01
Anti-foaming agent g/T	170		30	30

Total volume of main raw material required at the time of 100% operation is as follows:

Case 10:

Phosphate rock	206,000 T/Y
Sulfuric acid	412,000
Ammonia	105,000
Potassium chloride	47,200
Urea	12,900
Heavy oil	19,000

IX.5 Climatic Conditions and Others

Major weather conditions at site which are to be basis for plant designing, are as follows: Please refer to Annex Table IX-1 through 7 for further detail data.

1. Temeprature:

Annual normal	mean	27.5°C
	max.	31°C
	min.	24°C

Monthly maximum normal wet bulb temperature		25°C

2. Relative humidity:

Monthly maximum normal relative humidity

	max.	82%
	min.	76%
	mean	81%

3. Wind velocity and direction:

Velocity:	max.	40 m/sec.
	design	20 m/sec.
Prevailing wind direction		NE

4. Rainfall:

Annual average rainfall	2,000 mm
Monthly maximum rainfall	200 mm
Monthly minimum rainfall	50 mm

5. Tidal level:

H.W.L.	1.530 m
L.W.L.	0.183 m

6. Earthquake:

Seismic factor	0.1

7. Soil bearing capacity:

As it is not made yet, further investigation is required, but 15 T/m^2, more or less, can assumedly be expected, for the time being.

CHAPTER X

DETAIL OF PLANT DESIGN

X. DETAIL OF PLANT DESIGN

X.1 Plant Site

1. Location and Terrain

Since the basic condition that the plant site is to be in adjoining to the PASAR's copper smelter is given by the Government of the Philippines, the study team has not conducted any investigation to look for a plant site for selection purpose, and taken a position to develop an appropriate plant design and layout planning in adjacent to the said copper smelter.

However, the mission team has not been notified yet officially where the said copper smelter is determined to be sited. Therefore, the most possible place is assumed to be a candidate site for the said copper smelter through discussion with PASAR, and the site deemed to be most suitable for this fertilizer project in ajoining to it is selected as a candidate for this project.

Should our assumption for PASAR's copper smelter site not be right, some revision would be necessary regarding the contents of this report.

Please refer to Fig. X-1 for both assumed sites of PASAR's copper smelter and this fertilizer manufacturing plant.

The proposed sites are situated at Isabel district in Leyte Island, on the peninsula along the east of Dupon Bay, and it is assumed that the PASAR plans the plant site to be at the top end of this peninsula, while the site for this fertilizer manufacturing plant is selected at the north of PASAR along Dupon Bay, more precisely at the place near to the small village of St. Rosario, north of Catiyoman Point.

About 17 hectares of land is just enough, if it is limited to the project in this report, but 50 hectares is determiend to be secured, in view of its future expansions.

The mouth of Dupon Bay is about 2 km wide, and the peninsula is stretched into Camates Sea, so that the west-southwest wind gives a straight blow into the proposed site, but prevailing wind direction in notheastward, so that no breakwater is judged to be necessary.

This land is a relatively gentle hill of 20 – 40 m in height above the sea, and forms a steep cliff along the coastline, at the bottom of which a coastline runs. The coast under the cliff is coral reef of nearly plane, whose width reaches almost to about 150 m, to form a dry beach at low tide.

It is, therefore, planned in the site preparation to reclaim the area at the bottom of the cliff into a part of the site, by dorpping surplus soil down to the coastline at the time of leveling the land above the cliff and filling the soil over the coral reef.

The sea depth is rapidly increasing right after the end of the plane coral reef, forming almost parallel contours with the coastline at about 20/100 of slope, and reaches to 30 m at 200 m distance, all which are very favorable to port construction.

2. Soil Conditions

The detailed analysis data for soil conditions are unknown now, because the soil investigation this time has remained just to explore from surface and to collect all necessary existing data. The detail ground investigation including borings is indispensable, when the plant construction is decided, but the outline of soil conditions is as follows:

The strata including all neighboring area are inferred to belong to the last cainozoic era which is relatively a new age of the tertiary period in terms of the geological age, and the deeper strata to the middle cainozoic era.

The gentle hill of 20 – 40 m above the sea forms a so-called Karst terrain, which is studded with lime stones. The land can be assumed to have a relatively simple ground structure in terms of strata, as it has little of grown fault owing to no track of violent orogenesis all over the peninsula. It is also geologically formed with lime stones of upheaved coral reef state and such marine deposits as, sand, pudding stone, marlstone, etc., while it has the strata of new period in terms of geological age, as previously described, so that it can possibly be judged to be soft soil, except lime stones partly studded.

Further, the created coral reef are formed to cover about 150 m in width along the coastline under the cliff. Their thickness varies generally from several tens centimeters to several meters, and moreover, have considerable hardness, so that piling works will be difficult, if such thickness is increased, and the questions of pre-boring work application and others will arise and eventually additional cost might be needed.

Viewing so far from the actual investigation results on Ormoc Bay, the bottom bed under these created coral reef is a sand layer of good quality, having 10 – 20 at N-value.

At all events, to conduct a detail ground investigation and to confirm all the ground conditions are indispensable, before designing is started.

3. Land Preparation and Plant Layout

As previously mentioned, the proposed plant site is planned to be made at both upper and lower part of the cliff, by dropping surplus soil of about 600,000 m^3 created from leveling the land above the cliff down to the lower land and filling the soil over coral reef.

The upper land is at about 15 m in height, having 6 ha. of area, while the lower at about 5 m in height, having 11 ha. of area, totaling to 17 ha. of area.

It is not desirous to have a cliff in the middle of plant site, but the reclamation of the lower portion under the cliff makes it possible to bring a vessel of 10,000 DWT class alongside the wharf adjacent to warehouse, which gives great conveniences for shipment.

The soil bearing capacity can probably be expected about 10 – 15 t/m^2 at the lower land and more than 15 t/m^2 at the upper.

A plant layout proposed is given in Fig. X-2.

Phosphoric acid manufacturing plant, office building, and utility facilities are laid on the upper land, while warehouses and storages for raw materials and products, fertilizer granulation plant and ammonium sulfate manufacturing plant on the lower.

A port facility proposed is composed of an exclusive pier for phosphate rock, alongside which a vessel of 50,000 DWT class for phosphate rock can lie, and a wharf, alongside which a vessel of 10,000 DWT class can lie.

Since this layout proposed here is developed by ourselves, having no discussions with PASAR, it should be adjusted by both parties concerned, if there are any problems in relation with the PASAR project.

X.2 Process Plants

1. Phosphoric Acid

As described in para VII-1, the hemi-dihydrate process for Case 10 is chosen as phosphoric acid manufacturing process, whose production capacity is about 200 T/D.

A flow chart of hemi-dihydrate process is shown in Fig. X-3.

Phosphate rock is stored in a silo, after ground; from there, sent into the premixer, through the weigher with a belt conveyor, thereby mixed with recycling phosphoric acid; resultant slurry is sent into the first disgester, thereby sulfuric acid is added in, and sent into the second digester. All slurry after the second digester is re-crystallized into calcium sulfate dihydrate under the condition of different temperature in the 3-series of hydration tank and filtered. Resultant liquid is 30% concentration phosphoric acid, and gypsum is washed out with washing liquid and water, and discharged. Washing liquid from second stage is utilized as recycling phosphoric acid. Cooling air is discharged into the atomosphere, after washed out with scrubbing water.

2. Granulated Fertilizers

A flow chart of NPK/NP fertilizer granulation plant is shown in Fig. X-4.

In comformity with grades to be manufactured, a specified volume of phosphoric acid, sulfuric acid and ammonia are charged into a reactor vessel. The resultant liquid in the reactor, which is heated up with reaction heat, are spread upon recycled granulated fertilizers in the granulator, and granulated over the recycled granular. All granular sent into the dryer from the granulator is dried out with combustion gas of fuel heavy oil; then, screened. All granular of inadequate size is recycled into the granulator. Urea, potassium chloride and gypsum for dilution are added in th recycle line. Resultant product is cooled off by air, added with some anti-caking agents and sent into a silo. Gas from each of the granulator, the dryer and others is contacted with phosphoric acid at each of the fume scrubber and the dust scrubber, all of fume, dust and ammonia are removed out of the gas, and further, contacted with scrubbing water to eliminate hazardous substances like fluorine and others, and then, discharged out into the atomosphere.

Phosphoric acid and scrubbing water are sent back into the reactor, but a part of scrubbing water is derained off and sent into the water treatment facility.

The plant capacity is 2 trains of 600 T/D for case 10.

3. Ammonium Sulfate

A flow chart of ammonium sulfate manufacturing plant with Krystal direct reaction crystallizer type, is shown in Fig. X-5. Its production capacity is 460 T/D.

Inside of the crystallizer is separated into two compartments, upper and lower, whose pressure at the upper compartment is depressed to cool off by means of evaporation. Sulfuric acid, ammonia and recycling mother liquid are fed into slurry piping which drains out slurry with a pump from the upper portion of the lower compartment and sent back into the upper compartment.

The slurry in the upper compartment are dropped down into the lower. The slurry taken out of the lower portion of the lower compartment is centrifuged and crystal is separated, while the mother liquid is sent back into the crystallizer. Resultant crystal is dried out with the dryer, and then sent into a silo, and from there, bagged.

X.3 Utility

1. Boiler and Water Treatment Facility

Steam requirement is 11.7 T/H for Case 10. Heavy oil is used as fuel. A package boiler of 20 T/H capacity is to be installed. Steam pressure is 10 kg/cm^2 saturated. A water treatment facility for boiler use is determined to be 15 T/H of capacity to cope with the boiler.

2. Substation

Electricity is planned to be bought from the geothermal plant now being undertaken at Tongonan of north Leyte owned by the Philippine Electric Power Company (NPC).

112 MW of this plant is scheduled to be completed by March, 1981, including transmission line up to Isabel district and substations as well.

NPC will complete the transmission line up to the substation at the plant site. Inside the site high and low voltages are 3,300 V and 440 V, respectively. An estimated electric consumption in the plant is normally about 5,000 KW. However, the substation capacity is determined to be 8,000 KVA, by taking account of a little bit of tolerance, in view of additional electric consumption for sporadic use of phosphate rock unloader and others.

Because of frequent stoppage of electricity in the Philippines, some people say that this project should have an emergency-power generator with enough capacity to keep full operation of the plant. However, all the processes now being undertaken in this project are characterized that the plant will return to its normal operation soon after the electricity is recovered, even if it is stopped by short stoppage of electricity. It is, therefore, useless to have an emergency-power generator just for the purpose of keeping its full operation, if stoppage frequency is only 20 – 30 times a year. However, it is determined to have a diesel generator of 500 KVA to be used for such equipment that their operation can never be stopped even during such stoppage period likely as agitators for digesters in the phosphoric acid process.

3. Industrial Water and Sea Water

Since sufficient research for industrial water sources is not made yet, a prompt exploration on it with boring tests is indispensably to be conducted.

In case that river water is planned to be used, sufficient volume of water could be secured, even in winter, with installation of an easy dam at Dupon River. It is, however, disadvantageous, because its location is more than 5 km away from the plant site and in addition, a big scale of water treatment facility will be necessary.

People in a vicinity of the proposed plant site are now using well water or spring water, acquiring sufficient volume of water throughout the year, but aquisition of large volume of water will at once give rise to mixture of sea water. With all these, it is planned to drill some wells at Sogod or Human district, which are located at the bottom of a mountain about 2 km away from the proposed plant site, assuming that possibly a plenty of sweet water will be obtained there and sent into the plant.

Since estimated requirement of industrial water at the site is about 90 T/H, drilling of three wells having 80 m in depth per well and delivery with two pumps are planned. Just for readers' references, water analyses on sample water from Dupon River, neighboring well and spring are shown in Annex Table X-1. Some sea water is contaminated with river and well water.

Sea water is utmostly used for simple cooling. An estimated consumption is about 1,200 T/H, and installation of sea water pumping up facility with 1,300 T/H capacity is planned.

X.4 Port Facility

As seen in Fig. X-2, proposed port facility is composed of a pier, alongside which a big vessel of 50,000 DWT class for phosphate rocks can be brought, and a wharf, alongside which vessels of 10,000 DWT or less can be brought for product shipment and unloading of ammonia and fuel heavy oil.

Each of them is outlined below, and further please refer to Figs. X-6 and 7, and Annex X-2, Port Installation Design Conditions.

1. Berth for Phosphate Rock

1) Fundamental Conditions:

Rock unloader is of fixed type, which means a method of rock unloading by way of moving a vessel.

The fundamental conditions for planning are as follows:

a) Vessel:

Overall weight		50,000 DWT (5 – 6 times per annum of port entry)
Overall length		222 m
Width		31.4 m
Depth		17.1 m
Full draft		11.7 m
Access speed		15 cm/sec.

b) Planned water depth: –13 m

c) Planned tidal level: MHHWL +1.530 m; MLWL +0.183 m

(Note) From Tide and Current Table Philippines, 1979.
Height from MLLW at Cebu

d)	Maximum wind speed	40 m/sec.
e)	Design wave height	2.0 m

2) **Unloader Platform:**

Platform, on which a 450 T/H unloader is mounted, is steel-reinforced concrete structure supported with steel-pipe piles of 812.8 mmϕ and about 31 m in length, equipped with two of 70 ton bollard. Its size is 25 m x 23 m and height is +5.0 m up to top end. Unloader to be installed has 25 m of turning radius and 25 m of elevation.

3) Access Bridge:

Belt conveyor rack up to phosphate rock warehouse and access bridge from unlaoder platform, are as follows:

Overall length		137 m
Width:	Side walk	3 m (total width)
	Belt conveyor	2 m (total width)
	Planned height	+5.0 m (at bridge surface)

Design load is planned to be 0.6 T/m at belt conveyor side and with T-20 for bridge. It is structured with steel-reinforced concrete girder supports at 14 m interval upon steel-pipe piles of 457.2 mmϕ and about 24 m length, upon which H-beam, reinforced concrete slab bridge and belt conveyor frame are mounted.

4) **Dolphin**

Four of breasting type and three of mooring type are planned for dolphin, the latter of which normally requires four just for main berth, but one of such type is determined to be installed on the product shipment berth, as they are very close each other under this planning.

Dolphin's design load is determined to be 70 tons for breasting type and 150 tons for mooring type, both of which have height of +4.0 m up to top end. Its structure is of a form of connecting steel-pipe piles of 914.4 mmϕ and about 30 - 34 m in length with reinforced concrete beams at their top ends each other, but as for mooring dolphin, structure is devised to get more resistant force by slantly piling, as lateral force is relatively large.

2. Berth for Product Export

Product warehouses and storages are constructed on the reclaimed land over coral reef, and a wharf of pier type is erected at the end of the land, which is utilized for product shipment and unloading of ammonia and fuel heavy oil.

They are scaled available to bring both vessels of 10,000 DWT and 1,000 DWT at the same time, or three vessels, if each is about 3,000 DWT, alongside the wharf.

The fundamental conditions are as follows:

a)	Vessel:		
	Overall weight		10,000 DWT
	Overall length		142 m
	Width		19 m
	Depth		11.1 m
	Full draft		8.3 m
	Access speed		15 cm/sec.
b)	Planned water depth		-9 m
c)	Planned tidal level	MHHWL	+1.530 m
		MLWL	+0.183 m
d)	Maximum wind speed		40 m/sec.
e)	Design wave height		2.0 m

Overall length of the wharf is 208 m, and its front line is designed to be parallel with contour. Its apron width is planned to be normal width of 18 m, connected with product stockyard with three bridges. This bridge connection form was taken to save the construction cost of revetment slant surface by moving its position to the coast line by about 13 m, because sea depth becomes sharply deeper at around the back of the apron.

Wharf structure is of an application of slab upon reinforced concrete beams connecting each of PC piles having 45.7 cm square and 30 m length at their top ends.

X.5 Warehouses and Storages

Specifications on warehouses and storage tanks now being undertaken in this plan are as follows:

1. **Phosphate Rock Warehouse:** 80,000 tons (Approx. for 100 days operation)

   Potassium chloride warehouse: 12,000 tons (Approx. for 100 days operation)

   Note that a partition is installed in a warehouse, in each side of which phosphate rock and potassium chloride are separately stored.

   Delivery capacity: 50 T/H for phosphate rock
   12 T/H for potassium chloride

2. **Ammonia Tank:**

   Tank capacity: 15,000 tons (Approx. for 42 days operation)

   Temperature: -33°C

   Pressure: 0.1 kg/cm² G

   Low temperature tank, with refrigerators and ammonia delivery pumps.

   Design seismic factor: 0.05 G

3. **Sulfuric Acid Tank:**

   Four of 5,000 tons tank, totaling to 20,000 tons.
   (Approx. for 18 days operation)

4. **Product Warehouse and Shipping Facility:**

   Product silo: Six silos, each 4,000 tons for NPK and ammonium sulfate, having a total capacity of 24,000 tons (Approx. for 14 days operation)

Bagging equipment:	45 T/H x 4 Lines
Bagged product warehouse:	30,000 tons (Approx. for 20 days operation) 60 m x 100 m, 5 m in height 2 warehouses
Forklift:	18
Pallet:	2,000
Crane:	5 tons, travel type (Auxiliary use for shipping)
Others:	Belt conveyor, portable type for shipping use, Shoot

X.6 Other Auxiliary Facilities

All other major off-site facilities are as follows:

1. Office
2. Repair and maintenance shop
3. Test and laboratory room
4. Miscellaneous storage
5. Clinic
6. Fire station
7. Canteen
8. Central air-conditioner

X.7 Roads and Housing Colony

1. Access Road

The Government of the Philippines is now undertaking road repair works to include both expansion and partial alteration of route between Ormoc and Palonpon, via Isabel. Regarding about 20 km of road repair between Isabel and Palonpon, its repairing design and cost estimate are already completed, awaiting budget allocation from the government and being ready for execution.

In accordance with the governmental program, the duration of work is one year, total cost is 42 million pesos and the basic specifications are as follows:

Design vehcile speed	70 km/hr.
Maximum design load	45 tons
Road width	6.1 m
Minimum turning radius	15 m
Maximum vertical gradient	7%
Pavement material	Concrete
Pavement thickness	20 cm

On the assumption that the local government should be liable for construction of about 3 km road of similar grade at the middle of the peninsula toward the copper smelter and the fertilizer plant, branching out of the above main road, this project would be liable for construction of an access road of about 500 m from the branched road to the plant site.

The proposed access road and its cross section are shown in Figs. X-8 and X-9, respectively.

2. In-site Roads

The in-site roads are planned to have two lanes of 3.0 m lane width plus two side shoulders of 0.5 m, totaling 7.0 m in width, by taking account of traffic with big size trailers, with concrete pavement same as the access road.

Its cross section drawing is shown in Fig. X-10.

3. Housing Colony

This plan has just taken account of construction of 50 houses for management level personnel use including guest house, bunk house and club house, but nothing for general employees.

Additionally, such house construction site is not given here now, because it should be linked with the local colony construction program which is to be established by local government of Leyte.

Fig. X-1. Plant Site Location

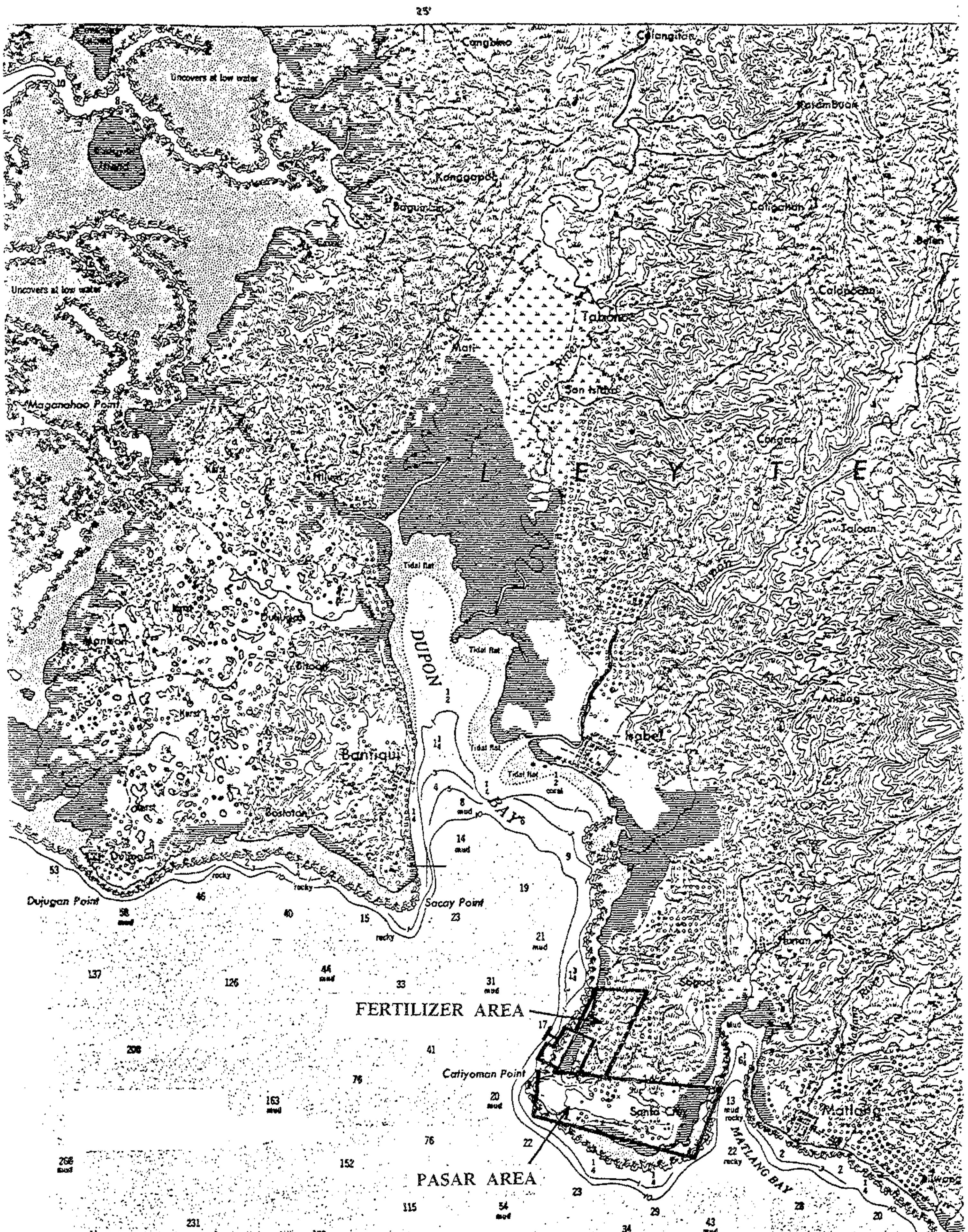
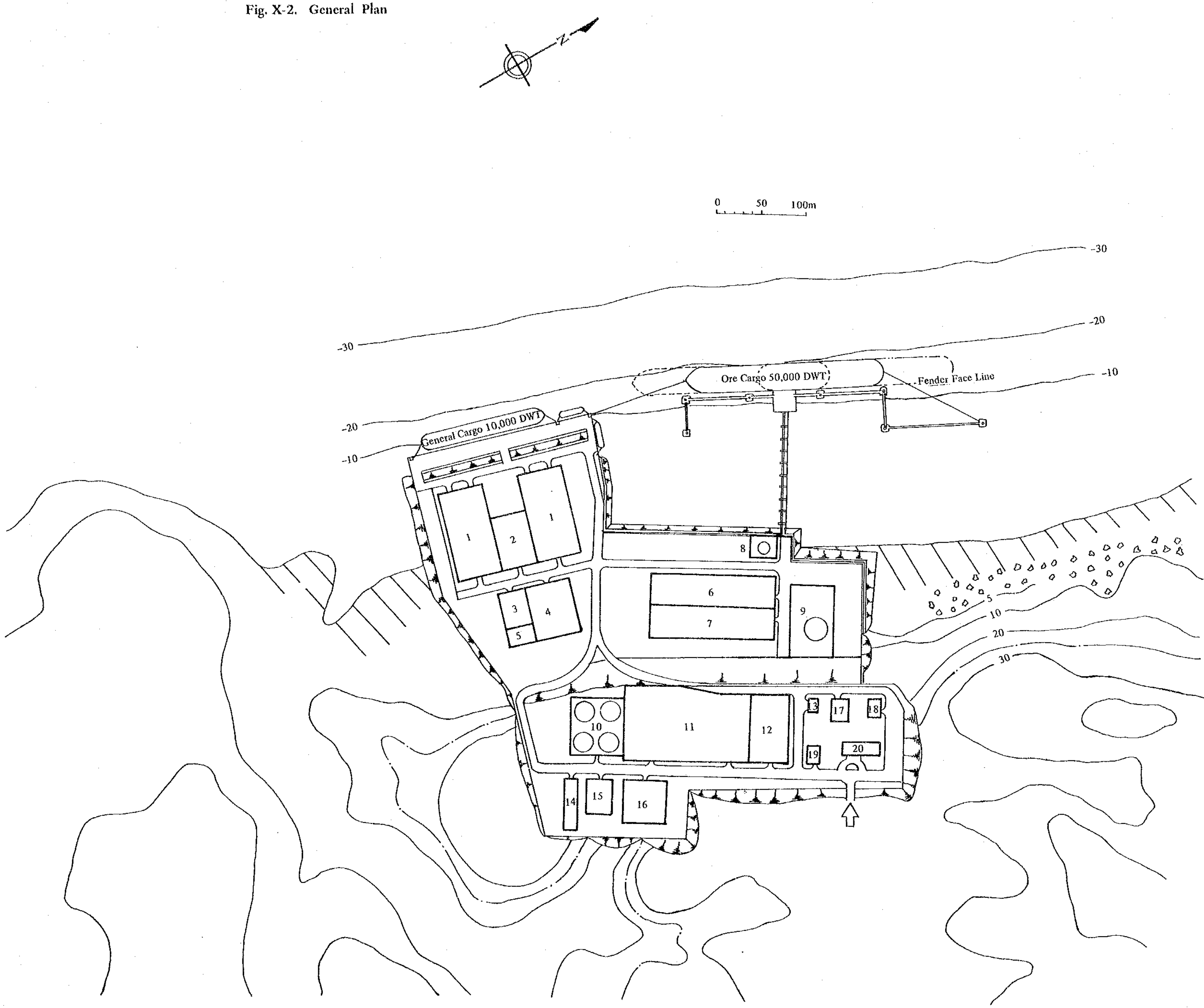


Fig. X-2. General Plan



LEGEND

(1) Bagged Product Storage House
(2) Product Silo & Bagged Facility
(3) Ammonium Sulfate Plant
(4) NPK Plant
(5) Air Compressor
(6) Phosphate & Potash Storage House
(7) Phosphate Storage House
(8) Oil Storage House
(9) Ammonia Storage Tank
(10) Sulfuric Acid Storage Tank
(11) Phosphate Acid Plant
(12) Water Treatment & Boiler
(13) Fire Station
(14) Work Shop
(15) Warehouse
(16) Main Substation
(17) Canteen
(18) Clinic
(19) Laboratory
(20) Office

Fig. X-3. Phosphoric and Acid Process (Case 10)

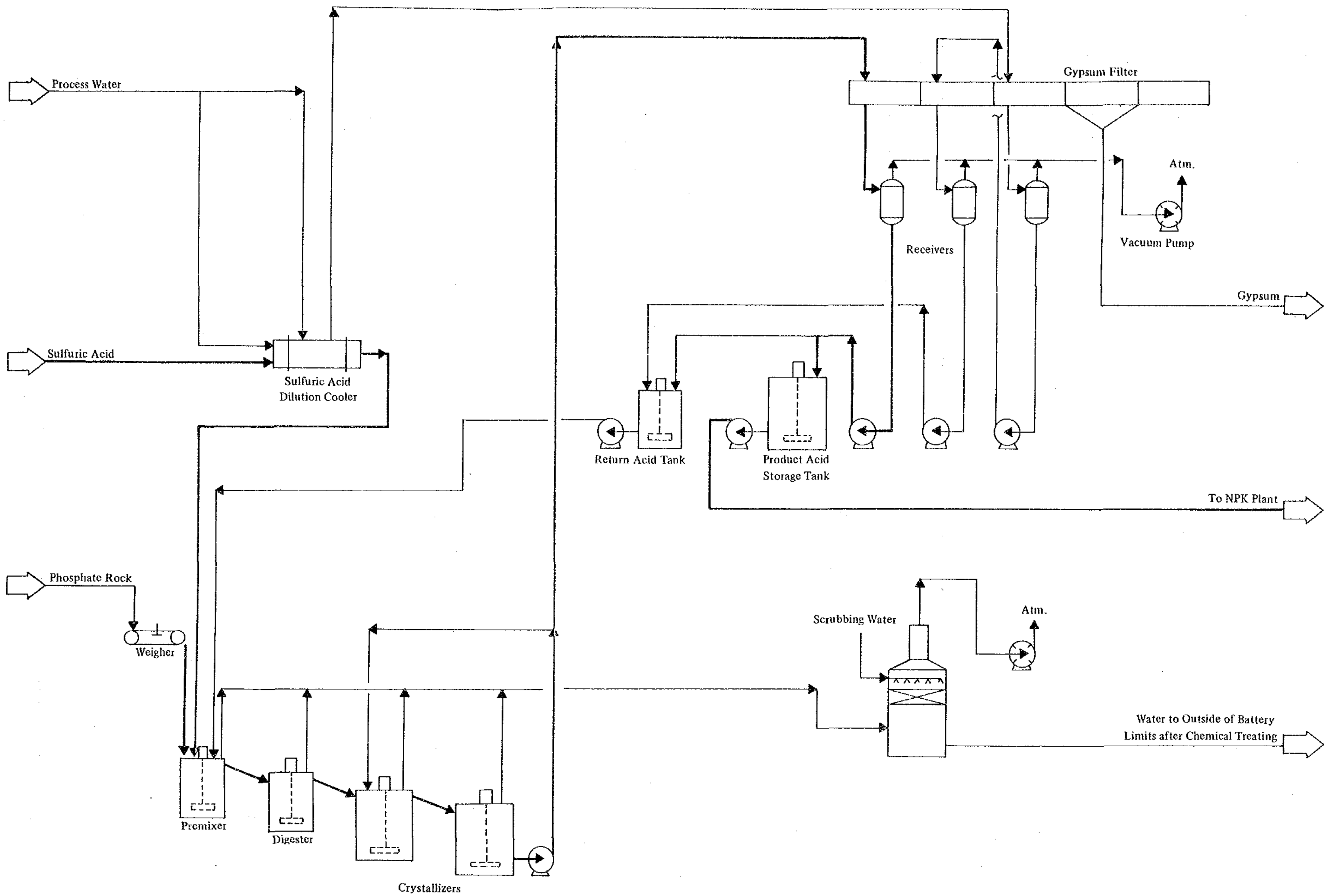


Fig. X-4. Fertilizer Granulation Process

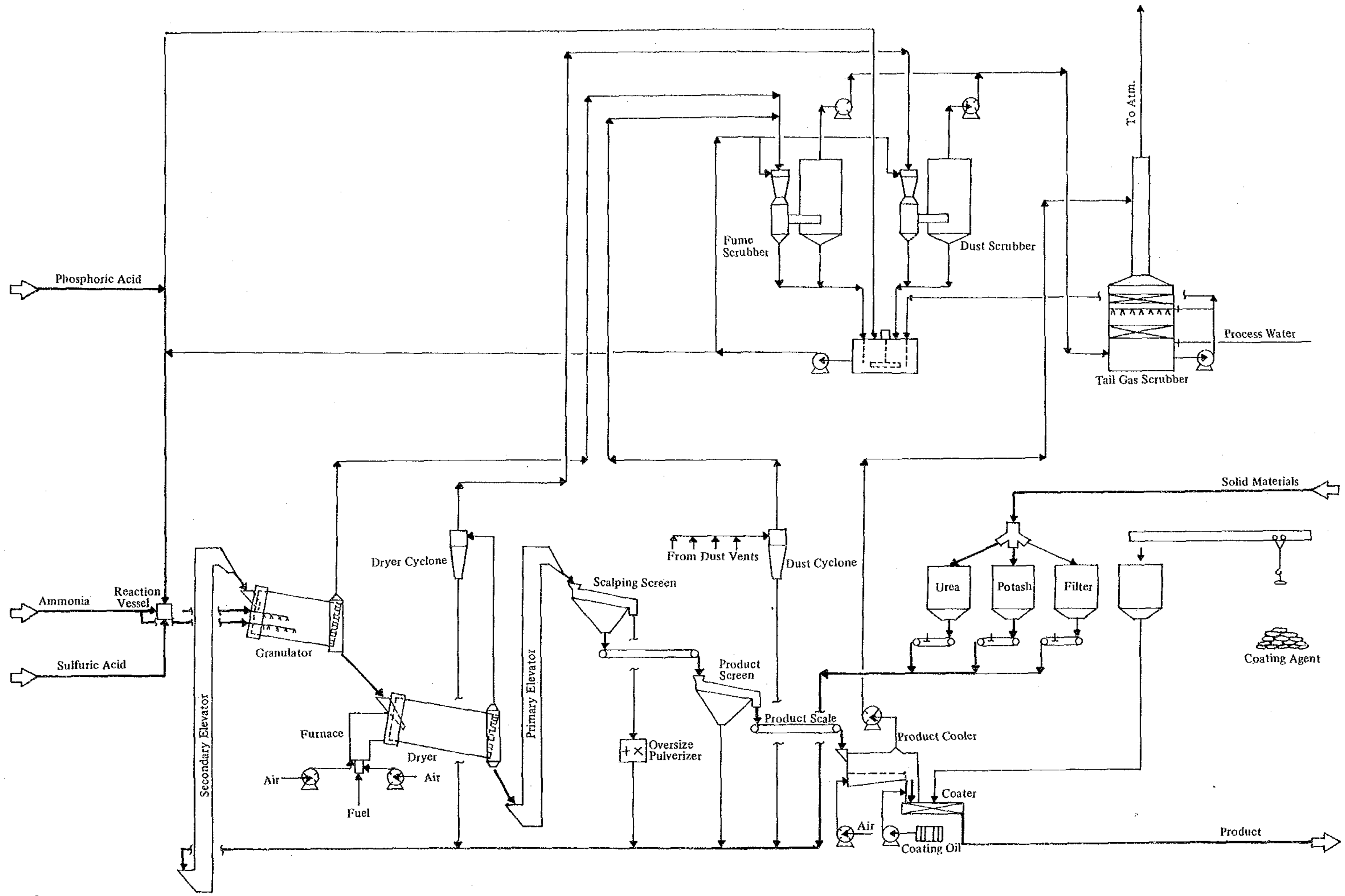


Fig. X-5. Ammonium Sulfate Process

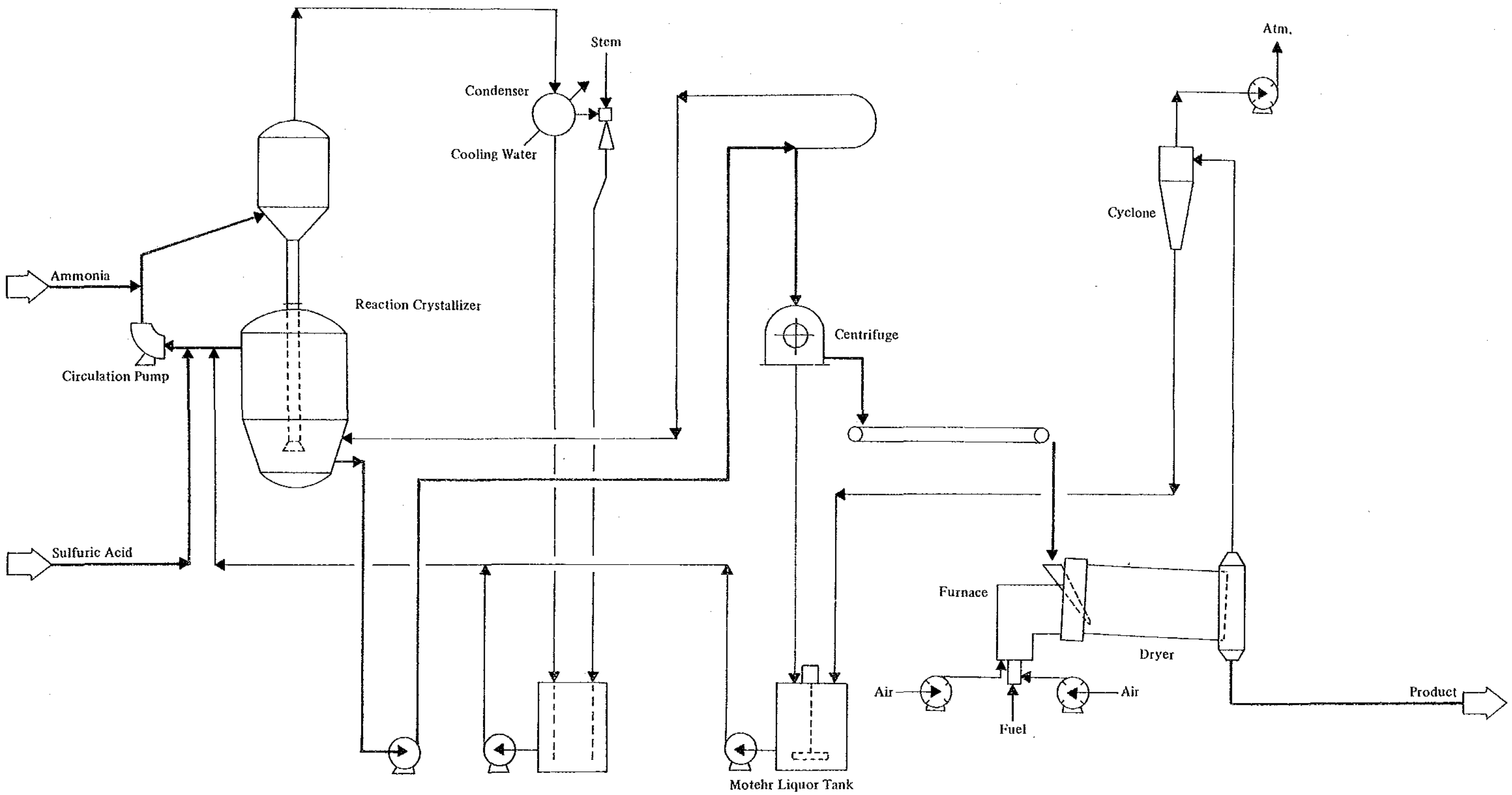
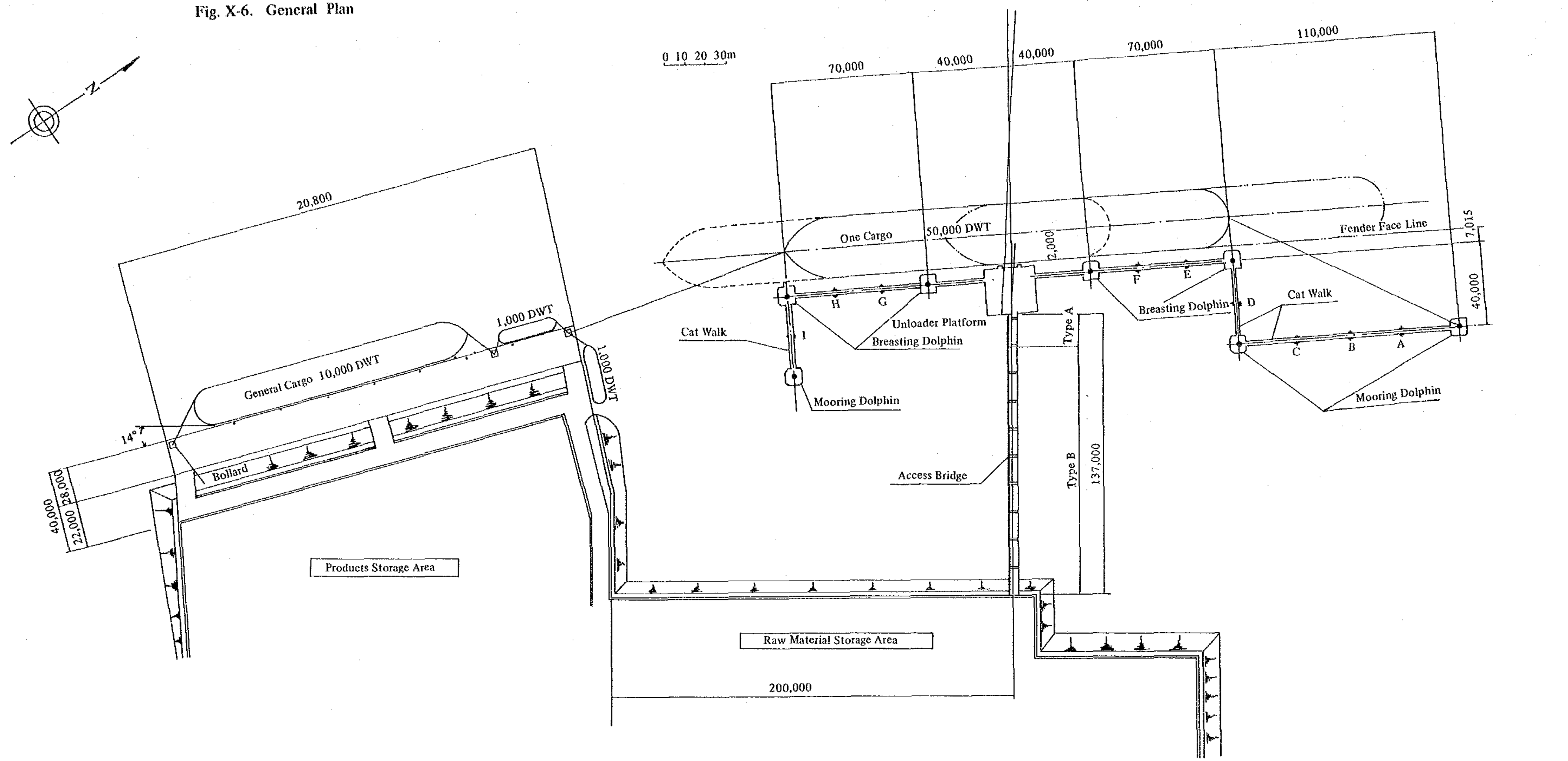
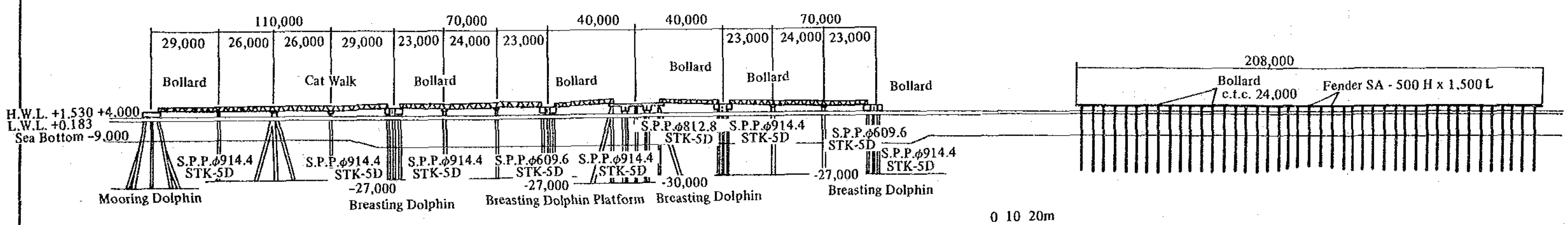


Fig. X-6. General Plan





FRONT VIEW

Fig. X-7. Structure

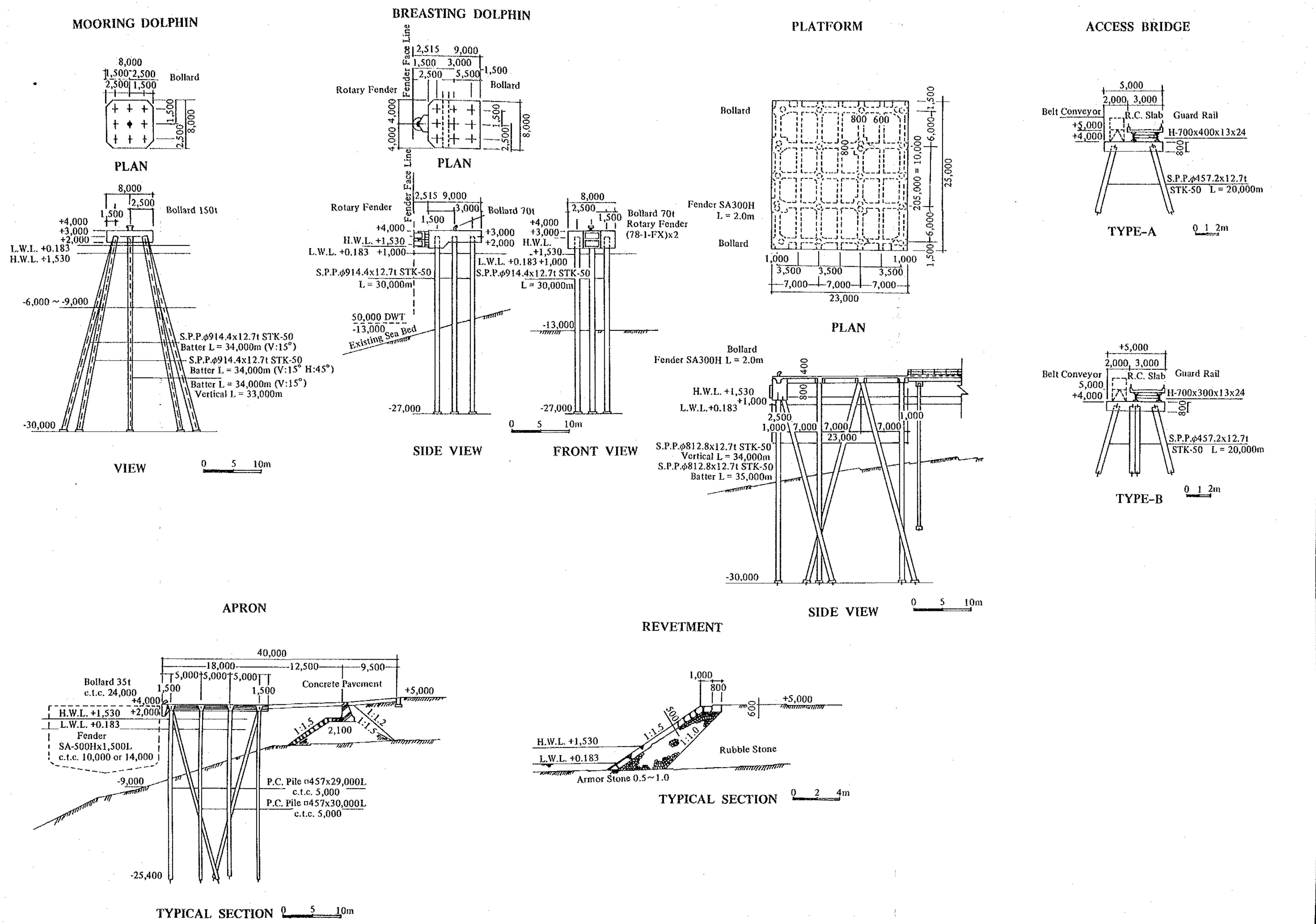
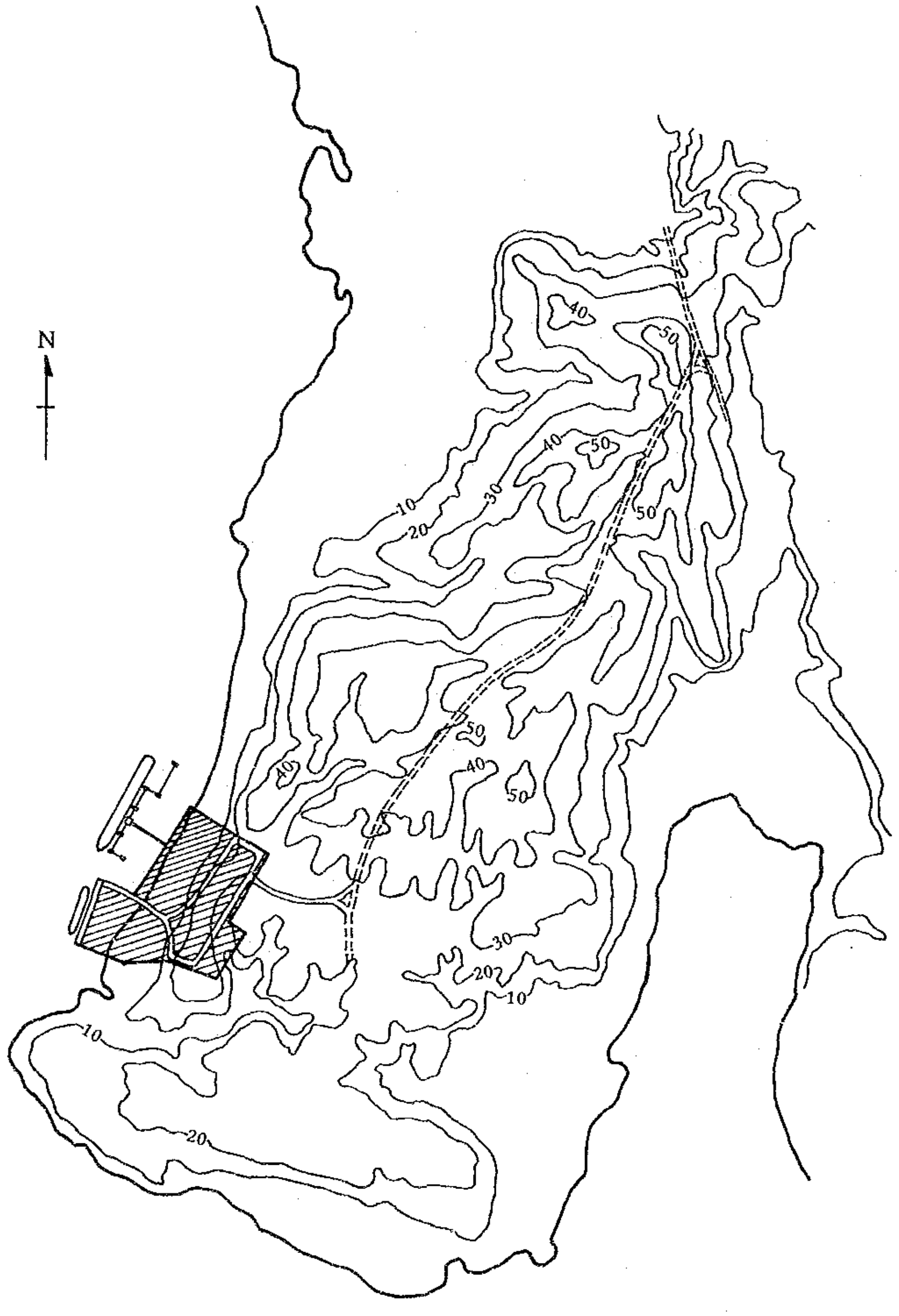


Fig. X-8. Proposed Access Road

S = 1 : 20,000



CHAPTER XI

PLANT CONSTRUCTION AND MANAGEMENT

XI. PLANT CONSTRUCTION AND MANAGEMENT

XI.1 Plant Construction Formation

1. Type of Construction Contract

The plant construction shall be executed by the new company jointly established and invested by the ASEAN countries, i.e. the project owner is the new joint venture company.

While, as previously mentioned in para. IV. 1, there are currently existing in the Philippines two leading phosphate fertilizer manufacturers, i.e., Planters Products and Atlas Fertilizer.

Although it cannot be said that they have currently no technical problems at all, they hold very good maintenance of their plant operation and fairly high level of technology, and is thought to deserve becoming the center of this project.

Therefore, subject to the cooperation of both Planters and Atlas, it is assumed that the new company will have the ability to carry out the construction work as orderer and execute overall management and control on the work from owner's points of view.

As a practical form of plant construction, a package contract is advisable to contract with single foreign general contractor for whole work covering all the scope of this project as defined in paga. IX.1 under its full responsibility, and not a divided contract to several contractors. Again, the former is thoughtfully considered to be better than the latter, from either economical point of view or smooth execution point of view.

There are two ways of contract in the package contract: one is a way to contract with a single contractor at lump sum price to undertake the entire scope of the project including designing, engineering, equipment and material procurement, plant construction and equipment installation, operation training, test run supervision, and so on; while the another is a way to contract with a contractor at a certain lump sum, but, although such contractor shall be bound to be responsible for the general management and control, all the assignable jobs, such as installation, construction works, and so on, shall be procured, with approval of the owner party, by means of competitive bids under the control of the contractor, and accounts shall be settled with the owner for completion of the project at the actual cost basis.

In these two, the one has the merit that no risk shall be borne to the owner party at all, as the contractor shall be liable to all the risk, including the total amount contracted, while has the demerit that almost no place shall be spared to the owner party to reflect his own intension in due course of execution.

Which is better is hard to tell, but it is thoughtfully advisable that the former will be better than the latter, in view of that both of risk and owner's responsibilities should be reduced as much as possible.

2. Jobs of the Owner Party

It is necessary for the owner party to perform the following jobs, before selection of a contractor.

a) Arrangement of plant site:

To include acquisition of land, geological survey, investigation of soil bearing capacity, topographical survey, water source research with boring tests, etc.

b) Determination of "Terms and Conditions" of construction contract

c) Preparation of tender documents:

To prepare a complete tender document which clearly specify contractor's duties, responsibilities and obligations, including design stndards and specifications.

d) Selection of well qualified candidate contractors

e) Invitation of tenders

d) Evaluation of submitted proposals, determination of contractor and contract

After determination of a contractor, to watch whether the execution is smoothly carried out or not, and to approve important matters will become major jobs of the owner party, while establishment of new company organization, recruitment of employees, training, arrangement and ordering of primary and secondary raw materials required, etc., are indispensable for the owner party.

As previously described, this kind of industry is already existing in the Philippines, so that the adoption of some qualified foreign advisors or supervisors who have a plenty of good experiences in this line of business, may not always be necessary, depending upon the situations, but it will be useful for the owner party to adopt foreign advisors or supervisors to carry out smooth execution of construction work and plant operation, as the owner's jobs at this time are greatly diversified and complicated.

XI. 2 Construction Schedule and Training Plan

The construction schedule under this project must correspond with that of PASAR's.

The current PASAR's projection is to complete the construction work by middle 1982, to attempt test running during the second half of 1982 and to commence its commercial operation from the first half of 1983.

It is, therefore, necessary for this project to commence the commercial operation at the same time as PASAR does.

No matter how the construction period for this project is tried to be shortened, it is deemed impossible to reduce it to less than 30 months including test run period. From this, the construction contract must be concluded with the contractor selected by middle 1980. This means that time is quire short for this project.

In Fig. XI-1 is shown the construction schedule proposed.

One of the major jobs for the owner party during the construction period is to educate and train operators employed.

It is scheduled to recruit operators, supervisors, engineers and foremen 9 months prior to the commencement of commercial operation and all other employees 6 months prior to the same, and to educate and train them.

It is assumed that there are broadly three courses of training program, i.e. the first to be conducted under a program of foreign process owner in his plant, the second in the plants of Planters or Atlas already existing in the Philippines, and the third in the plant under construction.

For the first one in overseas, to dispatch employees at supervisor, engineer and/or foreman level including employees in maintenance field, 3 to 4 persons for one process, for about 10 days at a time is appropriate.

For the second at the other manufacturer's plants in the Philippines, a part of general operators and maintenance employees, mainly shift leader level, for about 20 days at a time is recommended to receive training at similar plant.

Thereafter, the employees who have received off-site training shall offer training to employees who have not, and further, all employees shall receive final training from supervisors who will be dispatched from the process owners or equipment suppliers or manufacturers, including actual operation and handling.

XI. 3 Proposed Organization of New Company and Personnel Expenses

A proposed organization chart under this project is shown in Annex XI-1-(1) through (10).

Company organization is first divided into four divisions, Marketing, Manufacturing, Corporate Services and Finance.

The head office is located in Metro Manila and Marketing, Corporate Services and Finance divisions are stationed here. Manufacturing division is stationed in Leyte with some exceptions and totoal manpower of this division counts to 341 and total manpower for other divisions in Manila counts to 52. In results as total company 393 men.

This organization is projected based on the idea that domestic sales will be done through distribution channel already established in the Philippines and export business will be made with governmental or semi-governmental organizations in other ASEAN countries. From this reason, number of staff in sales division is rather small.

Besides this 393 manpower, about 100 daily contract worker will be necessary.

Based on this personnel frame and monthly salary table by ranks, the estimated amount of monthly salary and yearly total personnel expenses are computed. The results are shown in Table XI-1. The total personnel expenses include basic salary, fringe benefits of 35% to basic salary and 15% of overtime pay for non-management level employees.

Fig. X-1 Construction Schedule

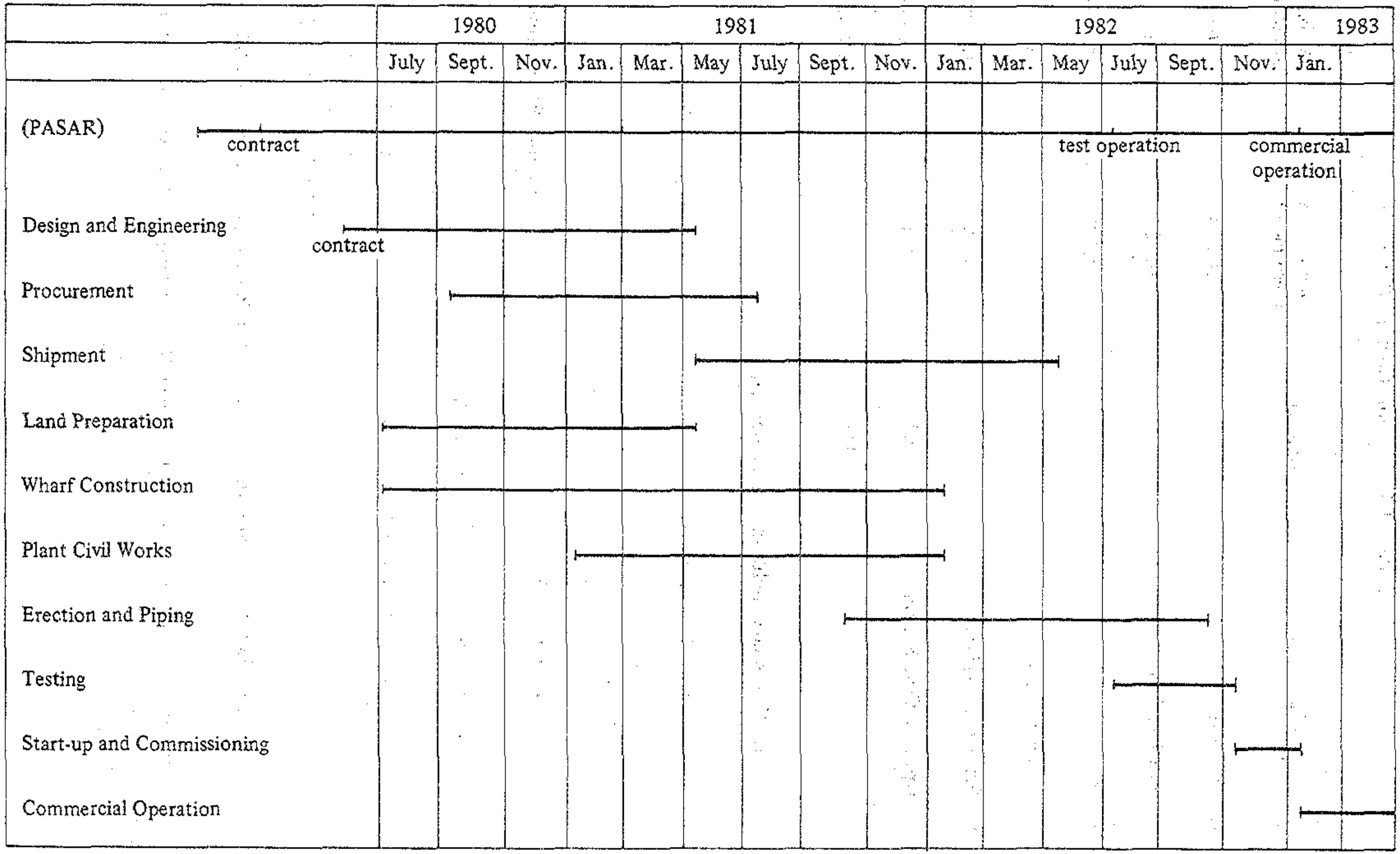


Table XI-1. Labor Cost (1979 base)

	Class	Number	Basic salary (Peso/month)	Amount (Peso/month)
1.	President	1	20,000	20,000
2.	Vice President	4	14,000	56,000
3.	Manager	13	8,000	104,000
4.	Superintendent	16	6,000	96,000
5.	Supervisor, Engineer	56	3,000	168,000
6.	Operator, Clerk Secretary	303	800	242,400
		393		686,400

Monthly salary including fringe benefit

686,400 x 1.35 = 926,640 Peso/month

Overtime pay for class 6

242,400 x 0.15 = 36,360 Peso/month

Daily contract worker (100 persons/day)

100 x 20 Peso/day x 25 day/month = 50,000 Peso/month

1,013,000 Peso/month

1,013,000 Peso/month = 12,156,000 Peso/year = 1,660 (1,000 US$)

When 7%/year escalation is considered, yearly labor cost is about 2,100 (1,000 US$) in 1983.

CHAPTER XII

TOTAL CAPITAL REQUIREMENT

AND FINANCING PLAN

XII. TOTAL CAPITAL REQUIREMENT AND FINANCING PLAN

XII.1 Total Capital Requirement

1. Total Capital Requirement

Assuming that the commercial operation shall commence in January 1983 total capital requirement for Case 10 is shown in Table XII-1. For more detail, please refer to Annex XII-1, 4, 5 and 6 in which breakdown for each item is given. Total investment of 124.28 million US dollars is composed of 59.9% foreign currency portion and 40.1% of local currency portion.

The capital requirement in Table XII-1 is estimated on the assumption that all equipment, materials and services required shall be ordered by the middle of 1980 on the basis of actual prices at July, 1979, which are determined from the data owned by the study team and the various data collected in the Philippines. 4%/Year average interest rate is taken in these tables for the calculation of interest during construction.

The plant construction cost is estimated in terms of US dollars, subject to the package contract with a general contractor on turnkey lump sum basis after the current type in the Philippines.

2. Contingency

Physical contingency is defined as a cost to cover risk of all unforeseenable factors which may be arising from accuracy of conceptual design, estimating and forecasting methods and techniques, and, local marine phenomena, geological conditions, and so on, and the rate is determined to be 10% for each item.

Price contingency is defined as a cost to cover price escalation which may incur during the period up to the end 1982 from July 1979, the time of estimation, and the rate is determined per item to cope with construction schedule of each plant and facility. An escalation rate is set to be 7% per annum for both foreign currency portion and local currency portion.

The detailed contingency schedule is shown in Annex XII-2, and the relation between July 1979 investment cost and the investment cost to be completed end 1982 is shown in Annex XII-3.

If we explain the calculation method of Annex XII-3, the word "Months" means the average time duration from July 1979 to the time when the payment will occur. Price contingency is calculated from 7%/Y and "months" for the escalation until the time of payment. Fore example, in case of 18 Months:

$$(1.07)^{\frac{18}{12}} = 1.107 \rightarrow 10.7\,\%$$

Combined contingency is calculated by multiplying price contingency by physical contingency. In case of 18 months and 10% Physical contingency:

$$(1.10) \times (1.107) = 1.218 \rightarrow 21.8\,\%$$

3. **Import Taxes, Initial Working Capital and Interest During Construction**

It is assumed that the import taxes on all equipment, instruments, apparatus, materials and others deemed necessary for this project to be imported shall be exempted in accordance with "Investment Incentive Act" of the Philippines.

Initial working capital is estimated to require total of 11.56 million US dollars to include such requirements as, inventory of raw materials and products, accounts receivable, accounts payable, cash, etc., subject to the estimated prices at the commencing time of commercial operation in January, 1983.

Interest during the construction period is tentatively taken to be at 4% per annum, assuming that loans shall be financed from foreign countries.

Please refer to Annex XII-5 and XII-6 for the calculations of initial working capital requirement and interest during construction period.

4. **Increments of Capital Requirement Due to Delay in Implementation**

In order to commence the commercial operation in January, 1983, which is the basis of price contingency calculation, all the things planned here must necessarily be carried out as planned, i.e. the construction work must be started from the middle of 1980, sulfuric acid must be supplied by PASAR, sole supplier of sulfuric acid for this project, from January, 1983, resulted from the completion of PASAR's construction project as scheduled, etc.

It is, however, assumed that it contains practically a hard schedule, so that an increment of price contingency shall be required, if the implementation is delayed.

A comparison of estimated total capital requirements by base case, 6-month delay and 1-year delay is tabulated, below.

Total capital requirement: (In Million US Dollars)

Base Case	124.28
6-month Delay	128.63
1-year Delay	132.98

Table XII-1. Estimated Capital Requirement (Case 10) Early 1983

(1,000 US$)

	Foreign	Local	Total
A. Land Acquisition	0	176	176
B. Site Preparation		2,287	2,287
C. Plant Cost			
Plant Equipment & Material			
– Phosphoric Acid Plant	9,054	950	10,004
– NPK Granulation Plant	10,746	1,100	11,846
– Ammonium Sulfate Plant	4,761	200	4,961
– Storage & Warehouses	18,654	1,450	20,104
– Utility Facilities	3,155	250	3,405
– Offsite Facilities	4,808	540	5,348
Spare Parts	2,144	0	2,144
Erection, Civil Work & Building	4,490	30,255	34,745
D. Pier Facilities & Water Intake	6,448	2,087	8,535
E. Housing Colony	0	1,785	1,785
F. Ocean Freight, Insurance	5,940	0	5,940
G. Pre-operation Expenses	100	1,340	1,440
Total Plant Cost	70,300	42,420	112,720
H. Initial Working Capital	4,100	7,460	11,560
Total	74,400	49,880	124,280

XII.2 Financing Plan

A total capital requirement is 124.28 million US dollars and it is planned to be 30 % of equity capital and 70 % of long-term loan, as a financing way.

	(In Thousand US Dollars)
Equity capital (30%)	37,284
Long-term loans (70%)	86,996
Total	124,280

As agreed in the meeting of the ASENA Economic Ministers, 60 % of equity capital shall be subscribed by the Philippines and remaining 40 % by all member countries of ASEAN other than the Philippines, and such amounts are tabulated as follows:

	(In Thousand US Dollars)
Philippines (60%)	22,370
Indonesia (13%)	4,847
Thailand (13%)	4,847
Singapore (1%)	373
Malaysia (13%)	4,847
Total	37,284

All loan shall be appropriated for expenditure in foreign currency. Financing sources and arrangement for the loans are not yet definite for the time being, but, to simplify the further study, here we introduce "consolidated average interest rate and repayment (grace period)." For the sake of theoretical analysis, calculation hereafter are made based on the assumed conditions of annual equal installments of the principal for 15 years including 4-years grace period and interest rate of 4, 5 and 6 %. In the main part of this report discussions are made in the case of 4 % interest rate and the results in other cases such as 5 and 6 % interest rate are given in Annex.

But, this does not imply that the loan of 4 % interest rate is indispensable to make the project economically feasible.

The outline of long-term loan repayment schedule is given in Annex XII-8. Loan schedule is assumed to be 30 % for 1980, 40 % for 1981 and 30 % for 1982. (Refer to Annex XII-7).

CHAPTER XIII

FINANCIAL ANALYSES

XIII. FINANCIAL ANALYSES

XIII.1 Sales Program

Plant production capacity is as follows: (In 1,000 tons/year)

Ammonium sulfate	150.0
15-15-15	184.5
16-20-0	184.5

Operating rate is 60 % for initial year of 1983, 80 % for 1984 and 90 % for 1985 in terms of production capacity and thereafter to enter into constant operation.

Estimated product selling price is likely as shown in Table XIII-1. These prices are based on FOB, Philippines factory site, in January 1983.

CIF price for the ASEAN countries in July, 1979, is equivalent to the sum of Philippines' FOB price plus 15 US$/T of ocean freight cost to the ASEAN neighbors for bag products. If product is desired in bulk, freight cost is 12 US$/T and bagging cost is about 12 US$/T. Please refer to Annex XIII-1 for the basis of how ocean freight cost is determined.

C & F prices are planned to be rather low, as compared with such current prices in the ASEAN countries, as mentioned in Capter III and reference table of Table XIII-1.

Early 1983 prices are determined considering the escalation rate of 7%/Y.

Table XIII-1. Selling Price of Products

(US$/T)

	FOB Philippines		CIF ASEAN	
	July 1979	Early 1983	July 1979	Early 1983
Ammonium Sulfate	100	127	115	146
15-15-15	200	253	215	272
16-20-0	165	209	180	228
54% Phosphoric acid	345	437	370	469

Reference: Market Price July 1979

(US$/T)

	FOB Korea, Japan or USA	CIF Philippines
Ammonium Sulfate	100	120
15-15-15	205	230
16-20-0	183	200
54% Phosphoric acid	330	380

Total turnover is computed by computing turnover for each product by the following formula,

(Production capacity) x (Operating rate) x (Sales price)

and summing them up, while sales revenue is practically determined by adjusting turnover to keep constant product inventory of half month production of the year.

Table XIII-2 shows annual production and sales revenue.

Table XIII-2. Production and Sales Revenue Schedule (1983 price)

	1983	1984	1985	1986 onwards
Rated capacity (1,000 tons/year)				
Ammonium sulfate	150.0	150.0	150.0	150.0
15-15-15	184.5	184.5	184.5	184.5
16-20-0	184.5	184.5	184.5	184.5
Capacity utilization (%)	60	80	90	90
Total production (1,000 tons/year)	90	120.0	135.0	135.0
Ammonium sulfate	90	12.0	135.0	135.0
15-15-15	110.7	147.6	166.0	166.0
16-20-0	110.7	147.6	166.0	166.0
Invensoty increase (1,000 tons/year)				
Ammonium sulfate	3.75	1.25	0.63	0
15-15-15	4.61	1.54	0.77	0
16-20-0	106.1	146.1	165.2	166.0
Total sales volume (1,000 tons/year)				
Ammonium sulfate	86.3	118.8	134.4	135.0
15-15-15	106.1	146.1	165.2	166.0
16-20-0	106.1	146.1	165.2	166.0
Sales revenue (1,000 US$/year)				
Ammonium sulfate	10,954	15,081	17,065	17,145
15-15-15	26,840	36,954	41,818	42,010
16-20-0	22,172	30,527	34,543	34,705
Total	59,966	82,562	93,426	93,860

XIII. 2 Manufacturing Cost

1. Raw Materials and Their Costs

Raw materials to be used and their costs are shown in Table XIII-3, below. Please refer to Chapter V for further detail description on raw material prices.

Table XIII-3. Raw Materials to be used and Their Prices

	July 1979	Early 1983
Phosphate rock (US$/T)	55	70
Sulfuric acid (US$/T)		19
Ammonia (US$/T)	150	190
Potassium chloride (US$/T)	82	104
Urea (US$/T in bag)	170	215
Electricity (US$/KWH)	0.036	0.044
Heavy fuel oil (US$/T)	138	175
Anti-foaming agent (US$/T)	1,700	2,154
Anti-caking agent (US$/T)	120	152
Bag (US$/T Fertilizer)	10.3	13.1

2. Raw Material Consumptions Rate

Raw material consumptions required to manufacture a unit weight of product are shown in Table IX-1.

3. Variable Costs

Variable costs are computed with the following formula:

$$\Sigma \begin{pmatrix}\text{Production capacity per product}\end{pmatrix} \times \begin{pmatrix}\text{Operating rate}\end{pmatrix} \times \begin{pmatrix}\text{Raw material consumption rate per unit product}\end{pmatrix} \times \begin{pmatrix}\text{Raw material price}\end{pmatrix}$$

Summary of annual variable cost thus computed are tabulated in Table XIII-4. Further, ratio of each raw material occupied in the variable cost is as follows:

	Case 10
	(%)
Phosphate rock	23.4
Sulfuric acid	12.7
Ammonia	32.2
Potassium chloride	8.0
Urea	4.5
Electricity	2.5
Fuel Heavy Oil	4.8
Anti-caking agent	0.9
Anti-foaming agent	–
Bags	11.0
Total	100.0

4. Depreciation

Depreciable life or depreciation rate to be used in the depreciation computation are not legally set in the laws of tax, Philippines, while are customerily determined by tax payers themselves with a prior written approval of the Director of the Domestic Revenue Bureau.

In practice, Bulletin F issued by the US Treasury Department is referred to and followed in many cases.

In this project it is determined to use a straight line method with 10% salvage value as well as to conform with Bulletin F.

Depreciable life and annual depreciation amount per major equipment and facility are as follows: (In thousand US$)

	Depreciable life	Amount
Pre operation expenses	5	288
Plants	12	7,387
Interest during construction	12	372
Houses	30	54
Port facilities & Water intake facility	50	154
Total		8,254

* Pre-operation expenses are amortized in five years without salvage value.

Further, please refer to Annex XIII-2 for details on depreciation, Annex XII-4 for pre-operation expense and Annex XII-6 for interest during construction.

5. Maintenance Costs

Maintenance cost is determined to be 2% for ammonium sulfate plant, 3.2% for phosphoric acid and NPK plant and 3% for other plants, all for total plant construction cost. These includes only repair and maintenance materials, expendables and consumables, but not labor, plant and utility cost for maintenance, all of which are already costed in respective account.

The same rate, 3% to construction cost, is also applied for port and water intake facilites.

Repair and maintenance cost of 1% to total construction cost is planned for houses.

	(In Thousand US Dollars)
Plants	2,972
Port and Water Intake Facilities	256
Houses	18
	3,246

6. Personnel Expenses

Personnel expenses consist of basic salary, overtime fee, fringe benefits, and daily contract employee wages.

Total number of employees are 52 in the head office in Manila and 231 in the factory in Leyte, totaling to 393 employees.

Basic salary is denoted in terms of annual rate for every employee; overtime is at 15% of basic salary for all non-management level employees; fringe benefit at 35% of basic salary for every employee; and total daily contract employees expenses in terms of 100 daily workers for 25 days in a month.

Total personnel expense estimated is 1,660 thousand US dollars in July, 1979, and its escalation at annual rate of 7% results in 2,100 thousand US dollars in January, 1983. Please refer to para. XI-3 Table XI-1 for further details on personnel expense estimation.

7. Overhead Expenses

Overhead expense is estimated at a rate of 4% to total manufacturing cost, in reference with the statistical data of similar manufacturers in the same line of business in the Philippines. Included are rental fee for Manila head office, travel expenses, acquisition/repair/maintenance cost of passenger vehicles, cost for miscellaneous use of electricity, expenses for guardmen, and others, but sales expenses are excluded.

When we take this calculation system, overhead expense is influenced by operation rate and this is unreasonable. But we are of the opinion that this gives almost no influence on conclusion.

8. Taxes, Levies, and Insurance

Total tax and levies are estimated at a rate of 2.0 % to the remaining sum of such fixed assets as, plants, port facilities, water intake facilities, houses, acquisition cost of land plus land preparation cost, roads construction cost, and others, after deduction of all depreciations.

Insurance premium is estimated at a rate of 1.6 % to the remaining sum of such construction costs as, plants, port facilities, water facilities, and houses.

9. Manufacturing Cost

Total manufacturing cost and manufacturing costs for each product for the year of 1988 with interest rate 4 % as example are computed in terms of all cost elements estimated in preceding paras., and recapitulated in Table XIII-4 with detailed variable cost. Total manufacturing cost for each year with interest rate 4, 5 and 6 % are given in Annex XIII-3 through 5.

When many products are manufactured in one plant, it is very difficult to allocate the common fixed costs to each product. In this calculation for each product, fixed cost proper to each product is separated as much as possible and remaining common fixed cost is allocated among each product following the ratio of sales value. The fixed cost for phosphoric acid manufacturing is allocated among NPK, NP following the phosphoric acid consumption ratio of each product.

Main manufacturing cost composition is as follows:

Variable cost	72.5 %	
Phosphate rock		16.9 %
Ammonia		23.3
Sulfuric acid		9.2
Fixed cost	27.5 %	
Depreciation		10.8 %

Table XIII-4. **Production Cost of Each Product, 1988 (Case 10 base case, Interest rate 4 %, Operating rate 90 %) (1,000 US$)**

Variable cost	Total	AS	15-15-15	16-20-0
Phosphate rock	12,991		5,590	7,401
Sulfuric acid	7,046	1,934	2,193	2,919
Ammonia	17,880	6,746	4,762	6,372
Potassium chloride	4,422		4,422	
Urea	2,500		2,500	
Electricity	1,417	196	568	653
Fuel heavy oil	2,668	284	1,134	1,250
Anti-caking agent	504		252	252
Anti-foaming agent	22		11	11
Bag	6,121	1,769	2,176	2,176
(1) Variable cost total	55,571	10,929	23,608	21,034
Plant cost (proper)	28,938	7,278	10,830	10,830
PA plant cost**	18,029		7,734	10,295
Other plant cost*	51,530	9,430	23,034	19,066
Plant cost total	98,497	16,708	41,598	40,191
Depreciation (plant)*	7,387	1,253	3,199	3,014
Depreciation (housing)*	54	10	24	20
Depreciation (harbor)*	154	28	69	57
Depreciation (interest during construction)	372	68	166	138
Amotrization	288	53	128	107
(2) Depreciation total	8,254	1,412	3,506	3,336
Maintenance cost (plant)*	2,972	429	1,290	1,253
Maintenance cost (housing)*	18	3	8	7
Maintenence cost (harbor)	256	47	114	95
(3) Maintenance cost total	3,246	479	1,412	1,355
(4) Labor cost*	2,100	384	939	777
(5) Overhead cost*	2,967	543	1,326	1,098
(6) Tax & Insurance*	2,326	426	1,040	860
(7) Interest*	2,214	405	990	819
Fixed total cost [(2) – (7)]	21,107	3,649	9,213	8,243
Total cost [(1) – (7)]	76,678	14,578	32,821	29,279
Total US$/T product		108	198	176
Cash cost US$/T product		98	177	156

* Total cost is allocated following the sales value ratio of each product

** Total plant cost is allocated following the phosphoric acid consumption ratio for each product.

XIII.3 Financial Analysis Idnicators

1. Assumptions on Financial Analysis

Assumptions on Financial analysis are set as follows:

Sales Expenses:

Nil, with the reason because it is assumed that a majority of products under this project shall be exported, and domestic sales shall be made through the existing distribution channels, by commissioning the currently existing fertilizer manufacturers. These jobs shall be performed by head office in Manila, while such personnel expenses are already counted in manufacturing cost.

Interest for long-term loans:

As examples of consolidated average interest rates, 4, 5 and 6 % per annum are taken. Annex XII-8 shows the payment schedule of long-term loan for the case of interest rate 4 %.

Corporate income tax:

Rate of corporate income tax is 35 % to total net profit and development tax is 5 % to toal net profit. Income tax totals to 40 %. But loss can be carried over to the succeeding year.

2. Income Statements

Income statements computed in accordance with previous descriptions of paras. XIII-2 and 3, are shown in Annex Tables XIII-6 through 8. Total sales revenue after 1986 is 93,860 thousand US$/Y.

In these tables, net profit before tax, income tax and net profit after tax for each year are shown.

Sales revenue calculation method is shown in Table XIII-2. In the column of "cost of sales" in Annex XIII-6 through 8, increase in product inventory is deducted. This value is calculated as the difference of inventory value between beginning and end of the year. Such inventory value is calculated using production cost of that year.

3. Profitability and Internal Rate of Return (IRR)

Average net profit over 12 years and average return on paid-up equity capital (ROE) for the cases of interest rate 4, 5 and 6 % are as follows:

Interest rate	4 %	5 %	6 %
Profit (1,000 $)			
before tax	16,265	15,601	15,057
after tax	9,759	9,397	9,034
ROE average			
before tax	43.6 %	42.0 %	40.4 %
after tax	26.2 %	25.2 %	24.2 %
ROE discounted base			
before tax	25.1 %	23.9 %	22.7 %
after tax	16.0 %	15.1 %	14.3 %

Internal rate of return (IRR) and payout period for the cases of interest rate 4, 5 and 6 % are as follows.

Interest rate	4 %	5 %	6 %
IRR			
after tax	10.41 %	10.58 %	10.74 %
before tax	14.46 %	14.43 %	14.40 %
Pay-out period (years)			
after tax	6.51	6.41	6.32
before tax	5.26	5.26	5.26

For the calculation detail of internal rate of return and pay-out period, please refer to Annex XIII-9 through 14. Regarding the break-down of salvage value, please refer to Annex XIII-2.

4. Debt Service Coverage Ratio (DSR)

Profit to sales revenue, Debt Service Coverage Ratio (DSR) to denote capability of credit repayment are shown in Annex XIII-15 through 17 for the cases of interest rate 4, 5 and 6 %.

Average value for 12 years are as follows:

Interest rate	4 %	5 %	6 %
Profit to sales revenue (%)			
after tax	10.54	10.12	9.70
before tax	17.57	16.87	16.17
DSR	2.25	2.14	2.04

(Reference):

DSR = (Depreciation amount + Net profit after tax + Interest payable) ÷ (Principal repayable + Interest payable)

5. Break Even Point

Profit and cash break even point of operating rate and price are also shown in Annex XIII-15 through 17. Profit break even point for operating rate and price are plotted on Figs. XIII-1 and 2.

Fig. XIII-1. Break Even Point of Operation

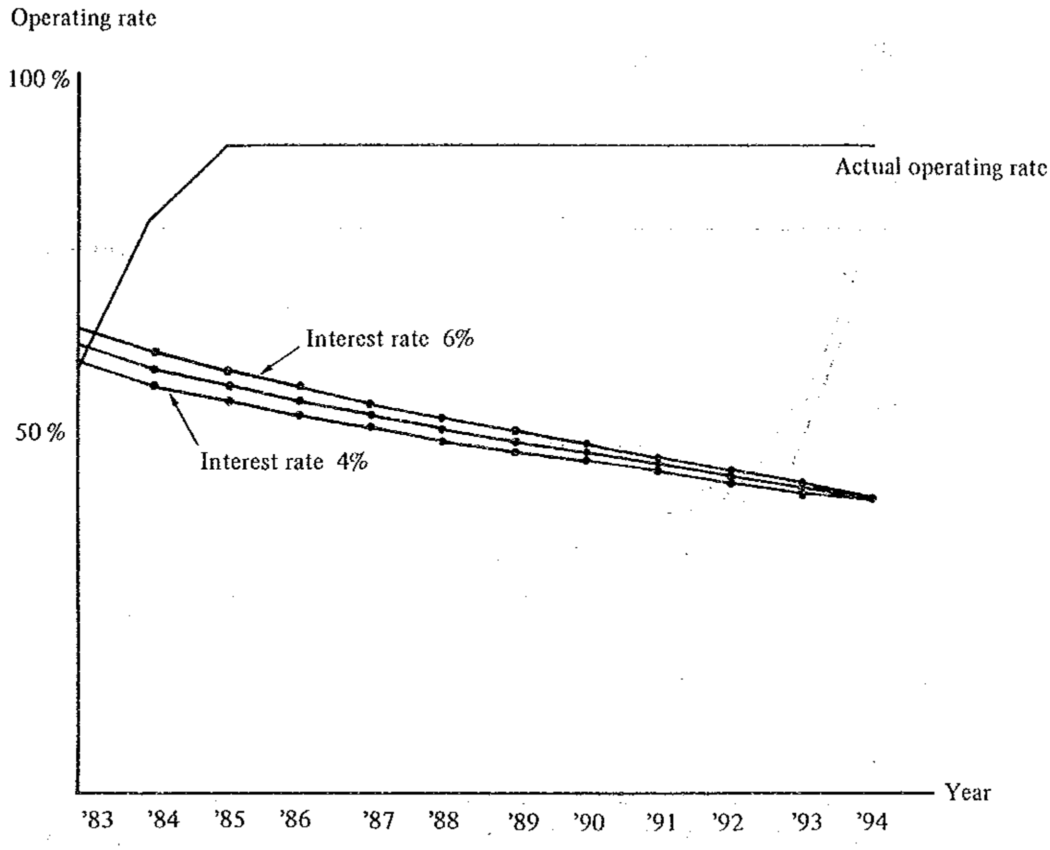
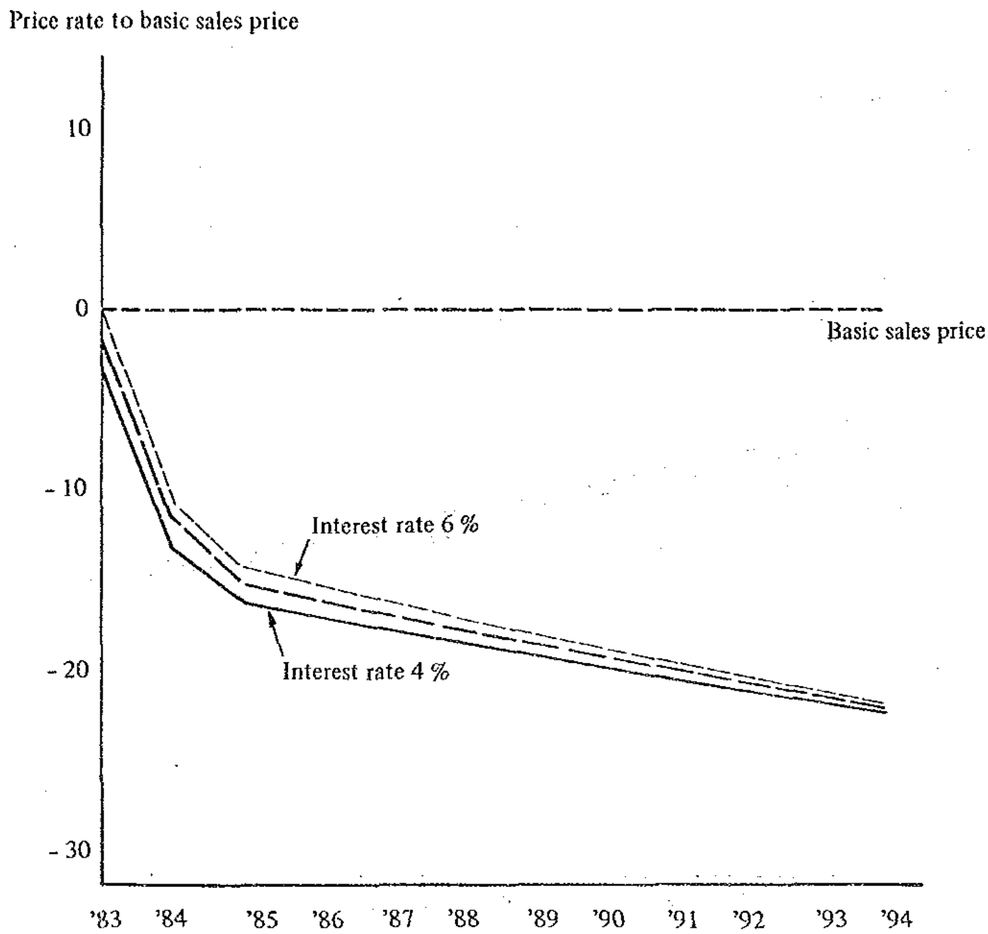


Fig. XIII-2. Break Even Point of Sales Price



6. **Financial Statements and Conclusions**

From the financial analyses studied above, it can be concluded that the resulted financial indicators show reasonably favorable figures from profitability, commercial soundness and cash flow points of view.

It is, therefore, concluded that this project is commercially sound and feasible and deserved to be implemented as one of the ASEAN projects.

Cash flow statements are shown in Annex XIII-18 through 20 and balance sheets are shown in Annex XIII-21 through 23 for the cases of long term interest rate 4, 5 and 6 %.

XIII.4 Sensitivity Analyses and Overall Evaluation

1. **Interest**

Difference of interest affects upon capital requirements (caused from difference in interest druing construction), profitability and cash flow.

The results of sensitivity analyses in terms of changes in the interest rate are shown in lines of Case 10-1-1 through 6, Table XIII-5.

For example, when interest rate is raised to 6 % from 4 % in Case 10, the following changes would come after.

	Case 10	Case 10-1-3	Increments
Interest rate (%)	4	6	2
Interest during construction (thousand US$)	4,959	7,438	2,479
Manufacturing cost 1988 (thousand US$)	76,390	77,691	1,301
Average return on paid-up equity capital (after tax) (%)	26.17	24.23	- 1.94
Average sales profit ratio (after tax) (%)	10.54	9.70	- 0.84
Average DSR	2.25	2.04	- 0.21

For more detail, please refer to Annex XIII-3 through 23. The effects upon IRR with change of interest rate is quite small, because interest is very little related with a process of IRR calculation, and only interest during construction period affects upon depreciation amount.

2. Product Sales Price

Affects of change in product sales price upon feasibility is extraordinarily large, and this change is apt to happen most often in reality.

The results of sensitivity analyses in terms of changes in the product sales price, per case 10 with interest rate 4 %, are shown in lines of Case 10-2-1 through 16, Table XIII-15 and the effects on IRR are also plotted on Fig. XIII-3.

Supposed that a tolerable range of IRR (after tax) is upper limit of 20 % and lower limit of 8 %, IRR would reach to such limits in the following cases.

Regarding Case 10:

(1) IRR (after tax) would reach to 20 % in cases of:

When the prices of all products are raised by 28 %, namely

	From	To
AS	127 US$/T	163 US$/T
15-15-15	253 US$/T	324 US$/T
16-20-0	209 US$/T	268 US$/T

When only the prices of NPK/NP are raised by 34 %, but no changes in AS, namely.

	From	To
15-15-15	253 US$/T	339 US$/T
16-20-0	209 US$/T	280 US$/T

(2) IRR (after tax) would reach to 8 % in cases of:

When the prices of all products are lowered by 6 %, namely

	From	To
AS	127 US$/T	119 US$/T
15-15-15	253 US$/T	238 US$/T
16-20-0	209 US$/T	196 US$/T

When only the prices of NPK/NP are lowered by 8 %, but no changes in AS, namely:

	From	To
15-15-15	253 US$/T	233 US$/T
16-20-2	209 US$/T	192 US$/T

With these results, the cases are relatively possible to happen that the price of all product come down by 6 % or the prices of NPK/NP come down by 8 %. In such cases, IRR would reach lower limit of 8 %.

The affect of product sales price over return on paid-up equity capital is keenly sensitive. For example, when the prices of all products are raised by 10 %, return on paid-up equity (after tax) would rise up to 40.67 % from 26.17 %, while when lowered by 10 %, it comes down to 11.68 %.

3. **Raw Material Price**

The results of sensitivity analyses with interest rate 4 %, regarding the effect of raw material prices change are shown in lines of Case 10-3-1 through 26, Table XIII-5. The effect upon IRR are also plotted in Fig. XIII-4.

Supposed that a tolerable range of IRR (after tax) is 8 – 20 %, IRR would reach to such limits, when the prices of raw materials are as follows:

(1) IRR (after tax) would reach to 20 % in cases of:

When the prices of all raw materials are lowered by 57 %, namely:

	From	To
Phosphate rock	70 US$/T	40 US$/T
Sulfuric acid	19 US$/T	11 US$/T
Ammonia	190 US$/T	108 US$/T
Potassium chloride	104 US$/T	59 US$/T
Urea	215 US$/T	123 US$/T

(2) IRR (after tax) would reach to 8 % in cases of:

When the prices of all raw materials are raised by 12 %, namely:

	From	To
Phosphate rock	70 US$/T	78 US$/T
Sulfuric acid	19 US$/T	21 US$/T
Ammonia	190 US$/T	213 US$/T
Potassium chloride	104 US$/T	116 US$/T
Urea	215 US$/T	241 US$/T

When only the price of ammonia is raised by 29 %, but no changes in other raw materials, namely:

Ammonia	190 US$/T	245 US$/T

When only the price of phosphate rock is raised by 41 %, but no changes in other raw materials, namely:

Phosphate rock	70 US$/T	99 US$/T

When only the price of sulfuric acid is raised by 70 %, but no changes in other raw materials, namely:

Sulfuric acid	19 US$/T	32 US$/T

With these results, the cases are relatively possible to happen that the prices of all raw materials would rise up by 12 %, or the price of sulfuric acid would become 32 US$/T at 70 % up.

What the prices of raw materials affect upon other financial analysis indicators is also very high. For example, when the prices of all raw materials are raised by 10 % in Case 10-3-5 the return on paid-up equity capital (after tax) and the sales profit ratio would come to 19.36 % to 26.17 % and 7.72 % from 10.54 % respectively.

4. **Sales Price and Raw Material Price**

In actual cases, the product sales prices and the raw material prices change at the same time. The sales prices will change following the change of the raw material prices, though they are not completely parallel. Fig. XIII-5 shows the IRR changes following the various changes of the sales prices and raw material prices, and figures are given in lines Case 10-4-1 through 28 in Table XIII-5.

But these figures show only for the cases when every sales price or raw material price changes at the same rate.

5. **Operating Rate**

In some cases, for example when sulfuric acid is not supplied fully from PASAR, the operating rate may be lowered down.

As seen in lines of Case 10-5-1, Table XIII-5, when the operating rate is 60 % in 1983 and kept 70 % thereafter, IRR (after tax) would be greatly lowered down to 7.30 % from 10.41 %. All other financial analysis indicators come naturally down. Naturally such cases as operating rate is temporarily lowered to 70 % are expected.

6. **Construction Cost**

In either cases that the acutal inflation rate exceeds the sum of price contingency assumed at the time of construction cost estimation, or any unforeseen cost increase is caused during the construction period than estimated as physical contingency, the total construction cost would exceed what is initially estimated.

The results of sensitivity analyses in terms of changes in the construction cost with interest rate 4 %, are shown in lines of Case 10-6-1 through 4, Table XIII-5. Everyone of the indicators would not be affected vitally, when the construction cost varies up or down within a range of 10 %.

7. Conclusions

Conclusions derived from all of the sensitivity analyses studied in the previous paras. 1 thorugh 6 are summed up as follows:

(1) The terms and conditions on long-term debts tentatively assumed in the project, i.e., consolidated average interest rate of 4, 5 or 6 % per annum and 15-year repayment term including 4 years grace period are greatly contributing to the profitability of this project.

(2) As far as any acutal selling prices of ammonium sulfate, NPK and NP stay within a range of 6 % lower, or those for NPK and NP within 7 % lower, IRR of above 8 % can possibly be maintained.

(3) In case that every actual price of all raw materials rises 12 % or more, IRR becomes 8 %. But in such a case, a rise in acutal product selling prices is naturally expected, so that there is little possibility that IRR becomes less than 8 % because of price increase of raw material.

(4) An average of break even point for operating rate is 49 % with interest rate 4 %. A drop in operating rate naturally gives bad effect to the porifitability, and a consistent operating rate of more than 75 % will allow maintenance of 8 % or more of IRR.

(5) It is advisable to limit a rise of construction cost within a range of 10 %, and indispensable within 20 %, even in the worst occasion.

(6) With all these, it is concluded that this project is well-deserved to be materialized from financial point of view.

Fig. XIII-3. Sensitivity Analysis IRR, Sales Price

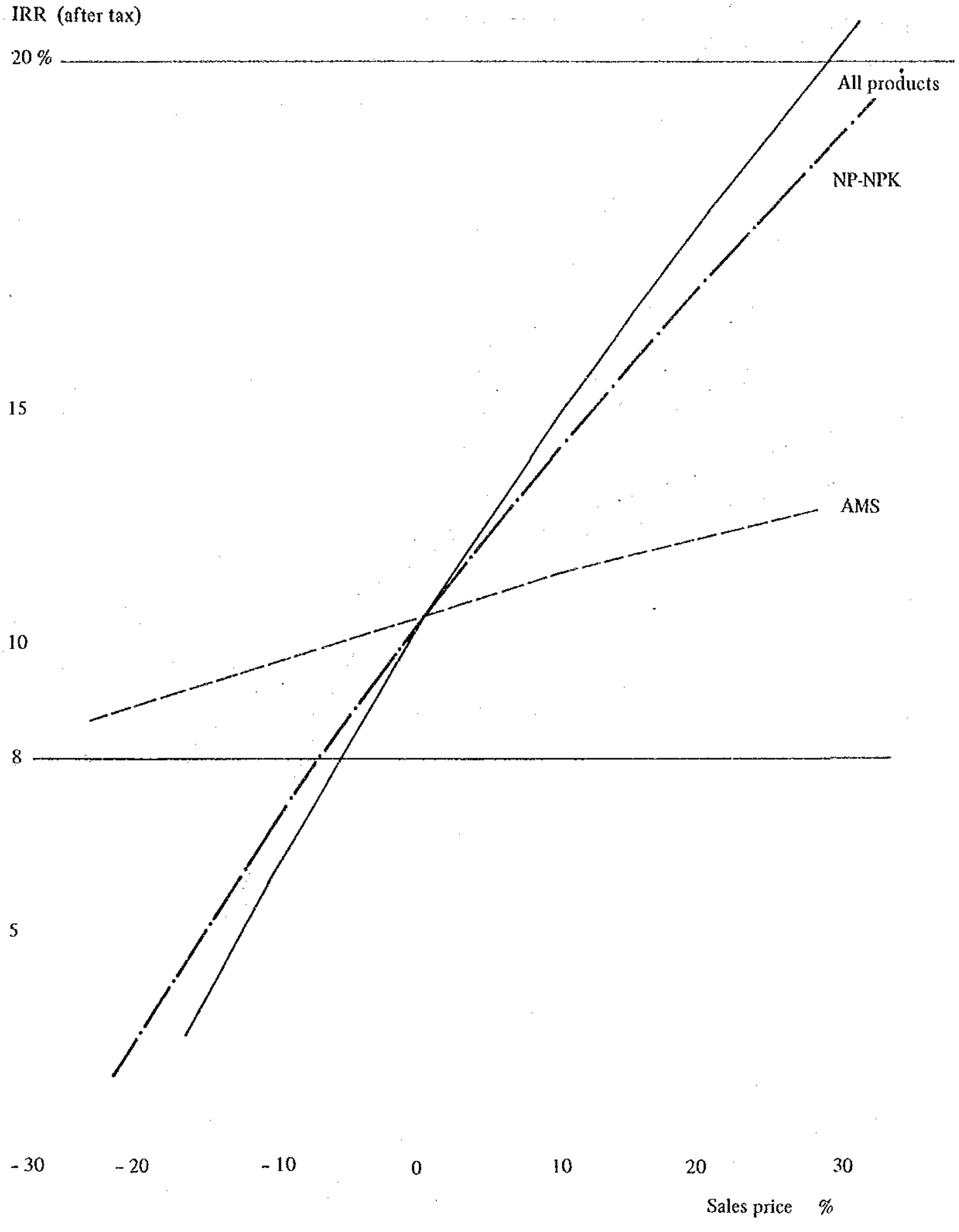


Fig. XIII-4. **Sensitivity Analysis IRR – Material Price**

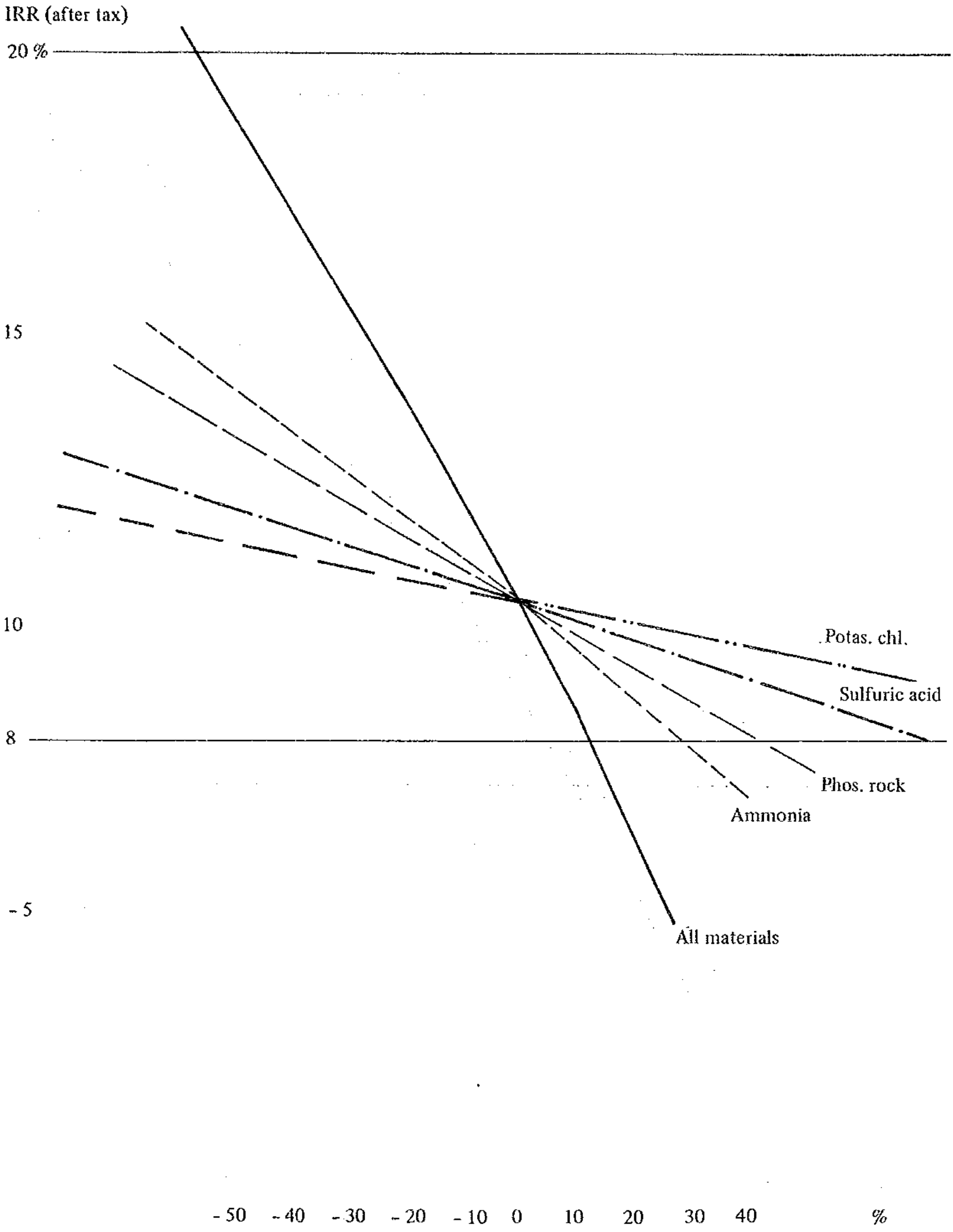


Fig. XIII-5. Sensitivity Analysis IRR – Sales Price and Material Price

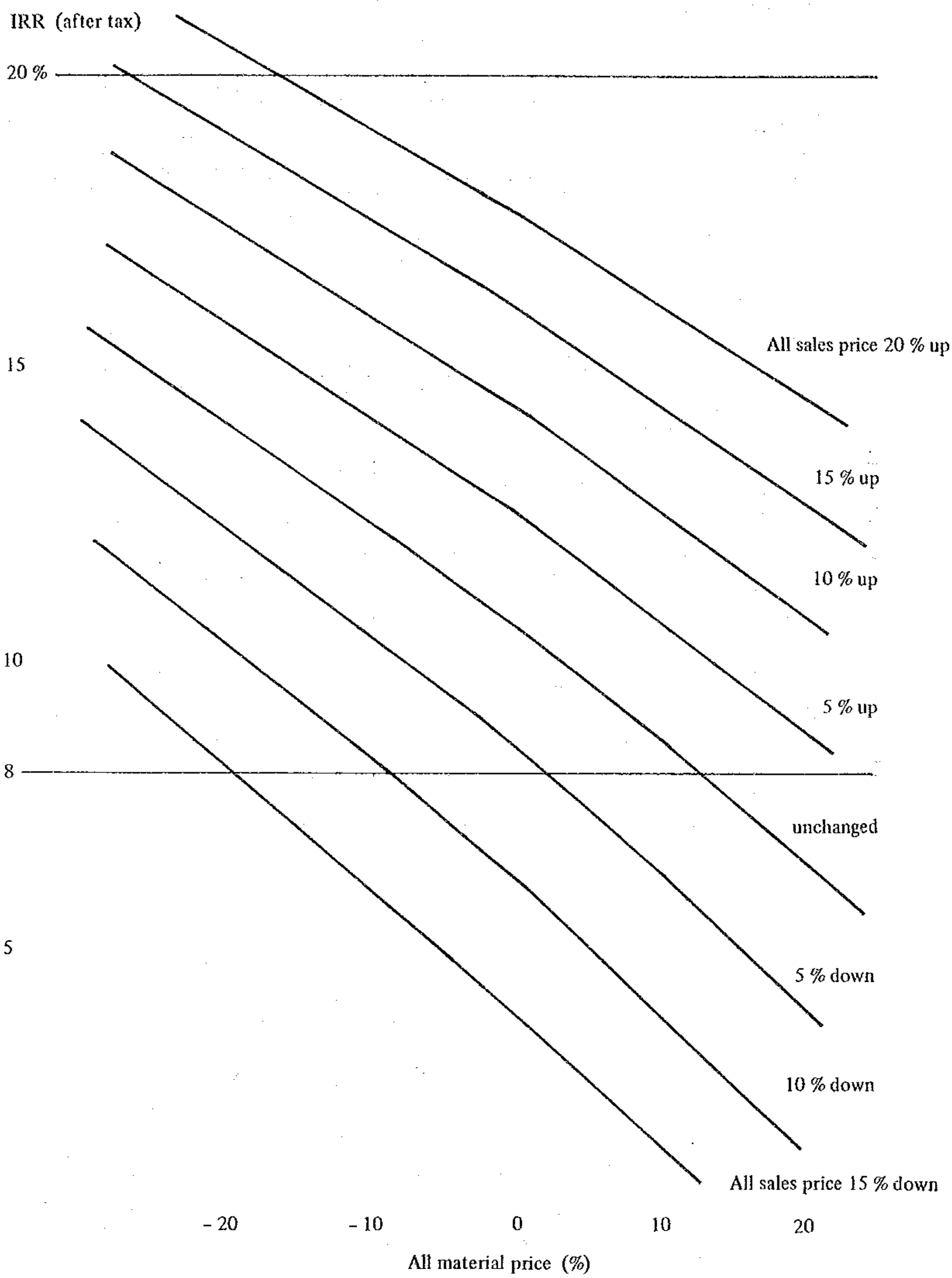


Table XIII-5. Results of Sensitivity Analysis

			IRR		Pay out period		Average return on paid-up capital		Average sales profit ratio		Average debt service coverage ratio
			After tax (%)	Before tax (%)	After tax (%)	Before tax (%)	After tax (%)	Before tax (%)	After tax (%)	Before tax (%)	
Case	10	Base Case	10.41	14.46	6.51	5.26	26.17	43.62	10.54	17.57	2.25
Case	10-1-1	Interest rate 3 %	10.24	14.49	6.62	5.26	27.15	45.24	10.97	18.28	2.41
	10-1-2	Interest rate 5 %	10.58	14.43	6.41	5.26	25.20	42.00	10.12	16.87	2.14
	10-1-3	Interest rate 6 %	10.74	14.40	6.32	5.26	24.23	40.38	9.70	16.17	2.04
	10-1-4	Interest rate 7 %	10.91	14.37	6.22	5.26	23.26	38.76	9.27	15.46	1.97
	10-1-5	Interest rate 8 %	11.07	14.35	6.13	5.26	22.29	37.14	8.83	14.76	1.90
	10-1-6	Interest rate 9 %	11.24	14.32	6.03	5.26	21.31	35.52	8.39	14.05	1.84
Case	10-2-1	Sales price AMS 10 % up	11.12	15.84	6.23	4.98	28.82	48.04	11.43	19.05	2.37
	10-2-2	Sales price NPK, NP 10 % up	13.51	18.83	5.42	4.22	38.02	63.37	14.28	23.80	2.75
	10-2-3	Sales price PA 10 % up	–	–	–	–	–	–	–	–	–
	10-2-4	Sales price All products 10 % up	14.15	19.74	5.22	4.04	40.67	67.78	15.04	25.07	2.87
	10-2-5	Sales price AMS 20 % up	11.83	16.48	5.97	4.73	31.47	52.45	12.29	20.48	2.48
	10-2-6	Sales price NPK, NP 20 % up	16.33	22.75	4.66	3.54	49.87	83.11	17.49	29.16	3.26
	10-2-7	Sales price PA 20 % up	–	–	–	–	–	–	–	–	–
	10-2-8	Sales price All products 20 % up	17.52	24.38	4.39	3.31	55.16	91.93	18.79	31.31	3.48
	10-2-9	Sales price AMS 10 % down	9.67	13.41	6.83	5.57	23.53	39.21	9.62	16.04	2.14
	10-2-10	Sales price NPK, NP 10 % down	6.94	9.45	8.23	7.08	14.33	23.88	6.10	10.24	1.73
	10-2-11	Sales price PA 10 % down	–	–	–	–	–	–	–	–	–
	10-2-12	Sales price All products 10 % down	6.11	8.21	8.76	7.68	11.68	19.47	4.98	8.42	1.62
	10-2-13	Sales price AMS 20 % down	8.91	12.31	7.18	5.93	20.88	34.80	8.67	14.45	2.03
	10-2-14	Sales price NPK, NP 20 % down	2.95	3.47	11.30	10.88	2.48	4.14	0.68	1.47	1.21
	10-2-15	Sales price PA 20 % down	–	–	–	–	–	–	–	–	–
	10-2-16	Sales price All products 20 % down	–	–	–	–	-4.68	-4.68	-3.03	-3.03	0.90

Table XIII-5. Results of Sensitivity Analysis (Cont'd)

			IRR		Pay out period		Average return on paid-up capital		Average sales profit ratio		Average debt service coverage ratio
			After tax (%)	Before tax (%)	After tax (%)	Before tax (%)	After tax (%)	Before tax (%)	After tax (%)	Before tax (%)	
Case	10-3-1	Material price Phos. Rock 10 % up	9.82	13.63	6.76	5.50	24.08	40.14	9.68	16.13	2.17
	10-3-2	Material price Sulp. Acid	10.09	14.00	6.65	5.39	25.04	41.74	10.08	16.79	2.21
	10-3-3	Material price Ammonia	9.61	13.31	6.86	5.60	23.30	38.83	9.35	15.59	2.13
	10-3-4	Material price Potas Chl.	10.21	14.18	6.60	5.34	25.46	42.44	10.25	17.08	2.22
	10-3-5	Material price All materials	8.48	11.68	7.40	6.16	19.36	32.27	7.72	12.88	1.96
	10-3-6	Material price Phos. Rock 20 % up	9.23	12.78	7.03	5.78	21.99	36.66	8.81	14.69	2.08
	10-3-7	Material price Sulp. Acid	9.78	13.56	6.78	5.53	23.91	39.85	9.61	16.01	2.16
	10-3-8	Material price Anmonia	8.78	12.12	7.24	6.00	20.42	34.04	8.16	13.61	2.01
	10-3-9	Material price Potas Chl.	10.00	13.89	6.68	5.42	24.75	41.25	9.96	16.59	2.19
	10-3-10	Material price All materials	6.40	8.63	8.58	7.47	12.55	20.92	4.85	8.18	1.65
	10-3-11	Material price Phos. Rock 10 % down	10.97	15.27	6.29	5.04	28.27	47.11	14.33	23.88	2.34
	10-3-12	Material price Sulp. Acid	10.72	14.90	6.39	5.14	27.31	45.51	11.01	18.36	2.30
	10-3-13	Material price Anmonia	11.18	15.57	6.21	4.96	29.05	48.42	11.74	19.56	2.38
	10-3-14	Material price Potas Chl.	10.60	14.74	6.43	5.18	26.89	44.81	10.84	18.07	2.28
	10-3-15	Material price All materials	12.22	17.03	5.83	4.60	32.99	54.98	13.36	22.27	2.54
	10-3-16	Material price Phos. Rock 20 % down	11.54	16.05	6.08	4.83	30.36	50.59	12.28	20.46	2.43
	10-3-17	Material price Sulp. Acid	11.01	15.34	6.27	5.02	28.44	47.40	11.48	19.14	2.35
	10-3-18	Material price Anmonia	11.94	16.65	5.93	4.69	31.93	53.21	12.93	21.54	2.50
	10-3-19	Material price Potas Chl.	10.79	15.00	6.36	5.10	27.60	45.99	11.13	18.56	2.31
	10-3-20	Material price All materials	13.94	19.44	5.29	4.10	39.80	66.33	16.18	26.97	2.83
	10-3-21	Material price Sulp. Acid 40 % up	9.13	12.63	7.07	5.83	21.64	36.07	8.67	14.45	2.06
	10-3-22	Material price Sulp. Acid 60 % up	8.48	11.68	7.39	6.16	19.38	32.29	7.72	12.88	1.96
	10-3-23	Material price Sulp. Acid 90 % up	7.46	10.19	7.94	6.75	15.98	26.63	6.29	10.54	1.81
	10-3-24	Material price Sulp. Acid 40 % down	11.63	16.19	6.04	4.80	30.71	51.18	12.42	20.70	2.45
	10-3-25	Material price Oil 20 % up	10.17	14.12	6.61	5.36	25.30	42.20	10.19	16.98	2.22
	10-3-26	Material price Electricity 20 % up	10.28	14.28	6.57	5.31	25.72	42.87	10.36	17.26	2.23

Table XIII-5. Results of Sensitivity Analysis (Cont'd)

				IRR		Pay out period		Average return on paid-up capital		Average sales profit ratio		Average debt service coverage ratio
				After tax (%)	Before tax (%)	After tax (%)	Before tax (%)	After tax (%)	Before tax (%)	After tax (%)	Before tax (%)	
Case	10-4-1	All products 5% up	All materials 10% up	10.53	14.63	6.47	5.21	26.61	44.35	10.21	17.02	2.27
	10-4-2	All products 5% up	All materials 20% up	8.60	11.86	7.33	6.10	19.80	33.00	7.52	12.55	1.98
	10-4-3	All products 5% up	All materials 10% down	14.04	19.59	5.25	4.07	40.23	67.05	15.58	25.97	2.85
	10-4-4	All products 5% up	All materials 20% down	15.68	21.84	4.82	3.68	47.04	78.40	18.27	30.45	3.14
	10-4-5	All products 10% up	All materials 10% up	12.45	17.35	5.75	4.53	33.86	56.43	12.48	20.80	2.58
	10-4-6	All products 10% up	All materials 20% up	10.65	14.80	6.42	5.16	27.05	45.08	9.91	16.52	2.29
	10-4-7	All products 10% up	All materials 10% down	15.78	21.98	4.79	3.66	47.48	79.13	17.60	29.34	3.15
	10-4-8	All products 10% up	All materials 20% down	17.33	24.11	4.43	3.35	54.29	90.48	20.17	33.61	3.44
	10-4-9	All products 15% up	All materials 10% up	14.26	19.88	5.19	4.01	41.10	68.51	14.54	24.24	2.88
	10-4-10	All products 15% up	All materials 20% up	12.56	17.51	5.72	4.49	34.29	57.15	12.09	20.15	2.60
	10-4-11	All products 15% up	All materials 10% down	17.43	24.25	4.41	3.33	54.72	91.21	19.45	32.41	3.46
	10-4-12	All products 15% up	All materials 20% down	18.90	26.27	4.11	3.08	61.54	102.56	21.90	36.50	3.75
	10-4-13	All products 20% up	All materials 10% up	15.97	22.27	4.74	3.61	48.35	80.58	16.44	27.40	3.19
	10-4-14	All products 20% up	All materials 20% up	14.37	20.03	5.16	3.99	41.54	69.23	14.09	23.48	2.90
	10-4-15	All products 20% up	All materials 10% down	18.99	26.40	4.09	3.06	61.97	103.28	21.14	35.23	3.77
	10-4-16	All products 20% up	All materials 20% down	20.42	28.33	3.83	2.86	68.78	114.64	23.49	39.14	4.06
	10-4-17	All products 5% down	All materials 10% up	6.25	8.42	8.67	7.57	12.12	20.20	4.91	8.29	1.64
	10-4-18	All products 5% down	All materials 20% up	3.97	5.00	10.37	9.65	5.31	8.85	1.86	3.34	1.33
	10-4-19	All products 5% down	All materials 10% down	10.29	14.29	6.56	5.31	25.74	42.90	10.91	18.18	2.23
	10-4-20	All products 5% down	All materials 20% down	12.11	16.87	5.87	4.63	32.55	54.25	13.88	23.13	2.23
	10-4-21	All products 10% down	All materials 10% up	3.82	4.78	10.50	9.82	4.87	8.12	1.76	3.17	1.31
	10-4-22	All products 10% down	All materials 20% up	–	–	–	–	- 3.23	- 3.23	- 2.03	- 2.03	0.97
	10-4-23	All products 10% down	All materials 10% down	8.21	11.30	7.53	6.30	18.49	30.82	8.17	13.64	1.92
	10-4-24	All products 10% down	All materials 20% down	10.16	14.11	6.61	5.36	25.30	42.17	11.32	18.86	2.22
	10-4-25	All products 15% down	All materials 10% up	–	–	–	–	- 3.96	- 3.96	- 2.50	- 2.50	0.94
	10-4-26	All products 15% donw	All materials 20% up	–	–	–	–	- 15.31	- 15.31	- 8.03	- 8.03	0.46
	10-4-27	All products 15% down	All materials 10% donw	5.97	8.00	8.45	7.79	11.25	18.74	5.05	8.56	1.60
	10-4-28	All products 15% down	All materials 20% down	8.08	11.11	7.60	6.38	18.06	30.09	8.43	14.07	1.90

Table XIII-5. Results of Sensitivity Analysis (Cont'd)

			IRR		Pay out period		Average return on paid-up capital		Average sales profit ratio		Average debt service coverage ratio
			After tax (%)	Before tax (%)	After tax (%)	Before tax (%)	After tax (%)	Before tax (%)	After tax (%)	Before tax (%)	
Case	10-5-1	Operating rate 60 %, 70 %, 70 %	7.30	10.03	8.01	6.76	14.96	24.94	7.68	12.80	1.82
Case	10-6-1	Construction cost 10 % up	9.17	12.68	7.04	5.80	21.71	36.18	9.47	15.79	2.07
	10-6-2	Construction cost 20 % up	8.07	11.08	7.57	6.37	17.92	29.86	8.38	14.00	1.91
	10-6-3	Construction cost 10 % down	11.82	16.47	5.98	4.73	31.52	52.54	11.62	19.36	2.47
	10-6-4	Construction cost 20 % down	13.45	18.77	5.45	4.23	38.04	63.40	12.69	21.14	2.74
Case	10-7	Depreciation period of Jetty 30 years	10.41	14.44	6.50	5.26	26.04	43.41	10.49	17.48	2.26

CHAPTER XIV

ECONOMIC EVALUATIONS

ON THIS PROJECT

XIV. ECONOMIC EVALUATIONS ON THIS PROJECT

XIV. 1 General

This project is defined to construct a phosphate fertilizer manufacturing plant in the Philippines, under joint investment by the ASEAN countries. Its major purposes are to make good use of by-product sulfuric acid from the adjacent PASAR's copper smelter, and to provide sufficient supply of phosphate fertilizers to all member countries of ASEAN in order to supplement the shortage growing year by year in these countries.

Therefore, the significance in the execution of this project lies in the point for the Philippines, the host country for this prôject, that the manufacture of phosphate fertilizers through a good use of domestically supplied sulfuric acid and manpower resources and the export of such products will specifically bring an increase of added value, saving of foreign currency, more positively, earning of foreign currency, and thus, contribute to a great advance of her domestic economy.

Further, this contributes significantly to each of the ASEAN countries in such points as, increase of investment opportunity, security of stable fertilizer supply source at reasonable price, and fasten the foundations of agricultural growth.

Moreover, the fact is greatly appreciable that the materialization of such project will become a foothold of joint exploitation and development of the ASEAN common market. Standing on these points of view, the economic benefits of this project for whole ASEAN region are evaluated below in terms of quality and quantity.

XIV.2 Economic Internal Rate of Return

With the reason that this project is a candidate of the ASEAN projects, it is determined to measure the economic benefits and the financial requirement, and to estimate the economic internal rate of return, from ASEAN stand point of view.

1. **Economic Benefits**

   (1) Direct Benefits:

The direct benefits of this project lie on the economic value of the products manufactured. Ammonium sulfate and complex fertilizers (NP and NPK) manufactured are supplied to each of the ASEAN countries and partly used to supplement a short of domestic supply to a certain extent.

As previously studied in Chapter IV, Markets of Phosphate Fertilizers and Ammonium Sulfate by ASEAN Countries, a balance between total demand and domestic supply, i.e. a shortage of such supply, is estimated in terms of the aggregate sum of all the ASEAN contries to be, in 1980, 470 thousand tons of ammonium sulfate, 446 thousand tons of NP/NPK and 270 thousand tons of phosphoric acid, which are imported from any countries other than ASEAN countries. The commencement of commercial operation of this project can possibly help to replace a fair volume of such imports.

Therefore, as far as the products manufactured under this project are provided to each of the ASEAN countries at the same price with the world market price, or less, this project will bring to the ASEAN as a whole such economic benefits by that amounts.

The product prices used under this study are around 5 US$/T less than the average world market price, in terms of CIF each of the ASEAN countries. Therefore, all the ASEAN countries can possibly buy any products under this project at cheaper prices by around 5 US$/T than what they can import the same products from the world market, and in this sense, the direct economic benefits are specifically created.

(2) Indirect Benefits:

(a) Increase of employment opportunity:

The execution of this project will demand an increased opportunity of employment in the Philippines, incidental to the plant construction work and subsequent operations.

(b) Extended effects toward its related industries:

This project is determined to use an entire quantity of by-product sulfuric acid supplied from the adjacent PASAR's copper smelter. The plant construction brings an increased consumption of construction materials, such as iron and/or steel products, cement, and so on, and stimulates the growth of such firms as, general consturction, engineering, etc., in the Philippines.

Further, the plant operation and shipping activities require an increased consumption of packing materials, and encourage shipping industry.

(c) Contributions to local economy:

The materialization of this project is specifically expected to provide direct or indirect contributions for local economic growth with complete arrangement of electric power, roads, water supply, port, dwelling houses, etc.

As mentioned above, the execution of this project is expected to provide a great deal of indirect economic benefits to the Philippines who is responsible for this project.

However, such indirect economic benefits are quite hard to be assessed quantitatively, and it is also considered that to account such benefits which only the Philippines will enjoy may be unappropriate for the assessment of the benefits which should be received by all the ASEAN countries.

Therefore, it is determined not to add up the indirect benefits in the calculation of economic internal rate of return.

2. Economic Costs

(1) Initial Requirements Incidental to the Execution of This Project:

Initial requirements consist of plant construction cost, test run cost and initial working capital. This total amount corresponds to the amount substracting the amount of interest during construction from the total investment used in the calculation of internal rate of return (IRR) in Chapter XIII. Financial Analyses.

(2) Requirements for Raw Materials

Major raw materials to be consumed in the manufacturing under this project are phosphate rock, ammonia and potassium chloride, which all rely on imports.

Urea is assumed to be imported at 215 US$/T (in terms of price in January, 1983) from Aceh urea fertilizer project of Indonesia which is also one of the ASEAN projects.

Sulfuric acid is to be supplied at 19 US$/T (in terms of price in January, 1983) from the PASAR's copper smelter now being undertaken to be constructed adjacently. This price is selected to correspond to the manufacturing cost of sulfuric acid, when a sulfulic acid manufacturing plant is constructed and owned by this fertilizer project and such acid is manufactured with SO_2 gas supplied free of charge from the PASAR's copper smelter, and considered to be appropriate. (Please refer to para. V-2 for further details.)

(3) **Requirements for Manpower Resources**

All personnel to be employed in this plant are reasonably judged to stand on a fairly high level, from the nature of this business. So, it is not appropriate to apply shadow wages, and determined to appraise here with the prevailing wage and salary rates.

(4) **Other Costs Required for Production**

All other costs required for production include these for electricity, fuel heavy oil, anti-caking agents, anti-foaming agents, bags, repair and maintenance for various installations and equipment, property insurance, etc.

Tax to be levied in accordance with the tax law of the Philippines, is not included as cost in this study as it is deemed to be transferable cost, from Philippines' stand point of view.

Further, the appraisal on all above costs shall be made in terms of US dollar of prevailing exchange rate, instead of the shadow rate of foreign exchange.

3. Economic Internal Rate of Return

The economic internal rate of reutrn during an economic life period of this project are computed for the case of interest rate 4%, based on both the economic benefits and the financial requirements previously mentioned. The result is 14.5 % and this is a little higher than IRR (befire tax) computed in Chapter XIII, Financial Analyses. (Please refer to Tables XIV-1 and 2.)

XIV.3 All Other Economic Contributions and General Evaluation

For ASEAN countries as a whole, the execution of this project can possibly be expected to provide a great deal of contributions to each of the ASEAN countries in terms of savings of their foreign currencies.

However, this can be told to be a secondary matter of economic benefits in the light of the purposes of this project. Judging from economic internal rate of return points of view, each of the ASEAN countries now undertaking to invest to this project can possibly expect a fair amount of returns. Further, it is greatly significant that the economic development of each ASEAN country can possibly be advanced with furtherance of industrialization through investment in the field advantageous for each countries, enjoying scale-merit by means of joint investment, in addition to helping each other.

Table XIV-1. Economic Internal Rate of Return, Case 10

	Economic Cost			Economic Benefit			Discounted Cash		
	Initial Investment (1)	Annual Operating Cost (2)	Total	Sales Revenue (3)	Benefit (4)	Total	Discount Factor	Economic Cost	Economic Benefit
1980	37,284		37,284				1.000	37,284	
1981	49,712		49,712				0.874	43,697	
1982	37,284		37,284				0.763	28,448	
1983		45,992	45,992	59,966	1,640	61,606	0.667	30,677	41,091
1984		60,405	60,405	82,562	3,385	85,947	0.583	35,216	50,104
1985		66,820	66,820	93,426	1,590	95,016	0.509	34,011	48,363
1986		66,820	66,820	93,860	1,350	95,210	0.445	29,735	42,368
1987		66,518	66,518	93,860	1,150	95,010	0.389	25,876	36,959
1988		66,234	66,234	93,860	1,065	94,925	0.340	22,520	32,275
1989		65,937	65,937	93,860	980	94,880	0.297	19,583	27,585
1990		65,652	65,652	93,860	915	94,775	0.259	17,004	24,547
1991		65,367	65,367	93,860	845	94,705	0.226	14,773	21,403
1992		65,083	65,083	93,860	795	94,655	0.198	12,886	18,742
1993		64,798	64,798	93,860	795	94,655	0.173	11,210	13,375
1994		64,513	64,513	93,860	795	94,655	0.151	9,741	14,293
Total								372,661	371,105

Internal rate of return: 14.5 %

Notes:
(1) Derived from Table XIII-9
(2) Derived from Annex XIII-6, (Cost of sales) – (Depreciation and amortization)
(3) Derived from Table XIII-6
(4) Derived from Table XIV-2

Table XIV-2. **Additional Economic Benefit Gained by ASEAN Countries other than Philippines, through Their Off-taking of Fertilizer from the Plant (Case 10)**

	Off-taking by ASEAN Countries (1,000 ton)				Value gained (@5 US$/ton) (1,000 US$)
	AMS	NP	NPK	Total	
1983	93	148	87	328	1,640
1984	98	166	85	677	3,385
1985	87	166	65	318	1,590
1986	76	155	39	270	1,350
1987	64	163	3	230	1,150
1988	51	162	0	213	1,065
1989	38	158	0	196	980
1990	24	159	0	183	915
1991	10	159	0	169	845
1992	0	159	0	159	795
1993	0	159	0	159	795
1994	0	159	0	159	795

CHAPTER XV

CONSIDERATIONS

ON THE PROJECT IMPLEMENTATION

XV. CONSIDERATIONS ON THE PROJECT IMPLEMENTATION

As previously described, this project can be said feasible from the profitability point of view, but cannot be said to be very sound project without any problem. There are still some questions to be considered, including assumed premises. Materialization of this project amy be possible when such questions are satisfied in favorable ways. These questions are outliend below in this Chapter.

1. This project is basically schemed to use by-product sulfuric acid to be supplied from PASAR. From this, a selection of plant site, commencement time of commercial operation, etc., under this project are planned to correspond with the PASAR's plan, and the operating rate of 90 % is assumed in this study expecting that the operating rate of the PASAR's copper smelter plant will be higher than 90 %.

   Should all these premises be changed, the contents of this report would be changed greatly.

   Further, the study team has not been inquisitive in the detail plan for the PASAR's copper smelter, so that we, as the study team, do not stand on a position to put any of our opinion in whether the PASAR can satisfactorily meet such premises.

   Additionally, should expected volume of by-product sulfuric acid be decreased with curtailment of plant capacity of the PASAR's copper smelter less than what is now being undertaken, the foundation of this study would be shaken from the ground and the profitability of this project would be lowered greatly.

2. Both of the PASAR's copper smelter and this fertilizer manufacturing plant are now scheduled to receive electric power from the geothermal plant at Tonogonan of Leyte Islands. This geothermal plant project is now being carried out with a schedule to complete its power generating plant and transmission line of 112 MW, by March, 1981.

   Should this plant be delayed or greatly changed, such would largely affect upon this project. It is quite important for this project that the geothermal plant project should be carried out as scheduled now.

3. This project is schemed to manuacture and sell such finished fertilizer products as NPK/NP complex fertilizers and ammonium sulfate in bag.

In either cases when such intermediate fertilizers as DAP and TSP are manufactured, and such products manufactured are shipped in bulk, the profitability will be reduced than the figures given in this study.

However, some of the ASEAN neighbors other than the Philippines may be expecting to import some of such intermediate fertilizers. For example, Thailand may be expecting DAP import from this project, as she is now importing DAP and ammonium chloride and domestically manufacturing NP fertilizers. Malaysia may also be another example. However, it is believed that even such countries can provide a good cooperation to this project, because they are now importing NPK/NP fertilizers.

It is a very important key for this project whether the finished fertilizer products can possibly be imported by these countries, even if they are expecting to receive intermediate fertilizers in bulk.

4. NPK/NP fertilizers are not such commodities that single grade of product is on the market internationally in large quantity, so that their price fluctuations are quite radical, incidental to their supply-demand conditions from time to time. It is very hard to specifically grasp a reasonable market price even through the past price data. As the range of such price fluctuation is quite large, no profit is probably expected, if the lowest end of such fluctuation is taken.

The prices in this report is determined based on the price level of one period. We believe that those are not unrealistic, but it is hardly denied that the risky commodities of large price fluctuation are selected as main product under this project.

5. The affect of ammonia and sulfuric acid prices upon this project is very large.

It is absolutely indispensable that the sulfuric acid should be supplied from the PASAR at cost and ammonia should be provided at the cheapest price. It is advisable that ammonia is supplied from Indonesia by means of shattle services.

6. This project is schemed to manufacture amonium sulfate and a various grade of

NPK/NP fertilizers and to distribute them to all of the ASEAN countries.

However, a various kinds of fertilizers are desired by each of the ASEAN countries, and it is impossible for this project to completely satisfy all such demands in terms of either kind of quantity.

Further, the world market prices for fertilizers to be manufactured under this project may not parallelly fluctuate for every grade, but such a case could probably happen that only the price of a certain grade goes up, and manufacturing this grade is more lucrative. In such a case, a conflict may come up between the country who wants cheap grade and other countries who hopes more lucrativel grade, and this requires a coordination on what grade should be manufactured.

In any way, this project is schemed to manufacture multiple products and capable to alter production volume by grade, and not a single product manufacturing project like other ASEAN projects.

It is indispensable to eastablish a management rule of the new joint company in a spirit of cooperation in this regard among the ASEAN countries.

ANNEX

ANNEX II-1. DRAFT TERMS OF REFERENCE FOR FEASIBILITY STUDY OF THE PROPOSED PHOSPHATE FERTILIZER PROJECT IN THE PHILIPPINES

I. Objectives of the Study

1. The study will be carried out by a selected consultant to help the Philippines authorities determine the most feasible location and technical scope for a phosphate fertilizer project based on by-product sulfuric acid from copper smelters - existing and proposed - and imported and or locally available rock phosphate. The report is to be submitted to the Fertilizer and Pesticide Authority.

2. The study will cover three main parts: (a) Market and Marketing; (b) Technical Aspects; and (c) Financial and Economic Analyses. The terms of reference are given below:

Market and Marketing

3. Analyze the worldwide trend of P_2O_5 capacity and supply and evaluate its effect on the Philippine project.

4. Analyze the trend of phosphatic fertilizer capacity and supply by plants and products and consumption by products during 1970 – 1976 in the Philippines and the ASEAN /1 neighbors (i.e., Indonesia, Manalysia, Thailand and Singapore).

5. Carry out an investigation of the phosphate fertilizer market for ASEAN countries by reviewing and revising as necessary the demand projections for phosphatic fertilizer in general and for triple superphosphate (TSP), mono-ammonium phosphate (MAP), diamonium phosphate (DAP) and NPK in particular prepared by competent organizations, taking into account crop production, crop yields, agricultural and credit programs, irrigation development, fertilizer application rates, cropping patterns, and relative prices of fertilizer and crops in those countries.

/1 Association of South-East Asian Nations.

6. Based on the available data, prepare 10-year projections for phosphate fertilizer requirements for different ASEAN countries.

7. Project phosphate fertilizer supply products during the next 10 years in the ASEAN region by countries taking into account the production from existing plants and plants likely to be constructed.

8. Based on local demand forecasts and prospects for export of phosphate fertilizer from the Philippines to the ASEAN neighbors, examine and recommend whether the proposed plant in the Philippines should produce for sale phosphoric acid, TSP, MAP, DAP, NPK or combinations thereof. At least two alternative capacities for the plant be evaluated: (a) based on the availability of sulfuric acid in the Philippines and; (b) based on the most feasible economic size in relation to the forecast demand and supply in the ASEAN region during 1980-85.

9. Based on the market and review of the present phosphate marketing and distribution facilities, propose and evaluate a marketing system as well as for possible exports to the ASEAN neighbors. A proposal be developed for a seeding program in the Philippines for phosphate fertilizers of the type recommended for production.

10. Examine the existing facilties in the Philippines for bag making and evaluate the need for expanding such faciliteis to meet the needs of the proposed project, and compare the cost of local bags with that of imported bags.

11. Based on the projected consumption within the Philippines and the ASEAN neighbors, evaluate the existing bagging faciliteis and bulk receiving stations and examine the need for expanding such facilities in the region to meet the requirements of the proposed project.

12. Define and evaluate the transportation system needed, including any ships and other auxiliary facilities required to implement the distribution system recommended. Provide preliminary cost estimates for the system recommended.

13. Propose and adequately document an organizational and management system needed to implement and put into operation the proposed distribution facilities.

Technical Aspects

14. From an examination of information already available, assess the domestic availability, quality and cost of sulfuric acid for use in the proposed project. In this context, examine the status of the proposed copper smelter and the availability of by-product sulfuric acid from it during the first five years of operation assuming realistic capacity utilization rates for the smelter.

15. Estimate the quantity of sulfuric acid, rock phosphate, ammonia and other materials required for the proposed project at full production (100 %) and indicate which of the raw materials are to be imported. Estimate the foreign exchange cost (CIF, Philippine port) of such imports based on realistic price projections for such products.

16. Evaluate available sources of rock phosphate and ammonia /1 and recommend the most economic sources considering f.o.b. price (exporting country) and freight charges to the Philippines.

17. Study alternative locations for the proposed project and recommend the most suitable location with due regard to sulfuric acid source, transportation faciliteis including ports, water supply and other utilities, housing, labor availability, and market and environmental considerations, especially gypsum disposal and fluorine treatment /2.

18. Determine infrastructure requirements for the proposed location including township, hospitals, schools, etc. Develop cost estimates for those facilities.

19. Investigate the merit of installing an in-plant power generating station to overcome power supply problems from external power supply sources, and insure the continued operation of the proposed fertilizer plant without fluctuations and dips in power supply. Estimate the cost of such an in-plant facility.

20. Define the project scope in sufficient detail along with offsite faciliteis required including utilities, office building, site storage facilities, etc.

/1 If ammonium phosphate is recommended.

/2 If not recovered as fluosilicic acid.

21. List all effluent streams whether solid, liquid or gaseous coming out of the proposed project during normal and foreseeable abnormal operations. Define the standards for effluent disposal in consultation with the Government. Outline a plan for the treatment of effluents to an acceptable level and estimate cost of such facilities.

22. Study the scope for including facilities for recovery of fluosilicic acid and its use for the production of aluminum fluoride/cryolite. This should cover an examination of the market prospects for those products.

23. On the basis of preliminary design concepts, prepare capital cost estimates with the following breakdown: (a) land acquisition; (b) site preparation including clearing, grading and installation of services such as sewes, water mains, power lines, roads, and rail sidings; (c) civil works; (d) equipment costs, freight and insurance, duties and taxes, and other charges incurred in the purchase and delivery of equipment; (e) design engineering and construction supervision; (f) erection; and (g) project management services. Present the above breakdown to show costs classified as follows: (1) by major plants for functions; (2) by labor and material components; and (3) by domestic and foreign currency costs.

24. Prepare estimates of the other related capital costs of the plant including: (a) infrastructure costs; (b) preoperating expenses; (c) spare parts; (d) recruitment and training costs; (e) start-up expenses; (f) interest during construction; and (g) working capital.

25. Prepare physical and price contingency estimates on the base cost of the project /1 and include those contingency provisions in arriving at the total financing required for the project.

(i) Raw materials:
- Sulfuric acid
- Rock phosphate
- Ammonia
- Others

(ii) Process chemicals and supplies

/1 Excluding interest during construction and working capital.

(iii) Power, fuel and water

(iv) Maintenance materials

(v) Administration and overhead costs

(vi) Selling and delivery costs

(vii) Direct labor costs

(viii) Cost of bags

27. Provide details of staff manning, salary and wage rates and examine the availability of labor, technicians and trained supervisory staff. Prepare a personnel recruitment and training program and indicate the timing schedule for its.

28. Provide preliminary plant layout diagram; a process flow diagram; a bar chart for the project implementation schedule; and a project organization chart.

29. Examine likely bottlenecks for the transportation of equipment and materials to the site, and also evaluate the capability of local civil works contractors.

30. Comment on the equipment supply and price situation in the world for fertilizer plants as part of the projection of price escalation.

Financial and Economic Analyses

31. Financial and economic analyses should be prepared, including capital and operating costs, for the alternatives studied and the recommended project. Costs should be broken down into local and foreign currency components. Realistic assumptions be used regarding capacity utilization rates and production build-up in the project.

32. Regarding fertilizer prices, the consultant should: (a) summarize the price structure for phosphate fertilizers in the Philippines and the ASEAN region and compare it with world prices; (b) estimate the prices for the product mix at which the project would yield an internal financial rate of return of 12 %; and (c) use world market projections for inputs and output to calculate the economic rate of return.

33. Collect and use appropriate data including the following in preparing financial projections: (a) tariffs and taxes on imported and locally manufactured machinery, raw materials and products; (b) rates of taxation on income, manufacturing, property, turnover, payroll or any other levies on production and distribution by the State and/or local government; (c) legislation relating to the distribution of profits to reserves and shareholders; (d) interest charges and financing charges; (e) insurance rates for property and equipment; (f) allowance rates of depreciation and amortization; (g) indirect payroll costs such as contributions to health and pension funds; and (h) investment incentives such as reduction in taxes and duties, tax holiday, investment credit, and concessional interest rates.

34. Prepare all data relating to capital costs, manufacturing costs and sales revenues needed to evaluate the alternatives studied.

35. Based on the recommended project, product mix, and also method of financing (to be provided by the Government), prepare the following:

(i) Investment requirements by years during the implementation period;

(ii) Schedule of repayment of principal and interest;

(iii) Depreciationschedule;

(iv) Project profit and loss statement over the project's operating life span (assume 12 years);

(v) Project cash flow statements and balance sheets over the project life span;

(vi) Calculation of internal financial and economic rates of return;

(vii) Sensitivity analysis of financial as well as economic rates of return by assuming changes in the value of key variables;

(viii) Table of financial ratios including return on assets in service /1, return on shareholders' equity, current ratio, acid test (quick) ratio, interest coverage /2,

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/1 $\dfrac{\text{Net Profit before Interest}}{\text{Net Assets in Operation + Net Working Capital}}$

/2 $\dfrac{\text{Net Income before Tax and Interest}}{\text{Interest}}$

and debt service coverage;

(ix) Break-even analysis for the project;

(x) A risk evaluation of the project;

(xi) Calculation of the annual net foreign exchange saving to the economy because of the project; and

(xii) Calcualtion of the annual value added by the project including: (a) wages and salaries; (b) interest and commissions; (c) indirect taxes minus subsidies; (d) depreciation; and (e) net profit before tax.

ANNEX II-2. MEMBERS OF THE STUDY MISSION

Name (Mr.)	In Charge Of
Jiro Inoue	Team leader; General, Financial and Economical Affairs
Yukitoshi Nagasawa	Advisor: General Affairs
Nobuo Yamanaka	Assistant team leader: Process and its related matters, Rawmaterials, Products and Environmental Pollution Affairs
Kango Mito	Civil engineering, Investigation on marine and land around proposed plant site, Infrastructures, Civil-work cost estimation, and all other related matters.
Takasuke Inoue	Market and Marketing, visit to ASEAN neighbors, Research on agricultural status, and all other related matters.
Takebi Ohtsubo	The same as above.
Yoshitaka Terashima	Plant, Plant construction cost estimation, Survey on local constructors, and all other related matters.
Yutaka Nakao	Economics, Treasury, Statute, Finance, and all other related matters.
Noboru Saeki	Civil engineering, Investigation on marine and land around proposed plant site, Infrastructures, Civil-work cost estimation, and all other related matters.

ANNEX II-3. SCHEDULE OF THE STUDY MISSION

Date		Activity
15 Oct., 1978	(Sun.)	Arrived at Manila. Internal meeting on itinerary.
16 Oct.	(Mon.)	AM: Meeting with JICA and the Embassy of Japan
		PM: General meeting with the Philippines counterparts at FPA.
17 Oct.	(Tue.)	Meeting with PASAR (Process, Plant & Civil Group).
		Meeting with PASAR (Process, Plant & Civil Group).
		Meeting with FPA (Market Group).
18 Oct	(Wed.)	Meeting with Philippine Port Authority, Leyte Development Committee and PAGASSA (Process, Plant & Civil Group).
		Visit to International Rice Research Institute and University of Philippines (Market Group).
19 Oct.	(Thu.)	Meeting with Department of Public Works, National Environmental Protection Council and National Power Corporation (Plant & Civil Group).
		Meeting with Department of Treasury (Market Group).
20 Oct.	(Fri.)	Meeting with Bureau of Public Works (Process & Civil Group).
		Meeting with Sugar Research Institute (Market Group).
		PM: General meeting with the Philippines counterparts.
21 Oct.	(Sat.)	Internal meeting. General arrangement.
		Moved to Jakarta (market Group).
23 Oct.	(Mon.)	Meeting with Ministry of Industry on utilization of by-product gypsum and overall matters of bag (Process Group).
		Meeting with Philippine Shipper's Council on transportation (Process Group).

Date		Activity
23 Oct. (cont'd)	(Mon.)	Meeting with Philippine Shipper's Council on transportation (Process Group).
		Meeting with Department of Treasury (Economic Group).
		Meeting in Jakarta with the Embassy of Japan, JICA and Japanese general trading firms (Market Group).
24 Oct.	(Tue.)	Meeting with Philippine Contractors Association (Plant & Civil Group).
		Meeting with FPA (Process Group).
		Meeting in Jakarta with the Embassy of Japan and Japanese general trading firms, and moved to Surabaya, PM (Market Group).
25 Oct.	(Wed.)	Meeting with Planters Products Inc., Atlas Fertilizer Corp., FILSYN and BIOPHIL (Process & Economics Group).
		Meeting with PETROKIMIA GRESIK, Indonesia, and moved to Jakarta, (Market Group).
26 Oct.	(Thu.)	Meeting with Southen Island Oil Mill Corp. (Economics Group).
		Meeting with Bogaulle CRIA, Indonesia (market Group).
27 Oct.	(Fri.)	Internal meeting. Arrangement of collected information.
		Meeting with Indonesia Food Crops Authority (Market Group).
28 Oct.	(Sat.)	Moved to Ormoc, Leyte Islands (All members, except Market Group).
29 Oct.	(Sun.)	Site investigation to St. Rosalio area (All members, except Market Group).
30 Oct.	(Mon.)	Site investigation to Bantique area (All members, except Market Group).
		Investigation to phosphate rock mining site, Bureau of Mines (Process Group).
		Meeting with Ministry of Industry, Indonesia and BIMA, Indonesia (Market Group).
31 Oct.	(Tue.)	Visit to Geothermal Plant, Tongonan, and BIOPHIL plant (Process, Plant & Economics Group).

Date		Activity
31 Oct. (cont'd)	(Tue)	Land and marine survey, St. Rosalio area (Civil Group).
		Moved to Singapore and meeting with the Embassy of Japan (Market Group).
1 Nov.	(Wed.)	Moved to Toredo, Cebu Islands (Process, Plant and Economics Group).
		Land Survey, St. Rosalio area (Civil Group)
		Meeting with Economic Development Board, Singapore, and moved to Kuala Lumpur, PM (Market Group).
2 Nov.	(Thu.)	Meeting at plant with Atlas Fertilizer Corp. (Process, Plant and Economics Group).
		Land survey, St. Rosalio area (Civil Group.)
		General meeting with the Embassy of Japan, Malaysia (Market Group).
3 Nov.	(Fri.)	Moved to Manila. PM: Meeting with Minstry of Industry (Process, Plant & Economics Group).
		Survey on land and marine, St. Rosalio area (Civil Group).
		Meeting with MARDI and FIDA, Malaysia (Market Group).
4 Nov.	(Sat.)	Plant and Economics Group returned to Japan.
		Land survey, Bantique area (Civil Group).
		Meeting with MRRDB, Malaysia (Market Group).
5 Nov	(Sun.)	Land and marine survey, Bantique (Civil Group).
		Moved to Bangkok (Market Group).
6 Nov.	(Mon.)	Meeting with FPA and PAN-MALAYA (Process Group).
		Investigation on status of water sources, and equipment and materials transport, and moved to Tagloban, (Civil Group).
		Meeting with Industrial Development Bureau, BOI and JICA, Thailand (Market Group).

Date		Activity
6 Nov. (cont'd)	(Mon)	Meeting with Industrial Development Bureau, BOI and JICA, Thailand (Market Group).
7 Nov.	(Tue.)	Meeting with Philippine Sugar Commission (Process Group).
		General meeting with local government, Leyte, and moved to Manila (Civil Group).
		Meeting with Ministry of Agriculture and TCCA, Thailand (Market Group).
8 Nov.	(Wed.)	Visit to plant of Planters Products Inc. (Process and Civil Group).
		Information collections from Japanese general trading firms in Bangkok (Market Group).
9 Nov.	(Thu.)	Meeting with Ministry of Human Settlement (Process Group).
		Estimation on local civil work cost (Civil Group).
		Meeting in Bangkok with Ministry of Agriculture, Industrial Development Financing Corporation, Prambri Sugar Industry Co., and ESCAP (Market Group).
10 Nov.	(Fri.)	Meeting with Planters Products Inc., at its Head Office (Process Group).
		Information collections from Kassessart University Institute (Process Group).
11 Nov.	(Sat.)	Civil Group returned to Japan.
12 Nov.	(Sun.)	Market Group moved to Manila.
13 Nov.	(Mon.)	Internal meeting. Arrangement of collected information and data.
14 Nov.	(Tue.)	Meeting with FPA, and preparation of an interim report (Process & Market Group).
15 Nov.	(Wed.)	Information collections from Asian Development Bank (Process & Market Group).

Date		Activity
16 Nov.	(Tue.)	Meeting with National Pollution Control Commission (Process Group).
		An interim report is submitted to the Ministry of Industry, with briefing (Process & Market Group).
17 Nov.	(Fri.)	Briefing to the Embassy of Japan and JICA, and meeting with Mr. Vicente T. Paterno, Minister of Industry (Process & Market Group).
18 Nov.	(Sat.)	All members returned to Japan.

ANNEX TABLE IV-1. CROP AREA HARVESTED BY KIND OF CROPS, PHILIPPINES, CROPYEAR 1968 - 1977

(In thousand hectores)

	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
Philippines	8,805.7	8,919.3	8,946.4	9,096.8	9,381.8	9,212.9	10,117.0	10,759.6	11,487.9	11,787.5
Food Crops	6,400.8	6,440.2	6,406.3	6,345.3	6,561.1	6,344.7	7,124.0	7,629.2	8,043.1	8,114.2
Palay (rough rice)	3,303.7	3,332.2	3,113.4	3,112.6	3,246.4	3,111.8	3,436.8	3,538.8	3,579.3	3,547.5
Corn (shelled)	2,247.9	2,256.1	2,419.6	2,392.2	2,431.7	2,325.4	2,763.0	3,062.4	3,257.0	3,320.6
Fruits & Nuts except Citrus	369.9	368.0	380.3	360.8	385.0	389.1	350.8	378.2	433.5	437.5
Cirtrus	28.0	25.2	21.3	18.9	18.7	19.0	19.1	20.1	22.3	22.1
Rootcrops	250.4	253.6	252.4	246.0	258.5	266.3	313.9	351.2	388.9	426.3
Vegetables except Onions and Potatoes	45.9	48.6	41.1	45.7	51.8	53.8	52.1	55.1	54.3	56.2
Other Food Crops	155.0	156.5	168.2	169.1	169.0	179.3	188.3	223.4	307.8	304.0
Commercial Crops	2,404.9	2,479.1	2,540.1	2,751.5	2,820.7	2,868.2	2,993.0	3,130.4	3,444.8	3,673.3
Coconut	1,800.4	1,845.5	1,883.9	2,048.5	2,125.5	2,133.3	2,206.0	2,279.5	2,521.1	2,714.0
Sugarcane	318.3	343.0	366.1	441.6	441.0	455.2	490.7	536.0	534.4	567.2
Abaca	170.7	172.9	173.0	155.3	145.2	163.3	170.1	179.7	243.8	250.3
Other Commercial Crops	115.5	117.7	117.1	106.1	109.0	116.4	126.2	135.1	145.4	141.8

Source: Bureau of Agricultural Economics

ANNEX TABLE IV-2. AGRICULTURAL PRODUCTION BY KIND OF CROPS, PHILIPPINES, 1968 - 1977

(In thousand metric tons)

	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
Philippines	13,236.5	13,259.1	15,200.6	15,621.4	15,191.1	15,092.1	17,546.3	19,807.3	22,475.8	23,669.5
Food Crops	9,293.8	9,345.6	10,670.0	10,773.8	10,629.4	9,890.2	12,072.6	13,556.1	15,082.6	16,057.0
Palay (rough rice)	4,560.7	4,444.7	5,233.4	5,342.9	5,100.1	4,414.6	5,594.1	5,660.1	6,159.5	6,456.1
Corn (shelled)	1,619.1	1,732.8	2,008.2	2,005.0	2,012.6	1,831.1	2,288.7	2,568.4	2,766.8	2,843.4
Fruits & Nuts except Citrus	1,371.4	1,373.3	1,569.5	1,663.2	1,742.8	1,803.4	2,092.1	2,687.1	3,330.7	3,594.3
Citrus	77.6	74.6	70.7	62.7	65.5	63.8	61.6	77.9	120.2	123.1
Rootcrops	1,305.2	1,338.1	1,316.3	1,220.8	1,217.7	1,220.5	1,410.8	1,807.1	1,783.9	2,048.0
Vegetables except Onions and Potatoes	201.1	215.4	255.0	244.8	239.8	271.8	311.2	337.1	358.6	370.1
Other Food Crops	158.7	166.7	216.9	234.4	250.9	285.0	314.1	418.4	562.9	622.0
Commercial Crops	3,942.7	3,913.5	4,530.6	4,847.6	4,561.7	5,201.9	5,473.7	6,251.2	7,393.2	7,612.5
Copra	1,541.8	1,515.5	1,656.2	1,574.1	1,703.0	1,698.4	1,702.7	1,718.5	2,006.7	2,119.7
Dessicated Coconut	51.0	44.2	70.0	105.0	110.4	98.8	97.0	101.3	92.0	67.1
Homemade Oil	–	–	–	–	–	–	–	5.6	7.7	3.6
Foodnuts	–	–	–	–	–	–	–	108.8	179.2	90.5
Commercial Manufacturing	–	–	–	–	–	–	–	788.9	1,271.4	1,535.7
Sugar: Centrifugal and Muscovado	1,658.4	1,662.7	1,987.0	2,109.3	1,870.3	2,305.2	2,506.0	2,459.0	2,576.7	2,746.8
Molasses	502.9	503.8	607.6	870.9	683.2	885.6	943.6	828.6	1,000.0	784.1
Abaca	103.4	105.9	122.4	104.6	110.1	119.2	125.9	133.6	139.3	150.6
Other Commercial Crops	85.2	81.4	87.4	83.7	84.7	94.7	98.5	109.4	120.2	114.4

Source: Bureau of Agricultural Economics

ANNEX TABLE IV-3. VALUE OF AGRICULTURAL PRODUCTION BY KIND OF CROP, PHILIPPINES, 1968 - 1977

(Million Pesos)

	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
Philippines	5,155	5,714	8,099	9,143	10,285	10,752	17,763	20,147	20,092	27,233
Food Crops	3,116	3,445	4,750	5,559	6,749	6,268	10,369	13,427	14,152	16,429
Palay (rough rice)	1,858	1,717	2,073	2,490	3,190	2,650	4,960	5,345	5,918	6,617
Corn (shelled)	346	403	525	720	1,043	828	1,537	2,153	2,450	2,684
Fruits & Nuts except Citrus	359	613	1,121	1,258	1,347	1,445	2,048	2,870	2,484	2,917
Citrus	36	36	40	37	41	50	87	102	242	264
Rootcrops	205	278	404	426	446	490	560	811	764	898
Vegetables except Onion and Potatoes	99	136	195	217	238	280	409	711	697	551
Other Food Crops	211	259	387	407	441	522	765	1,431	1,593	2,496
Commercial Crops	2,038	2,268	3,349	3,584	3,536	4,484	7,393	6,720	5,939	10,804
Copra	887	836	1,196	1,146	1,264	1,536	3,585	2,353	1,333	3,179
Dessicated Coconut	32	29	76	115	121	110	119	123	151	126
Homemade Oil	–	–	–	–	–	–	–	19	31	12
Foodnuts	–	–	–	–	–	–	–	76	75	41
Commerical Manufacturing	–	–	–	–	–	–	–	322	419	619
Sugar: Centrifugal and Muscovado	896	1,114	1,667	1,831	1,675	2,135	2,469	2,489	2,612	5,918
Molasses	73	85	133	247	195	363	550	499	602	250
Abaca	51	66	105	90	102	118	374	514	313	306
Other Commercial Crops	96	137	169	152	177	222	294	322	400	348

Source: Bureau of Agricultural Economics

ANNEX V-1. VARIABLE COST DIFFERENCE BETWEEN MOROCCO ROCK AND FLORIDA ROCK

1) Typical rock composition

	Florida 70/72	Morocco 70/72
P_2O_5	33.0 %	33.0 %
CaO	48.0	52.0
SO_3	1.0	1.4

2) Phosphate rock and sulfuric acid unit consumption by hemi-dihydrate process, P_2O_5 recovery is expected to be 98 % for Morocco rock and 98.5 % for Florida rock. (Recovery is affected by the content of other impurities.) On the contrary, sulfuric acid consumption is less in case of Florida rock, because CaO content is less.

Unit consumption of phosphate rock and sulfuric acid per ton of phosphoric acid production are as follows:

	Florida 70/72	Morocco 70/72
Rock	3.108 T/T P_2O_5	3.092 T/T P_2O_5
Sulfuric acid	2.635 T/T P_2O_5	2.820 T/T P_2O_5

3) Variable cost comparison

Taking the price of phosphate rock 70 US$/T and sulfuric acid 19 US$/T (1983 price), variable costs for production of phosphoric acid can be compared for each rock as follows:

	Florida 70/72	Morocco 70/72
Rock	3.108 (70 + X) = 217.6 + 3.108 X	3.092 x 70 = 216.4
Sulfuric acid	2.622 x 19 = 49.8	2.820 x 19 = 53.6
	267.4 + 3.108 X	270

To make the both variable costs equal, X must be 0.85 US$/T rock. That means, when phosphoric acid plant is designed to be able to treat both rock at the similar performance, Morocco rock becomes first advantageous when its price is more than 0.85 US$/T cheaper than Florida rock. But the investment cost is higher by 250 thousand US$ when Florida rock is considered than when only Morocco is considered for the case of 250 T P_2O_5/D phosphoric acid plant.

ANNEX V-2. AMMONIA OCEAN FREIGHT COST

Ammonia ocean freight cost is estimated as of January, 1979 in terms of the following conditions:

1. Embarkation and Disembarkation Ports:

Embarkation port:	Samarinda, East Kalimantan
Disembarkation port:	Leyte, Philippines
Distance:	Approx. 950 miles

2. Tanekr's Specifications:

$5,000\ m^3$ LPG, Ammonia and VCM Tanker

Tank capacity:	$1,000\ m^3$ x 5 tanks
SWT:	Approx. 6,000 MT
Overall length:	121.78 m
Max. draft in summer:	6.52 m
Speed:	14.5 knots
Fuel consumption:	IFO – Sea 21 ST Port Nil MDO – Sea 2.5 ST Port 2.5 ST
Loading capacity:	3,300 MT at – 34°C, 0 kg/cm^2 ·G

3. Operation Cost:

Port charge:	3,000 US$ at embarkation port 2,000 US$ at disembarkation port

Freight tax:	2 %
Loading & unloading time:	6 hours, respectively
Sailing time required:	6 days sailing + 2 days anchoring = 8 days

4. Charterage:

180,000 US$/month

5. Freight Cost Estimate:

Premises:	IFO	–	126 ST/voyage	180 US$/ST
	MDO	–	20 ST/voyage	330 US$/ST
Result:	26.15 US$/T of ammonia			

Ammonia tanker is very hard to hire time ot time, so that "Time Charter" contract is inevitable to secure stable delivery. In such a case, should a big tanker of 10,000 – 15,000 DWT be chartered, charterage would be more than double, while no change in annual volume of delivery, and moreover, it requires on-land ammonia storage tank of about 2 times capacity more than what is now planned, 12 – 15,000 tons, resulting in an extremely excessive requirement in installation cost and operating expenditure, even though no merit is expected.

To securely charter an appropriate size of tanker is easy, if it is arranged some period in advance, so that it is not necessary to worry about it from the beginning of planning. As reference, here attach the list of ammonia tanker in the world. There are many tankers available and it will be possible to charter one of them.

The similar can be said relating to the phosphoric acid tanker. But, to the contrary, to hire a vessel for phosphate rock delivery in terms of "Time Charter" can be not always advantageous.

Vessel	Capacity (MT)	Year Built Rebuilt	Min. Temperature Degc	Draft (M)	Loa (M)
Anna Tholstrup	1,000	1976	0	4.50	77.40
Bap Ferrat	1,000	1960	0	4.91	74.07
Brigitta Montanari	1,000	1970	- 48	4.57	68.71
Claude	1,000	1967	- 10	5.03	67.72
Dryburgh	1,000	1955/1968	- 5	4.44	79.40
Isla de Marnay	1,000	1965	0	5.25	75.72
James Cook	1,000	1971	- 48	4.80	68.71
Lanrick	1,000	1957	- 5	3.81	74.40
Pernille Throlstrup	1,000	1976	0	4.50	77.40
Sunny Baby	1,000	1965/1971	- 48	5.51	71.02
Sunny Bay / Sunny Boy	1,000	1967/1972	- 48	5.54	71.17
Sunny Fellow	1,000	1968	- 10	5.00	67.67
Tamames	1,000	1965	0	5.25	87.00
Tine Tholstrup	1,000	1968	- 42	4.60	71.76
Kokushu Maru II	1,100	1976	0	5.17	75.16
Cap Phaistos	1,200	1962	0	4.99	74.68
Capo Falcone	1,200	1963	0	4.99	74.68
Talete	1,200	1976	- 105	4.60	80.97
Ugarit	1,200	1962	- 5	4.99	79.88
Butacuatro	1,300	1965	0	4.93	80.80
Butados	1,300	1965	0	4.93	80.80
Butatres	1,300	1965	0	4.93	80.80
Butauno	1,300	1965	0	4.93	80.80
Marian P. Billups	1.300	1965	0	4.61	87.10
S.G. Tholstrup	1,300	1965	- 5	4.60	80.21
Sorine Tholstrup	1,300	1965	- 5	4.60	80.87
Andalusia	1,400	1968	- 5	5.50	75.64
Butaocho	1,400	1963/1966	- 5	5.54	79.75
Butasiete	1,400	1960/1966	- 5	5.54	79.75
Haugvik	1,400	1949/1963	- 10	6.55	77.47
Helen	1,400	1971	- 48	5.87	77.01
Heroya	1,400	1949/1963	- 10	6.55	77.47
Inga Tholstrup	1,400	1965	- 10	5.49	83.11
Johann Kepler	1,400	1968	- 30	4.60	77.72
Newton	1,400	1964	- 5	5.12	79.60

Vessel	Capacity (MT)	Year Built Rebuilt	Min. Temperature Degc	Draft (M)	Loa (M)
Alexander Schulte	1,500	1972	- 34	5.99	78.43
Bandim	1,500	1968	- 5	4.65	82.70
Cap Sounion	1,500	1968	- 5	5.50	79.99
Med Multina	1,500	1964	- 5	4.86	79.86
Anna Schulte	1,600	1973	- 5	6.18	78.10
Cidla	1,600	1968	- 5	4.65	82.70
Giambattista Venturi	1,600	1964	- 10	4.61	91.20
Heriot	1,600	1972	- 162	5.18	78.51
Marianna Tholstrup	1,600	1968	- 33	5.74	90.50
Niels Henrik Abel	1,600	1973	- 48	6.04	79.45
Pentland Glen	1,600	1972	- 34	6.22	78.10
Sigurd Jorsalfar	1,600	1973	- 48	6.04	79.45
Chemical Energy	1,700	1975	0	5.78	90.56
Kyokuyo Maru	1,700	1971	- 5	5.49	90.45
Gas Energy	1,750	1974	0	5.38	89.60
Alphagas	1,800	1970	- 34	6.55	81.13
Betagas	1,800	1971	- 34	6.55	81.13
Leiv Eirikson	1,800	1972	- 104	4.93	88.14
Melrose	1,800	1971	- 162	5.49	86.94
Petrolagas	1,800	1959	- 30	5.56	89.66
Pibigas Terza	1,800	1970	- 34	6.22	81.00
Capo Nord	1.800	1970	- 10	3.96	118.01
Capo Sud	1,800	1970	- 10	3.96	118.01
Columbus	2,000	1967	- 40	4.82	90.55
Coral Obelia	2,000	1966	- 5	4.85	90.53
Fridgeof Nansen	2.000	1968	- 44	4.83	90.50
Marco Polo	2,000	1967	- 40	4.82	90.55
Nicole	2,000	1967	- 48	5.99	89.54
Fred. H. Billups	2.100	1960	0	5.11	99.31
Copernico	2,200	1963	0	5.00	99.01
Emiliano Zapata	2,200	1970	- 103.7	5.64	100.89
C. Montanari	2,400	1968	- 48	4.97	100.92
Amedeo Avogadro	2,500	1965	- 5	5.04	99.29
Caty Multina	2,500	1969	- 48	5.72	101.93
Pentland Brae	2,500	1976	- 48	6.31	89.81

Vessel	Capacity (MT)	Year Built Rebuilt	Min. Temperature Dege	Draft (M)	Loa (M)
Sunny Queen	2,500	1976	-48	6.23	89.81
Thor Heyerdahl	2,500	1969	-48	5.00	101.92
Troika	2,500	1968	-40	4.97	102.05
Frosifonn	2,700	1965	-16	6.68	110.84
G. Gardano	2,700	1965	-16	6.68	110.84
Nestegas	2,700	1974	-104	6.13	105.00
Olav Trigavason	2,700	1975	-105	5.49	101.80
Roald Amundsen	2,700	1971	-104	5.30	105.50
Tordenskjold	2,700	1971	-48	5.35	106.05
Nordfonn	2,700	1962	-16	6.67	110.84
Deneb	2.800	1968	-45	6.25	101.98
Coral Meandra	3,000	1968	-48	6.25	103.30
Gammagas	3,400	1972	-48	7.26	106.38
Hebe	3,400	1976	-48	5.70	106.69
Fritz Haber	3,500	1971	-48	7.26	106.40
Coral Isis	3,600	1976	-48	5.70	107.99
Deltagas	3,700	1975	-48	7.45	106.60
Monomer Venture	3,800	1945/1962	-45	6.06	116.51
Erik Raude	4,000	1967/1977	-40	7.77	116.31
Vasco de Gama	4,000	1976	-104	7.60	112.14
Berga	4,200	1967	-45	6.50	116.89
Humbolt	4,200	1968	-45	6.04	116.95
Bow Elm	4,900	1971	-104	7.17	125.32
Hardanger	5,000	1972	-104	8.63	77.47
Barfonn	5,500	1969	-48	7.32	126.19
Hoegh Shield	5,700	1969	-47	7.07	122.88
Mundogas Atlantic	5,700	1969	-48	8.76	122.89
Global Gas	6,000	1968	-48	7.82	123.88
Joule	7,400	1965	-51	9.47	141.30
Harfrost	7,600	1966	-51	7.88	141.30
Clerk Maxwell	7,800	1966	-50	7.68	140.67
M. Escobedo	7,800	1967	-46	8.02	140.64
Gas Lion	7,800	1968	-50	7.85	140.49
Bolduri	8,000	1976	-48	8.20	139.65
Dubulti	8,000	1977	-48	8.20	139.65
Dzintari	8,000	1976	-48	8.20	139.65

Vessel	Capacity (MT)	Year Built Rebuilt	Min. Temperature Degc	Draft (M)	Loa (M)
SuFernbrook	8,000	1976	- 48	9.15	138.71
Fernwave	8.000	1972	- 48	9.27	138.61
Helios	8,000	1976	- 48	9.15	138.71
Inge Maersk	8,000	1972	- 48	9.22	138.71
Lielupe	8,000	1978	- 48	8.20	139.65
Mayori	8,000	1076	- 48	8.20	139.65
Sine Maersk	8,000	1976	- 48	9.19	138.71
Vestri	8.000	1972	- 104	8.23	138.71
Yurmala	8.000	1976	- 48	8.20	139.65
Joseph P. Grace	8,500	1964	- 46	7.53	156.45
William R. Grace	8.600	1964	- 45	7.53	156.45
Crystal	8,800	1963/1965	- 5	8.37	146.14
Gambhira	9,400	1969	- 48	7.85	153.19
Luigi Casale	9,500	1967	- 48	7.92	150.57
Pythagore	9,500	1967	- 48	7.87	150.50
Galileo	9,800	1967	- 45	7.60	154.00
Capo Ovest	10,000	1967	- 45	7,66	154.00
Pascal	10,000	1976	- 48	9.35	143.46
Havis	10,100	1970	- 48	8.13	146.75
Wiltshire	10,300	1968	- 50	8.23	151.69
Irina Multina	12,200	1968	- 51	9.22	166.14
Isfonn	12,500	1967	- 50	7.62	177.07
M. P. Grace	12,900	1967	- 54	7.92	162.76
Mundogas Rio	13,000	1967	- 42	8.84	162.69
Nyhavn	13,000	1968	- 47	8.88	161.29
Fernvalley	14,500	1969	- 48	8.28	170.99
Fernwind	14,500	1968	- 48	8.15	170.99
Fernwood	14,500	1969	- 48	8.84	170.99
Gandara	15,000	1976	- 50	9.14	160.50
Garbeta	15,000	1975	- 48	10.32	166.04
Norfolk Multina	16,700	1964	- 51	10.62	180.53
Amy Multina	17,500	1969	- 46	8.48	184.71
Antilla Cape	19,500	1968	- 51	9.37	173.85
Gambada	19,800	1973	- 51	9.09	178.00
Gazana	19,800	1972	- 51	9.09	178.00

Vessel	Capacity (MT)	Year Built Rebuilt	Min. Temperature Degc	Draft (M)	Loa (M)
Faraday	20,500	1971	-45	9.32	166.84
Lincolnshire	20,800	1972	-50	8.99	186.84
Cavendish	26,500	1971	-45	9.60	194.31
Gay Lussac	26,800	1969	-48	9.91	194.31
Hoegh Multina	34,600	1971	-48	10.31	207.26
Devonshire	35,000	1974	-48	11.34	207.02
Garmula	35,000	1972	-48	9.75	207.11
Hampshire	35,000	1974	-48	11.34	207.02
Antilla Bay	35,500	1973	-48	10.21	216.41
Providence Multina	35,500	1973	-48	11.02	216.10
Malmros Multina	35,600	1974	-48	11.02	216.10
Nyhammer	44,250	1975	-48	12.46	230.28
Amvrosios	46,500	1974	-43	11.93	223.96
Pine Queen	46,500	1974	-45	11.93	223.96

ANNEX TABLE V-3. BAG PRODUCTION SITUATION IN THE PHILIPPINES

	Looms in Operation	Capacity	Utilization	Idle	Labor	Investments
1. Summit	50	0.40M	0.25M	0.15M	170	P 3.50M
2. Industrial Fiber	76	0.50	0.30	0.20	150	4.00
3. Lunar Mfg.	53	0.50	0.35	0.15	720	3.20
4. Polyeon	56	0.40	0.20	0.20	160	3.80
5. Pacific	74	0.50	0.30	0.20	200	4.00
6. Skylark	20	0.20	0.14	0.06	120	1.00
7. Covico	48	0.48	0.33	0.15	100	1.34
8. Boeing	80	0.80	0.56	0.24	120	3.00
9. Windsor	50	0.50	0.35	0.15	155	1.50
10. General Bag	80	0.75	0.75	0.22	290	23.50
11. Wintex Mfg.	80	0.50	0.30	0.20	150	4.80
12. Wintex Ind.	50	0.50	0.35	0.15	150	1.30
13. Polybag Mfg.	170	1.50	1.00	0.50	480	13.70
14. Arrow	30	0.80	0.20	0.10	180	1.50
15. Itemcop	400	3.20	2.40	0.80	1,500	48.00
16. Chembag (formerly J & L)			Not Available			
17. Luzon Polymer			Not Available			
	1,317	11.03M	7.56M	3.47M	4,045	P 118.14M
ANNUAL		132.36M	90.72M	41.64M		

Notes:
1. The columns on "Capacity," "Utilization" and "Idle" are based on the month in million bags. Investments are in million pesos.
2. As of August 31, 1977, Itemcop had an inventory in bags and cloth equivalent to 1.5 million bags.
3. Idle capacity more accurately reflects status of the industry due to adjustment of production to sales to cut down an excessive buildup of inventory.

Source: Individual members of the Association