and the estimated demand in the world will keep growing after 1979. The gap is expected to attain the highest level in 1985. Thereafter, the difference will begin to narrow because of progress in the scrapping of obsolete plants on one hand, and expansion of demand on the other.

Regionally speaking, Asia will require the importation of nitrogenous fertilizers until 1979; however, regional self-sufficiency in the supply will be attained by 1980. Thereafter, Asia will be one of the regions in which the gap between the suppliable amount and the estimated demand will be in the largest scale. In the case of West European countries, the extent of surplus suppliable amount is estimated to be almost the same as the present status. The U.S.S.R. and East European countries are forecast to produce the highest degree of surplus suppliable amount of 9 million tons of N as of 1985.

In North America, the surplus suppliable amount will increase until 1981; however, the excess will begin to diminish from 1982 onward, so that this region will begin to feel import requirements from around 1985 or 1986. The Central American region will show a general surplus; however, the South American region will keep showing a supply shortage until 1984, while the African and Oceanean regions will not be able to attain a status of self-sufficiency before 1984, although the extent of supply shortage in these two regions will be slight. In other words, it is likely that the Asian region having surplus countries such as Japan, Indonesia, and Korea, the Mideast region, and the U.S.S.R. and East European Countries will all have a high extent of surplus suppliable amount, while West Europe will maintain the current level of surplus. At the same time, those countries which so far been dependent upon importation for the fulfillment of respective domestic demand will steadily approach the goal of self-sufficiency in the supply of fertilizers. Therefore, the global supply/demand balance of nitrogenous fertilizers will evolve on a basic oversupply.

In the supply projection which is the basis for the above supply/demand balance forecast, the plants which elapsed the presumed life span of plant were assumed to be shut down or to be abolished. The life span of plants are set as follows on the basis of the past trend:

North American countries	25 years
Western European countries	30 years

Japan	20 years
Other countries	30 to 45 years

It is true, however, that such a surplus suppliable amount will not be actually turned out in the form of annual production. Due to the deterioration of the availability and prices of raw materials and also the increase in the other cost elements, some plants might be either suspend operation or be scrapped before the machinery and equipment attains actual physical service life, as and when the countries find themselves in a position where their fertilizer products are no longer competitive in the markets. For the countries, which have so far been greatly dependent on exportation, this phenomena will be conspicuous. As will be discussed in Section 2-2, the prices of fertilizers in the international market has been formulated and fluctuate reflecting the supply/demand balance in the world and the changes in the competitive position of exporting countries in the market. In oversupply markets, the increase in the price will be suppressed to a level lower than the increase in the production costs. Thus the above described shut-down or scrapping of the facilities will be accelerated in the oversupply market. Consequently, the actual production will be arranged on such a level that can make the supply meet with all the demand plus some extent of inventory stock, in spite of the oversupply structure.

Therefore, it is essential to analyze what countries will be compelled to shut-down their plants, and what will be the impact on the world supply/demand balance, in view of the long term forecast on the market situation.

North America, West Europe, and Japan have so far occupied a position of major exporting countries. Their advantageous position is attributable to their cost competitiveness in the market compared with that of the products produced from the underdeveloping countries. These countries have the advantage in that they could enjoy the scale economies of the plants owing to their advanced technology and advantageous cost position which stems from the well prepared infrastructure, which is essential for such capital intensive industries as fertilizer industry, and high operational rate of plants.

Supported by such advantageous cost competitiveness, these developed industrialized countries build a number of large scale plant construction, and secured a large amount of exportable surplus. Another factor for these developed industrialized countries is to be able to be in the cost competitive position attributable to the fact that the price of hydrocarbon is low, and consequently the share of hydrocarbon in the total production costs is not high.

The nitrogenous fertilizer industry in North America has relied on natural gas with respect to its abundantly endowed raw materials. Whereas the industry in West European countries, excluding natural-gas rich Netherlands and France, have relied on naphtha and heavy oil supplied from the refinery plants. Particularly in Japan since Japan has only poor natural gas resources, has had to mainly relied on naphtha, heavy oil or imported buthane. Thus, the industry in West Europe and Japan have been subject to the impact from the oil-price fluctuation. The oil price hike since the beginning of 1970's led to the keen rise in the production cost in these countries, and their comparative advantage in cost position disappeared. As far as the industry in North America is concerned, as already mentioned above, since all the production is based on natural gas, the impact from the price rise was not so serious, but the rise in the energy cost followed by the oil price rise resulted in an increase in the production costs.

On the contrary, since the natural gas produced in the developing countries has no large outlet except for LNG industry, the price of natural gas has been fairly lower than that in the developed countries. Now that the hydrocarbon cost in the developed countries has increased, the natural gas endowed countries can compensate the disadvantage in the construction cost of plants by the low natural gas price.

Although such a sharp price hike of oil as seen in the first half of 1970's may not be expected in the future, some extent of a price rise will be inevitable. From this viewpoint, cost competitiveness of such natural gas rich countries as Indonesia and Mideastern countries will be further improved.

Fertilizer plant constructions in recent years have been observed mainly in formerly major importing countries (especially natural gas endowed countries), Mideastern oil producing countries, and the U.S.S.R. and East European countries. The former importing countries are constructing the plants with the intention to save foreign currencies, whereas the Mideastern oil producing countries are intending to utilize their oil-associated natural gas, and to export their products. In the case of the U.S.S.R. and East European countries, the production is based on their natural gas, and the products are destined to both domestic and export market.

Under such circumstances, North America, West Europe, and Japan will be the ones which will be most seriously affected by the oversupply because these countries have so far been heavily dependent on fertilizer exportation and are also prone to encounter production cost increase. It is reasonable to assume on the other hand, that almost no adverse effects will be felt by those countries which are dependent upon indigenous raw materials which are not subject to consumption in application fields other than fertilizer use, even if these countries have been, and will be, producing fertilizers for either for solely domestic consumption or for exportation. The adverse effect will also be mild in the case of centrally planned countries such as the U.S.S.R. and other East European countries, because they can correspond to the changes in the situation even under the oversupply to maintain their production. It is reasonable to state that the export market for North America, West Europe, and Japan will be further constricted as a result of this.

Table II-2-6 gives the result of supply/demand projection on the basis of the above described considerations. The result of this projection in regard with the future change in the international market can summerized as follows:

1) In West Europe, the supply and the demand will be balanced out in 1984/85, and the import will be required thereafter.

2) In the case of North America, exportable surplus will be felt until 1982. However, in 1983 the demand will meet the supply, and then supply shortage can be expected thereafter. Recently, in the U.S.S.R., many plants have been constructed on the premise of long term compensation deal of ammonia produced by the plants. This means that the shortage in the U.S.A. will be met by the supply from the U.S.S.R.

3) In Africa and Oceania, the supply will continue to be slightly lower than the demand.

4) Asia will produce more than 1 million tons of surplus in 1983.

5) In the case of the U.S.S.R. and East Europe, the supply surplus will be especially large, amounting to as much as 7 million tons.

The above facts follow that a shift in the major nitrogenous fertilizer exporting countries is expected to take place. The developing countries (especially the natural-gas rich countries), the U.S.S.R. and East European countries will be the major exporting countires, whereas formerly the developed industrialized countries occupied that position. At the same time, it follows that even after the control on the production in the developed countries an oversupply will persist, thus keen competition among the exporting countries is expected.

Asia, as shown in Table II-2-1, is one of the major fertilizer consuming regions, and it is obvious that the importance of Asia as a consuming region will increase more and more. Major prospective export market for the urea from Indonesia will naturally be Asian countries in terms of distance. In order for successful development of this project, it is essential for Indonesia to secure the Asian countires as its export market with such an oversupplied market for fertilizer. In the following section, the prospect on the supply/demand balance of nitrogenous fertilizers will be further analyzed.

2-1-2 Prospect on supply/demand balance of nitrogenous fertilizers in Asia

Asia is divided into four sub-regions namely, East Asia, South East Asia, South West Asia, and Mideast regions. With respect to Asia, world supply/demand balance of nitrogenous fertilizers is shown in Table II-2-5, and a country-wise balance is given in Tables II-2-7 to II-2-10.

In East Asian countries, except for China, the projected suppliable amount is expected to exceed the projected demand. As for China, during three years from 1979 to 1981, the suppliable amount will exceed the demand and after that, the supply shortage will be felt again. However, even during the above three years, when taking into account the increase in the inventory it is forecast that importing will be required. (Ref. Table II-2-7.)

As shown in Table II-2-8, in South East Asia, the suppliable amount is projected to exceed the demand by 1983. The supply surplus as opposed to the demand will increase year by year thereafter. The major supply-surplus countries in this region are Indonesia and Malaysia. However, the impact of new plant planned in the Philippines is almost negligible on the balance in this region.

In South West Asia, despite of the supply surplus in Bangladesh in and after 1982, a large amount of import requirement is forecast in the region as a whole, due to the great supply shortage projected in India and Pakistan. In India, despite of the large amount of possible increase in the production capacity of nitrogenous fertilizers, it is forecast that India will not be able to achieve self-sufficiency in the nitrogenous fertilizer supply. (Ref. Table II-2-9.)

Among the Asian region, the largest supply-surplus sub-region is the Mideast. Several construction projects of large export-oriented plants are proceeding in this region with the intention using the abundant indigenous natural gas. Consequently the amount of supply surplus is forecast to approach to as much as 1.2 million tons in 1983 and 1.6 million tons in 1985. (Ref. Table II-2-10.)

As a result of the above balances, Asia as a whole will have the supply surplus of 1.2 million tons in 1980, and 2.6 million tons in 1985. However, as seen in the above tables, of those countries other than ASEAN countries, South West Asian countries centering on India and Pakistan, also China and Vietnam are expected to be prospective markets for urea exportation in view of the country-wise supply/demand balance.

2-1-3 Outlook on the supply/demand balance of urea in Asia

Table II-2-11 gives an outlook on the urea supply/demand balance in several countries of the Asian region which are expected to become major urea importing nations. The suppliable amount of urea was forecast by employing a method the same as that employed for forecasting the suppliable amount of nitrogenous fertilizers in the foregoing. On the other hand, regarding the estimated demand for urea, calculations were made on the basis of the rate of the demand for urea in the past as against the total estimated demand for nitrogenous fertilizers. It should be noted here, however, due modifications have been incorporated in such a manner that the short supply extent of urea will not exceed the total shortage in the supply extent of the nitrogenous fertilizers as a whole.

In the case of China, the suppliable amount will exceed the estimated demand from 1979 until 1981; however, when the amount allocated to the increase in inventory is taken into account, the balance actually will be in supply shortage. Thereafter, the increase in the demand for urea in China is expected to exceed the increase in the suppliable amount, thereby resulting in a further expansion of the short supply.

Burma, Pakistan, and Australia will see a temporary reduction in the short supply due to the completion of new plants. However, the shortage will thereafter begin to increase. The shortage which will be felt in Vietnam will amount to 460 thousand tons in 1980. Although a new plant is scheduled to start production in 1982, the shortage will still be significant.

The level of shortage will increase to 360 thousand tons by 1987.

India has a number of new projects for the construction of urea producing facilities, and at the same time, India will see a conspicuously sharp growth in the demand. Consequently, it will not be possible for India to attain a self-sufficient status, although the extent of shrotage will be somewhat reduced. From 1985 onward, India will again see an uptrend in the shortage.

The following paragraphs will discuss the future trend of supply/demand balance of urea in the Asian region within the framework of worldwide supply/demand balance of urea.

As discussed in the foregoing several Asian countries centering on India, Vietnam, and Pakistan are expected to be the prospective markets for Indoneisan urea from the stand point of supply/demand balance in the respective countries alone. However, as analyzed already, since the export competition is forecast to be increasingly intensive, it is essential for Indonesia to have enough export competitiveness in terms of both export price and export system for its successful urea exportation.

2-2 Outlook on the trend of future international prices of urea, and export prices of urea from Indonesia

2-2-1 Past trend of international prices of urea

Figure II-2-1 illustrates the past trend of the international prices of urea in terms of FOB Japan. The establishment of technologies concerning large-scale ammonia/urea plant operations in 1960 enabled the producers to reduce the production cost of urea. Consequently, the large scale plants were constructed one after another in the developed countries centering on the U.S.A., West Europe, and Japan in the second half of 1960s and onwards. As a result, during the period from the latter half of 1960s to the first half of 1970s, the balance between supply and demand of nitrogenous fertilizers in the world became large. Reflecting the reduction in the production cost which was deduced by the scale up of size of plants as described above, and also the oversupply market in the world. The international market price of urea in those years had shown a long-term decline down to U.S.$ 60/T in terms of FOB in 1973 just before the oil crisis.

Because of the oil crisis in 1973, the international price of urea, which had continued to decline until that time, suddenly recorded a rapid upward turn. As described above, the gradual decrease in the price of urea, together with the efforts of developing countries on agricultural development, roused the fertilizer demand in respective countries, and consequently, the supply and demand of urea in the world had been in the direction of becoming balanced in the period after 1970. However, after the oil crisis in 1973, the producers in the U.S.A., West Europe , and Japan (especially the producers in West Europe and Japan whose raw material of ammonia is naphtha or hydrocarbon other than indigenous natural gas) were compelled to quit their production to some extent, because the production cost increased more rapidly than the increase in the market prices, and because they could not secure the raw material for the production. And, with the increase in the production costs, the supply/demand balance of urea became tight, this resulting in the rapid increase in the prices.

The increase in the prices led to the stagnation in the demand of importing countries on one hand, and stimulated the construction and expantion of plants in such countries as the U.S.S.R., East Europe, and many developing countries on the other. As a result, the supply of urea became excessively abundant while the demand stayed the same thus the price of urea rapidly declined. As shown in Figure II-2-1, the price of urea, which was recorded as high as U.S.$ 250 in terms of FOB in 1975, rapidly declined to U.S.$ 100 in the following year, increasing gradually after that from U.S.$140 to the present price of U.S.$150.

2-2-2 Future trend of the international price of urea

It is obvious from the past trend of urea prices that the past urea price in the international market has been formed on the relationships between the supply/demand balance in the market and the production cost of the producers who could export competitively. According to the analysis of the price formulation mechanisms in the past, the urea price in the international market during oversupply has been formed on the basis of the production costs of the marginal producers in the international market in question from time to time.

From 1982 onwards, it is expected, as mentioned above, to see a vast oversupply position. However, the international market from 1982 onwards will be different in its conditions from the past cases of oversupply in terms of the following points:

(1) In the past, approximately the same level of the production cost has been maintained by West Europe, Japan, and North America, thereby presenting keen competition among these countries. From 1982 onwards, the major suppliers in the future will be the Mideastern countries, Indonesia, and East European countries due to their cost competitiveness supported by low cost feedstocks in place of West Europe, Japan, and North America. The competition will be keenly engaged among

these new suppliers. Also, as there will be a great difference in the production cost between the new suppliers whose cost will be the most competitive, i.e., Mideastern countries and Indonesia, and the traditional large producers losing competitiveness, i.e., West Europe, Japan, and North America, the new suppliers may be able to rise their export prices up to the limit at which the traditional major suppliers will be vitally discouraged from participating into the international competition. Therefore, international price will increase up to such level.

(2) Under the long-term oversupply conditions which is expected in the future, the scrapping of producing facilities will be accelerated in West Europe, North America, Japan, etc. who will inevitably be in disadvantage in the competition. Therefore, the actual supply/demand gap will be smaller than the extent already forecast in this study.

(3) Even if the producing facilities in West Europe, the U.S.A., Japan, etc. would be continued in operation, it would be difficult for these producers to amply secure the export outlets, so that the reduction of operational rate will be inevitable. Consequently, the production cost difference between these countries and the new producer countries will further grow apart, which in turn will again increase the price level at which the traditional major producers will be sufficiently discouraged from participation in the international competition as explained above.

The international market price of urea was forecast on the basis of the above points. The forecast urea prices in Asian markets centering on India which is expected to be the one of major importing countries are shown as follows in terms of CIF price of bagged urea. The detail of the analyses is in Annex II-2-3.

Year	Projected urea prices
1982	U.S.$181
1983	U.S.$198
1984	U.S.$223
1985	U.S.$243

2-2-3 Future export price of urea exported from Indonesia

The future export price of urea, forecast on the basis of the above future international price, with the freight and bagging cost being subtracted from the price, is as follows:

Year	Export price of bulk urea from Indonesia in terms of FOB Indonesia (U.S.$/Ton)
1982	148
1983	164
1984	188
1985	206

The plant envisioned in this project is scheduled to be onstream at the beginning of 1982. The plant is expected to produce urea at 75% of its production capacity utilization ratio during 1982, and all the products will be absorbed in the market in the ASEAN region including Aceh and North Sumatra provinces, Indonesia. In this connection, when taking into consideration the advantage of freight to the markets in terms of distance, Indonesia is expected to export its urea competitively to the markets at FOB price of U.S.$ 160. In and after 1983, the export of urea destined to the markets outside the ASEAN is projected to increase. Therefore, the export price will be at the same level as above stated international prices. When taking into the above factors, the export price of bulk urea from Indonesia in terms of 1982 constant prices, will be U.S.$ 160 FOB Indonesia.

Chapter 3 Sales Plans

3-1 Arrangements among the ASEAN member countries

The ASEAN member countries have arrived at the following arrangements concerning the sales of the urea to be produced by the envisaged project:

(1) The Aceh urea project shall have the priority right to supply the product urea to the "available ASEAN market". The "available ASEAN market" means the markets in the Philippines, Singapore and Thailand after considering their domestic production of urea and also the market in Malaysia if there is not enough production of urea in Malaysia.

(2) As and when the ASEAN urea project in Malaysia is established and placed on-stream, then the "available ASEAN market" excluding the market in Malaysia shall be equally shared by the both ASEAN urea projects.

(3) As agreed upon Indonesia gurantees that of the urea to be produced by this project, the surplus after exporting to the "available ASEAN market" will be sold to its domestic market and also to market outlets outside the ASEAN region.

(4) In this project, floor and ceiling prices of the sales price shall be established. The floor and the ceiling prices shall be calculated on the basis of the actual production cost plus the maximum and minimum profit rates which will be agreed upon.

(5) The floor and the ceiling prices may be reviewed in the event of unexpected and/or abnormal developments in world market conditions which shall include the conditions when the prevailing world market price exceeds the agreed ceiling price by more than the agreed percentage or when the world market price falls below the floor price by more than the agreed percentage.

(6) There shall be one FOB selling price based on long term contracts and/or similar arrangements for the host country and the ASEAN markets.

(7) The acceptance of the products from the Aceh urea plant shall be conducted in

accordance with the Preferential Trading Agreements (PTA) concluded between and among the ASEAN member countries.

3-2 Sales plans for this project

The following paragraphs will examine the sales plans of urea for this project on the basis of the already discussed outlook on the supply/demand balance of urea and nitrogenous fertilizers in the world, in Asia, and in the ASEAN region, the international urea price estimation, and the arrangement on the marketing of the urea to be produced by this plant as concluded among the ASEAN members.

The following points are assumed in the sales plan:

(1) The produced urea shall be firstly exported to the ASEAN market. The surplus after exporting to these outlets shall be sold entirely to the Indonesian domestic market and to the markets outlets outside the ASEAN region. According to the sales plan of the Government of Indonesia, the Indonesian domestic market in this respect centers on Aceh and North Sumatra Provinces.

(2) The suppliable amount of urea to the ASEAN markets shall be equivalent to the total amount of the urea import requirements of all the ASEAN member countries until the time when the Malaysian urea project is placed onstream. After the commencement of the Malaysian urea production, the suppliable amount from this project shall be 50% of the total urea import requirements of the ASEAN member countries.

Table II-3-1 shows a sales plan formulated on the basis of these prerequisite conditions.

The estimated demand for urea in Aceh Province and North Sumatra Province is as shown in Table II-3-2.

3-3 Sales organization

As shown above by Table II-3-1, in and after 1983, the export from the plant to the markets outside the ASEAN, will increase year after year. However, as far as the urea produced by this plant is concerned, the residual after exporting to the ASEAN countries is guaranteed to be undertaken by the Government of Indonesia, with Indonesia shipping the residual to the domestic market or exporting to the markets outside the ASEAN in its responsibility. Therefore, no problems will remain concerning the sales of urea produced by the plant in terms of this project.

The Government of Indonesia is intending to appoint PUSRI as a sales agent of the urea produced by the plant, if the government can obtain the consent among the share holder countries for this point. PUSRI has well-arranged sales organization and distribution systems for domestic shipment, allocating transportation and distribution facilities such as bulk depots with bagging facilities in major consuming districts. As far as the PUSRI's facilities in the near districts to this plant are concerned, PUSRI has bulk depots of 150 thousand tons of annual holding capacity with shipping terminals of 100 tons of annual capacity, in Belawan and in Padan respectively. Both terminals are equipped with own wharf for large scaled ocean-going cargo boats, and loading and unloading facilities. Further, PUSRI has four bulk cargo boats for urea, and can transport the urea economically by the boats both to domestic bulk depots and to neighboring countries. The detail list of PUSRI's transportation and distribution facilities is given in Table II-3-2.

In recent years, PUSRI is positively tackling not only shipment to domestic market but also export, experiencing about 300 thousand tons of export in 1977. Thus, the export system of PUSRI is expected to strengthen increasingly in the future.

Therefore, as far as the sales system of this project is concerned, the satisfactory sales system is expected to be available by appointing PUSRI as the sales agent. At the same time, as described in Chapter 2, the markets outside the ASEAN is expected to be available for exporting urea. Nevertheless, it is essential for Indonesia to strive for the improvement of its export competitiveness by strengthening PUSRI's export system, and rationalizing the domestic supply system as from the stand point of a national united system.

Table II-1-1. SUMMARY OF DEMAND FORECAST ON NITROGEN FERTILIZER, INDONESIA

(N 000 ton)

	1971	1972	1973	1974	1975	1976	1977	1980	1985	1990
Food Crop										
BIMAS/INMAS										
Rice: BIMAS (Wet)					159.8	165.4	164.0	193.3	227.8	249.9
BIMAS (Dry)	187.9	222.4	307.4	266.6	86.2	80.3	88.1	101.9	113.4	115.1
INMAS (Wet)					21.0	10.8	57.5	58.9	108.4	163.1
INMAS (Dry)					10.6	15.8	99.3	106.7	134.4	151.9
Soybeans	0	0	0	1.1	0.9	1.6	(2.4)	3.8	8.5	12.8
Corn	0	0	0	8.9	14.2	20.7	(29.7)	87.6	117.4	129.9
Peanuts	0	0	0	1.1	2.6	2.9	(2.9)	7.7	9.4	10.2
Cassava	0	0	0	0	0	0	(0)	1.6	2.0	2.2
Estimate	187.9	222.4	307.4	277.7	295.2	297.4	(443.9)	561.5	721.3	825.1
Actual	187.9	222.4	307.4	277.7	308.4	306.2	429.3			
Non-BIMAS/INMAS										
Vegetables	6.7	5.6	4.6	13.1	2.9	7.1	13.9	9.1	14.8	23.5
Rice: Upland								22.1	15.9	7.7
Non-irrigated	0	0	0	0	0	0	0	11.4	8.6	6.0
Non-B/I irrigated								7.0	3.5	0
Estimate	6.7	5.6	4.6	13.1	2.9	7.1	13.9	49.6	42.8	37.2
Estimate	194.6	228.0	312.0	290.8	298.1	304.5	(457.8)	611.1	764.1	862.3
Actual	194.6	228.0	312.0	290.8	311.3	313.3	443.2			
Estate Crop										
Rubber: Estates	16.5	16.5	16.5	16.3	16.2	15.8		14.1	12.2	10.6
Smallholders	0	0	0	0	0	0		25.0	28.0	30.7
Sugarcane	13.0	14.9	16.1	17.1	17.8	13.9		24.0	30.6	37.5
Oil Palm								5.6	7.6	9.6
Tobacco								1.0	1.2	1.3
Tea	0	0	0	0	0	9.3		2.9	3.2	3.3
Coffee								15.3	17.2	18.7
Coconut								0	0	0
Estimate	29.5	31.4	32.6	33.4	34.0	39.0	(30.6)	87.9	100.0	111.7
Actual	17.1	27.3	16.9	25.6	27.5	39.0	30.6			
Grand Total: Estimate	224.1	259.4	344.6	324.2	332.1	343.5	(488.4)	699.0	864.1	974.0
Actual	211.7	255.3	329.0	316.4	338.8	352.3	473.8			

Continued on the next page.

Table II-1-1. SUMMARY OF DEMAND FORECAST ON NITROGEN FERTILIZER, INDONESIA (CONT'D.)

1. "Estimate" in the past years denotes the total of crop-wise demand estimation in the study.
2. "Actual" denotes the demand figures collected from the official statistics.

Source: Actual consumption: Up to 1976: "Kumpulan Data Pupuk Indonesia, 1967-76"
1977: Dept. of Chemical Industries, Indonesia

Table II-1-2. MAJOR AFFECTING FACTORS PROJECTED IN THE DEMAND FORECAST OF NITROGEN FERTILIZER, INDONESIA

	1974			1976			1985		
	Planted area 000 ha	Fertilized area 000 ha	Ave. Dosage N kg/ha	Planted area 000 ha	Fertilized area 000 ha	Ave. Dosage N kg/ha	Planted area 000 ha	Fertilized area 000 ha	Ave. Dosage N kg/ha
Food Crops									
Paddy									
BIMAS Wet season	2,186**	***	73**	2,102	***	79(90)*	1,439	***	102
BIMAS Dry season	901**	***	96**	873	***	129(104)*	1,009	***	112
INMAS Wet season	702**	***	23**	841(1,737)*	***	11(29)*	1,406	***	49
INMAS Dry season	459**	***	23**	659	***	24(96)*	1,190	***	113
Corn	2,669	8	44	2,064	22	47	2,666	76	58
Soybeans	768	13	12	636	22	12	829	55	30
Vegetables	647	***	20	529	***	13	655	***	23
Upland rice	1,168	0	0	1,137	0	0	550	32	92
Paddy in non-irrigated area	2,103	0	0	1,621	0	0	915	32	100
Estate Crops									
Rubber									
Estates: Mature	47	***	12	19	***	12	15	***	12
Estates: Inmature	393	***	40	389	***	40	302	***	40
Smallholders: Mature	} 1,868	***	0	N.A.	***	0	392	***	5
Smallholders: Inmature							1,475	***	18
Sugar Cane									
Estate	107	***	120	105	***	120	163	***	120
Smallholders	72	***	60	87	***	60	146	***	76

Notes: *: In 1977
**: In 1975
***: Average dosages are estimated based on the planted area.

1974-1976: Actual or estimated

Planted areas of paddy are estimated based on the following projections. (Continued on next page)

Table II-1-2. MAJOR AFFECTING FACTORS PROJECTED IN THE DEMAND FORECAST OF NITROGEN FERTILIZER, INDONESIA (CONT'D.)

	1974	1976	1985
A. Net wet land area (000 ha)	5,049	5,124	5,616
B. Gross wet land area (000 ha)	7,340	7,229	8,189
Land intensing ratio: B/A (%)	145	141 (144)*	146
C. Irrigated ratio (%)	71	76	84
D. Diffusion ratio of HYV in irrigated area (%)			
Wet season	62	58 (69)*	97
Dry season	62	71 (77)*	97
E. Percent of non-BIMAS/INMAS area in irrigated area (%)			
Wet season	20	24 (10)*	2
Dry season	26	12 (7)*	0

Notes: 1. *: In 1977

2. 1974, 1976: Actual

Table II-1-3. DEMAND FORECAST ON UREA, INDONESIA

(Urea 000 ton)

	1975	1976	1977	1980	1985	1990
Fertilizer:						
Food crop sector						
BIMAS/INMAS	670.2	665.6	919.0	1,220.7	1,568.0	1,793.7
Non-BIMAS/INMAS	-	-	12.5	100.2	85.4	73.3
Total	670.2	665.6	931.5	1,320.9	1,653.4	1,867.0
Estate crop sector	5.8	20.4	-	68.5	78.3	88.0
Total	676.0	686.0	931.5	1,389.4	1,731.7	1,955.0
Industrial:						
Urea-formaldehyde adhesive	0	0	0	8.9	11.7	15.2
Monosodium L-glutamate and Others	3.3	3.5	3.9	4.8	7.0	9.8
Total	3.3	3.5	3.9	13.7	18.7	25.0
Total:	679.3	689.5	935.4	1,403.1	1,750.4	1,980.0

Note: 1975-1977: Actual or estimated.

Table II-1-4. UREA SUPPLY/DEMAND PROJECTION, INDONESIA

(Product 000 ton)

		1975*)	1976*)	1977*)	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
Capacity/Production														
PUSRI - I	Urea Cap. (A)	100	100	100	100	100	100	100						
	Prod. (B)	92	85	95	95	95	95	95						
	(B)/(A) %	92	85	95	95	95	95	95						
PUSRI - II	Urea Cap.	380	380	380	380	380	380	380	380	380	380	380	380	380
	Prod.	292	280	353	354	354	354	354	354	354	354	354	354	354
	(B)/(A) %	77	74	93	93	93	93	93	93	93	93	93	93	93
PUSRI - III	Urea Cap.			570	570	570	570	570	570	570	570	570	570	570
	Prod.			332	428	456	513	513	513	513	513	513	513	513
	(B)/(A) %			58	75	80	90	90	90	90	90	90	90	90
PUSRI - IV	Urea Cap.			47	570	570	570	570	570	570	570	570	570	570
	Prod.			54	428	456	513	513	513	513	513	513	513	513
	(B)/(A) %			115	75	80	90	90	90	90	90	90	90	90
P.T. Petrokimia	Urea Cap.	45	45	45	45	45	45	45	45	45	45	45	45	45
	Prod.	13	1	11	14	14	14	14	14	14	14	14	14	14
	(B)/(A) %	30	2	24	30	30	30	30	30	30	30	30	30	30
Aceh (1982/1)	Urea Cap.								570	570	570	570	570	570
	Prod.								427	456	513	513	513	513
	(B)/(A) %								75	80	90	90	90	90
Kujang (1978/8)	Urea Cap.				238	570	570	570	570	570	570	570	570	570
	Prod.				178	439	480	513	513	513	513	513	513	513
	(B)/(A) %				75	77	84	90	90	90	90	90	90	90
Kaltim (1980/10)	Urea Cap.						143	570	570	570	570	570	570	570
	Prod.						107	434	470	513	513	513	513	513
	(B)/(A) %						75	76	83	90	90	90	90	90
Total	Cap.	525	525	1,142	1,903	2,235	2,378	2,805	3,275	3,275	3,275	3,275	3,275	3,275
	Prod.	397	366	833	1,495	1,814	2,075	2,436	2,804	2,875	2,932	2,932	2,932	2,932
Industrial Use		3	3	4	12	13	14	15	16	17	18	19	20	21
Supply Capability		394	363	829	1,483	1,801	2,061	2,421	2,788	2,858	2,914	2,913	2,912	2,911
Demand		676	686	932	1,105	1,257	1,389	1,483	1,565	1,633	1,689	1,732	1,786	1,835
Balance		-282	-323	-103	378	544	672	938	1,223	1,225	1,225	1,181	1,126	1,076

Continued on next page.

Table II-1-4. UREA SUPPLY/DEMAND PROJECTION, INDONESIA (CONT'D.)

1. *) Actual or estimated
2. "Supply capability" and "Demand" denote those of fertilizer use.
3. "Supply capability" is calculated on the following formula:
   (Supply Capability)=(Total Production) - (Industrial Use)

Table II-1-5. SUMMARY OF DEMAND FORECAST ON NITROGEN FERTILIZER, PHILIPPINES

(N 000 ton)

	1970	1971	1972	1973	1974	1975	1976	1977	1980	1985	1990
Food Crop											
Rice: Irrigated HYV	29.8	36.8	38.0	35.2	49.8	47.7	53.5	57.1	68.2	87.0	104.0
Irrigated LV	4.8	5.0	5.1	5.7	5.1	4.2	4.5	4.1	3.4	1.9	1.0
Non-irrigated HYV	0	0	2.4	2.9	4.5	3.0	3.9	5.5	10.0	15.5	17.1
Non-irrigated LV	0	0	1.0	1.1	1.3	0.9	1.1	1.1	1.2	1.0	0.5
Corn	15.0	15.5	16.5	16.3	25.7	35.5	39.7	41.4	52.1	72.2	94.1
Vegetables	1.5	2.3	3.5	5.3	8.0	3.5	5.3	8.0	8.9	10.5	12.4
Estimate	51.1	59.6	66.5	66.5	94.4	94.8	108.0	117.2	143.8	188.1	229.1
Actual				81.1	95.1	80.3					
Export Crop											
Sugarcane	45.1	54.1	54.0	56.6	57.3	51.1	51.5	(63.4)	58.9	67.8	76.1
Coconut	1.9	2.2	2.6	3.1	3.6	2.6	3.1	3.6	3.2	5.6	9.4
Pineapple Tobacco Banana Others	5.6	6.9	8.5	10.5	12.9	8.5	10.5	12.9	14.9	18.9	24.0
Estimate	52.6	63.2	65.1	70.2	73.8	62.2	65.1	79.9	77.0	92.3	109.5
Actual				73.4	85.6	54.5					
Grand Total: Estimate	103.7	122.8	131.6	136.7	168.2	157.0	173.1	197.1	220.8	280.4	338.6
Actual	107.1	125.4	117.8	153.8	180.4	134.5	156.0	179.5			

For notes of this table, see notes of Tab. II-1-1.

Table II-1-6. MAJOR AFFECTING FACTORS PROJECTED IN THE DEMAND FORECAST OF NITROGEN FERTILIZER, PHILIPPINES

	1975			1977			1985		
	Planted area 000 ha	Fertilized area 000 ha	Ave. Dosage N kg/ha	Planted area 000 ha	Fertilized area 000 ha	Ave. Dosage N kg/ha	Planted area 000 ha	Fertilized area 000 ha	Ave. Dosage N kg/ha
Food Crop									
Rice*									
Irrigated/HYV	1,109	**	43	1,253	**	46	1,611	**	54
Irrigated/Other varieties	303	**	14	237	**	17	85	**	23
Non-irrigated/HYV	1,066	**	3	1,192	**	5	1,486	**	10
Non-irrigated/Other varieties	608	**	1	466	**	2	138	**	7
Corn	3,063	**	12	3,184	**	13	4,056	**	18
Estate Crop									
Sugar Cane	536	93	103	535	93	128	572	93	128

Notes: 1975, 1977: Actual or estimated.
**: Average dosages are estimated based on the planted area.
*: Planted areas of palay are calculated based on the following projections.

	1975	1977	1985
A. Net wet land area (000 ha)	1,951	1,987	2,062
B. Gross wet land area (000 ha)	3,086	3,147	3,320
C. Irrigated ratio (%)	42	44	47
D. Double cropping ratio of palay:			
In irrigated area (%)	74	71	76
In non-irrigated area (%)	47	49	48
E. Diffusion ratio of HYV:			
In irrigated area (%)	79	84	95
In non-irrigated area (%)	64	72	92

Table II-1-7. DEMAND FORECAST ON UREA, PHILIPPINES

(Urea 000 ton)

	1975	1976	1977	1980	1985	1990
Fertilizer:						
Food crop sector	85.2	N.A.	N.A.			
Export crop sector	58.7	N.A.	N.A.			
Total	143.9	174.8	227.8	256.3	329.1	402.0
Industrial:						
Urea-formaldehyde adhesive	6.3	4.3	6.3	11.5	14.3	17.2
Total:	150.2	179.1	234.1	267.8	343.4	419.2

Note: 1975-1977: Actual or estimated.

Table II-1-8. UREA SUPPLY/DEMAND PROJECTION, PHILIPPINES

(Product 000 ton)

			1975*)	1976*)	1977*)	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
Capacity/Production															
Planters Products	Urea	Cap. (A)	68	68	68										
		Prod. (B)	24	14	-										
		(B)/(A) %	35	21	-										
New Project (1984/7)	Urea	Cap.										150	300	300	300
		Prod.										98	203	225	240
		(B)/(A) %										65	68	75	80
Total		Cap.	68	68	68	-	-	-	-	-	-	150	300	300	300
		Prod.	24	14	-	-	-	-	-	-	-	98	203	225	240
Industrial Use			6	4	6	10	11	12	12	13	13	14	14	15	15
Supply Capability			18	10	-6	-10	-11	-12	-12	-13	-13	84	189	210	225
Demand			144	175	228	236	245	256	270	284	298	313	329	344	358
Balance			-126	-165	-234	-246	-256	-268	-282	-297	-311	-229	-140	-134	-133

For notes of this table, see notes of Tab. II-1-4.

Table II-1-9. SUMMARY OF DEMAND FORECAST ON NITROGEN FERTILIZER, THAILAND

(N 000 ton)

		1973	1974	1975	1976	1980	1985	1990
Paddy:	North	0.7	0.7	1.1	1.1	1.5	1.7	2.4
	North East	10.8	8.7	14.4	17.1	16.5	21.0	26.4
	Central	25.8	21.7	23.2	29.4	30.1	38.3	47.2
	South	1.9	1.6	2.0	2.4	2.3	2.6	2.8
	Total	39.2	32.7	40.7	50.0	50.4	63.6	78.8
Vegetables		6.3	8.5	8.2	10.0	12.0	13.0	14.0
Sugar Cane		6.9	7.8	11.5	25.5	36.6	53.5	65.6
Tobacco		1.2	1.6	1.6	1.2	1.5	1.9	2.3
Corn		0.1	0.1	0.1	0.1	0.1	0.2	0.2
Rubber		5.2	4.6	5.3	4.9	6.2	7.4	8.7
Others		7.3	7.7	11.7	18.7	32.1	42.5	50.0
Grand Total:	Estimate	65.8	61.2	77.3	107.9	138.9	182.1	219.6
	Actual	64.5	62.1	73.4	103.1			

For notes of this table, see notes of Tab. II-1-1.

Table II-1-10. MAJOR AFFECTING FACTORS PROJECTED IN THE DEMAND FORECAST OF NITROGEN FERTILIZER, THAILAND

	1973			1976			1985		
	Planted area 000 ha	Fertilized area 000 ha	Ave. Dosage N kg/ha	Planted area 000 ha	Fertilized area 000 ha	Ave. Dosage N kg/ha	Planted area 000 ha	Fertilized area 000 ha	Ave. Dosage N kg/ha
Paddy:									
North region	1,839	**	1	1,727	**	1	1,912	**	1
North East region	3,552	**	3	3,802	**	5	3,956	**	5
Central region	2,479	**	10	2,424	**	12	2,503	**	15
South region	493	**	4	623	**	4	610	**	4
Vegetables	100	**	64	92	**	109	112	**	116
Sugar Cane	259	**	27	499	**	51	861	**	54
Corn	1,148	**	0.1	1,285	**	0.1	1,601	**	0.1
Rubber	1,372	**	4	1,456	**	4	1,638	**	5

Notes: 1. Average dosages are estimated based on the planted area.
2. 1973, 1976: Actual or estimated.

Table II-1-11. DEMAND FORECAST ON UREA, THAILAND

(Urea 000 ton)

	1975	1976	1977	1980	1985	1990
Fertilizer:						
Vegetables	4.3	7.8	N.A.	7.8	12.8	18.3
Paddy						
Straight Fert.				5.4	20.7	42.8
Raw material for Complex Fert.				0	5.9	12.8
Others				3.0	16.5	39.1
Total	4.3	7.8	N.A.	16.2	55.9	113.0
Industrial:						
Urea-formaldehyde adhesive	4.3	3.9	4.3	5.0	5.9	6.3
Monosodium L-glutamate	8.0	6.7	7.0	10.9	14.8	18.7
Total	12.3	10.6	11.3	15.9	20.7	25.0
Total:	16.6	18.4	N.A.	32.1	76.6	138.0

Note: 1975-1977: Actual or estimated.

Source: Actual demand: Division of Agricultural Economics, "Fertilizer Statistics" (in Thai).

Table II-1-12. UREA SUPPLY/DEMAND PROJECTION, THAILAND

(Product 000 ton)

		1975*)	1976*)	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
Capacity/Production														
CFC	Urea Cap. (A)	26	26	26	26	26	26	26	26	26	26	26	26	26
	Prod. (B)	3	3	4	4	4	4	4	4	4	4	4	4	4
	(B)/(A) %	10	13	16	16	16	16	16	16	16	16	16	16	16
Total	Cap.	26	26	26	26	26	26	26	26	26	26	26	26	26
	Prod.	3	3	4	4	4	4	4	4	4	4	4	4	4
Industrial Use		12	11	11	14	15	16	17	18	18	20	21	22	22
Supply Capability		-9	-8	-7	-10	-11	-12	-13	-14	-14	-16	-17	-18	-18
Demand		4	8	8	10	12	16	22	29	37	46	56	66	77
Balance		-13	-16	-15	-20	-23	-28	-35	-43	-51	-62	-73	-84	-95

For notes of this table, see notes of Tab. II-1-4.

Table II-1-13. SUMMARY OF DEMAND FORECAST ON NITROGEN FERTILIZER, MALAYSIA

(N 000 ton)

	1968	1969	1970	1971	1972	1973	1974	1980	1985	1990
- West Malaysia										
Paddy	7.1	10.3	12.8	13.0	16.3	16.3	15.1	27.1	30.7	33.6
Rubber: Estates: Mature	5.2	9.4	10.9	10.0	9.8	12.1	11.5	12.6	12.6	12.0
Inmature	3.2	2.9	2.6	2.4	2.0	1.9	2.0	1.0	0.6	0.4
Smallholders: FELDA	0.1	0.4	0.6	0.7	0.8	1.2	1.2	3.0	4.7	6.6
Inmature	5.8	5.1	4.7	4.3	3.8	4.0	4.1	2.7	1.9	1.3
Total	14.3	17.8	18.8	17.4	16.4	19.2	18.8	19.3	19.8	20.3
Oil Palm: Mature	4.1	4.9	6.9	10.6	13.3	14.3	18.2	33.5	42.0	48.8
Inmature	3.6	3.7	3.6	4.0	4.3	4.7	6.7	2.7	7.2	6.1
Total	7.7	8.6	10.5	14.6	17.6	19.0	24.9	36.2	49.2	54.9
Others	8.6	8.5	14.6	1.9	9.6	12.3	10.1	11.7	13.0	14.3
Estimate	37.7	45.2	56.7	46.9	59.9	66.8	68.9	94.3	112.7	123.1
Actual	33.3	45.2	56.7	46.9	59.9	78.0	96.5			
- Sabah	0.6	1.0	1.6	2.8	2.3	2.5	3.7	6.1	8.4	10.6
- Sarawak	3.1	3.1	3.7	3.4	3.1	3.7	3.7	3.9	4.2	4.5
Grand Total: Estimate	41.4	49.3	62.0	53.1	65.3	73.0	76.3	104.3	125.3	138.2
Actual	37.0	49.3	62.0	53.1	65.3	84.2	103.9			

For notes of this table, see notes of Tab. II-1-1.

Table II-1-14. MAJOR AFFECTING FACTORS PROJECTED IN THE DEMAND FORECAST OF NITROGEN FERTILIZER, MALAYSIA

		1971			1973			1985		
		Planted area 000 ha	Fertilized area 000 ha	Ave. Dosage N kg/ha	Planted area 000 ha	Fertilized area 000 ha	Ave. Dosage N kg/ha	Planted area 000 ha	Fertilized area 000 ha	Ave. Dosage N kg/ha
Paddy***										
Region I*	Irrigated	140	90	39	197	96	46	337	97	55
	Non-irrigated	116	87	39	83	80	46	18	94	55
Region II*	Irrigated	90	74	34	103	79	23	131	87	46
	Non-irrigated	22	74	34	20	57	23	24	81	46
Region III*	Irrigated	39	76	12	103	73	19	169	77	34
	Non-irrigated	125	63	12	75	54	19	56	67	34
Rubber										
Estates										
Mature		514	**	19	489	**	25	366	**	34
Inmature		118	**	20	100	**	19	32	**	20
Smallholders										
Mature (FELDA program)		38	**	19	47	**	25	138	**	34
Inmature		267	**	16	256	**	16	121	**	16
Oil Palm										
Mature (Estate & Schemes)		176	**	60	260	**	55	700	**	60
Inmature		130	**	31	175	**	27	205	**	35

Notes:
*: Region I: Perlis, Kedah, Pulau Pinang, and Selangor.
II: Perak, Negeri Sembilan, Melaka, and Johor.
III: Kelantan, Terengganu, and Pahang.
**: Average dosages are estimated based on the planted area.
1971,1973: Actual or estimated.
***: Planted area of paddy are calculated based on the following projections.

	1971	1973	1985
A. Net wet land area (000 ha)	373	369	377
B. Gross wet land area (000 ha)	532	581	735
C. Double cropping ratio of paddy (%)	43	57	95
D. Irrigated ratio (%)	51	69	82
Region I	56	70	95
Region II	82	84	85
Region III	21	58	75

Note: 1971, 1973: Actual

Table II-1-15. DEMAND FORECAST ON UREA, MALAYSIA

(Urea 000 ton)

	1972	1973	1974	1980	1985	1990
Fertilizer:						
West Malaysia						
Paddy Straight	26.1	24.8	25.7	48.9	56.7	63.0
Raw material for Complex Fertilizer	0	0	0	0	2.0	3.9
Total	26.1	24.8	25.7	48.9	58.7	66.9
Oil Palm	14.6	20.0	24.4	36.5	49.8	55.4
Others	0	0	0	0	5.7	12.4
Sabah	0	0	0	0	2.8	6.3
Total	40.7	44.8	50.1	85.4	117.0	141.0
Industrial:						
Urea-formaldehyde adhesive	7.0	7.6	8.0	13.0	17.8	22.2
Total:	47.7	52.4	58.1	98.4	134.8	163.2

Notes: 1. 1972-1974: Actual or estimated.

2. Actual consumption in 1972 and in 1974 is estimated taking into account the increase in inventory.

Table II-1-16. UREA SUPPLY/DEMAND PROJECTION, MALAYSIA

(Product 000 ton)

		1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
Capacity/Production														
PETRONAS (1983/1)	Urea Cap. (A)	-	-	-	-	-	-	-	-	496	496	496	496	496
	Prod. (B)									372	397	446	446	446
	(B)/(A) %									75	80	90	90	90
Total	Cap.	-	-	-	-	-	-	-	-	496	496	496	496	496
	Prod.	-	-	-	-	-	-	-	-	372	397	446	446	446
Industrial Use		8	9	10	11	12	13	14	15	16	17	18	19	20
Supply Capability		-8	-9	-10	-11	-12	-13	-14	-15	356	380	428	427	426
Demand		49	81	84	87	92	97	104	112	119	128	136	144	152
Balance		-57	-90	-94	-98	-104	-110	-118	-127	237	252	292	283	274

For notes of this table, see notes of Tab. II-1-4.

Table II-1-17. DEMAND FORECAST ON UREA, SINGAPORE

(Urea 000 ton)

	1975	1976	1977	1980	1985	1990
Fertilizer:	2.2	2.2	2.2	2.2	2.2	2.2
Industrial:						
Urea-formaldehyde adhesive	4.3	6.5	8.7	15.2	15.2	15.2
Total:	6.5	8.7	10.9	17.4	17.4	17.4

Note: 1975-1977: Actual or estimated.

Sources: 1. FAO, "Annual Fertilizer Review"
2. "Fertilizer Market Study, ASEAN Region"

Table II-1-18. SUPPLY/DEMAND BALANCE FORECAST OF NITROGEN FERTILIZER, ASEAN REGION

(N 000 ton)

		1975/76	76/77	77/78	78/79	79/80	80/81	81/82	82/83	83/84	84/85	85/86	86/87	87/88
INDONESIA	CAPACITY	289	289	582	942	1099	1199	1499	1769	1769	1769	1769	1769	1769
	SUPPLY	105	181	409	719	868	1017	1261	1489	1531	1558	1558	1557	1556
	DEMAND	339	352	474	559	634	699	745	784	817	844	864	891	915
	BALANCE	-134	-171	-65	160	234	318	516	705	714	714	694	666	641
PHILIPPINES	CAPACITY	101	101	101	101	101	101	101	101	101	175	249	249	249
	SUPPLY	35	31	19	25	25	25	24	24	24	72	122	134	141
	DEMAND	135	156	180	194	208	221	233	245	257	269	280	292	304
	BALANCE	-100	-125	-161	-169	-183	-196	-209	-221	-233	-197	-158	-158	-163
MALAYSIA	CAPACITY	43	43	43	43	43	43	43	43	352	352	352	352	352
	SUPPLY	37	37	36	36	35	35	35	34	257	274	309	308	308
	DEMAND	79	85	95	98	100	104	108	112	117	121	125	130	134
	BALANCE	-42	-48	-59	-62	-65	-69	-73	-78	140	153	184	178	174
THAILAND	CAPACITY	27	27	27	27	27	27	27	27	27	27	162	297	297
	SUPPLY	-1	2	2	1	0	0	-1	-1	-2	-2	85	179	199
	DEMAND	65	108	110	120	130	139	148	156	165	174	182	190	198
	BALANCE	-66	-106	-108	-119	-130	-139	-149	-157	-167	-176	-97	-11	1
SINGAPORE	CAPACITY	0	0	0	0	0	0	0	0	0	0	0	0	0
	SUPPLY	-2	-3	-4	-5	-6	-7	-7	-7	-7	-7	-7	-7	-7
	DEMAND	1	1	1	1	1	1	1	1	1	1	1	1	1
	BALANCE	-3	-4	-5	-6	-7	-8	-8	-8	-8	-8	-8	-8	-8
ASEAN TOTAL	CAPACITY	460	460	753	1113	1270	1370	1670	1940	2249	2323	2532	2667	2667
	SUPPLY	274	248	462	776	922	1070	1312	1539	1803	1895	2067	2171	2197
	DEMAND	619	702	860	972	1073	1164	1235	1298	1357	1409	1452	1504	1552
	BALANCE	-345	-454	-398	-196	-151	-94	77	241	446	486	615	667	645

Table II-1-19. SUPPLY/DEMAND PROJECTION OF UREA, ASEAN COUNTRIES

(Product 000 ton)

		1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
INDONESIA	CAPACITY	525	525	1142	1903	2235	2378	2805	3275	3275	3275	3275	3275	3275
	SUPPLY	394	363	829	1483	1801	2061	2421	2788	2858	2914	2913	2912	2911
	DEMAND	676	686	932	1105	1257	1389	1483	1565	1633	1689	1732	1786	1835
	BALANCE	-282	-323	-103	378	544	672	938	1223	1225	1225	1181	1126	1076
PHILIPPINES	CAPACITY	68	68	-	-	-	-	-	-	-	150	300	300	300
	SUPPLY	18	10	-6	-10	-11	-12	-12	-13	-13	84	189	210	225
	DEMAND	144	175	228	236	245	256	270	284	298	313	329	344	358
	BALANCE	-126	-165	-234	-246	-256	-268	-282	-297	-311	-229	-140	-134	-133
MALAYSIA	CAPACITY	-	-	-	-	-	-	-	-	496	496	496	496	496
	SUPPLY	-8	-9	-10	-11	-12	-13	-14	-15	356	380	428	427	426
	DEMAND	49	81	84	87	92	97	104	112	119	128	136	144	152
	BALANCE	-57	-90	-94	-98	-104	-110	-118	-127	237	252	292	283	274
THAILAND	CAPACITY	26	26	26	26	26	26	26	26	26	26	26	26	26
	SUPPLY	-9	-8	-7	-10	-11	-12	-13	-14	-14	-16	-17	-18	-18
	DEMAND	4	8	8	10	12	16	22	29	37	46	56	66	77
	BALANCE	-13	-16	-15	-20	-23	-28	-35	-43	-51	-62	-73	-84	-95
SINGAPORE	CAPACITY	-	-	-	-	-	-	-	-	-	-	-	-	-
	SUPPLY	-4	-7	-9	-11	-13	-15	-15	-15	-15	-15	-15	-15	-15
	DEMAND	2	2	2	2	2	2	2	2	2	2	2	2	2
	BALANCE	-6	-9	-11	-13	-15	-17	-17	-17	-17	-17	-17	-17	-17
ASEAN TOTAL	CAPACITY	619	619	1168	1929	2261	2404	2831	3301	3797	3947	4097	4097	4097
	SUPPLY	391	349	797	1441	1754	2009	2367	2731	3172	3347	3498	3516	3529
	DEMAND	875	952	1254	1440	1608	1760	1881	1992	2089	2178	2255	2342	2424
	BALANCE	-484	-603	-457	1	146	249	486	739	1083	1169	1243	1174	1105

Table II-1-20. SUPPLY/DEMAND PROJECTION OF UREA, ASEAN COUNTRIES – PROJECTED BY EACH MEMBER COUNTRY

(Urea 000 ton)

			1977	1978	1979	1980	1981	1982	1983	1984	1985
Supply	Indonesia	A	763	1,205	1,676	1,951	2,302	2,588	2,674	2,730	2,773
		B·C	763	1,212	1,789	1,881	2,209	2,694	2,778	2,836	2,879
	Malaysia	A	-	-	-	-	399	427	456	513	513
		B·C	-	-	-	-	-	260	396	446	446
	Thailand	A	13	13	13	13	13	0	0	0	0
		B	10	10	10	10	10	0	0	0	0
	Philippines	A	30	40	40	40	292	368	443	443	443
		B	40	40	40	40	40	278	304	337	337
	Total	A	806	1,258	1,729	2,004	3,006	3,383	3,573	3,686	3,729
		B·C	813	1,262	1,839	1,931	2,259	3,232	3,478	3,619	3,662
Demand	Indonesia	A·B·C	1,087	1,242	1,350	1,520	1,689	1,860	2,011	2,156	2,303
	Malaysia	A	132	146	160	174	189	203	217	231	246
		B·C	89	101	112	124	134	146	157	168	179
	Thailand	A	141	159	181	203	222	249	266	279	290
		B	80	90	104	130	143	157	173	190	209
		C	10	12	15	18	22	26	32*	38*	46*
	Philippines	A	226	272	314	359	407	456	511	572	638
		B·C	226	255	287	323	362	512	561	615	676
	Singapore	A·B	11	13	15	17	17	17	17	17	17
	Total	A	1,597	1,832	2,020	2,273	2,525	2,785	3,023	3,255	3,495
		B	1,493	1,702	1,868	2,114	2,345	2,692	2,919	3,146	3,384
		C	1,423	1,623	1,779	2,002	2,224	2,561	2,778	2,994	3,221
Balance		A	-791	-575	-291	-269	+482	+598	+550	+431	+234
		B	-680	-440	-29	-183	-86	+540	+559	+473	+278
		C	-610	-361	+60	-71	+35	+663	+700	+625	+441

Notes: 1. In case data "C" is not available, data "B" is used as a substitution.
2. *Demand is calculated by using the same annual growth rate as that for until 1982.

Sources: A: Agrar-Und Hydrotechnik Gmbh, "Fertilizer Market Study, ASEAN Region" (Final Report, Dec. 1976)
B: "Feasibility Study on the ASEAN Ammonia-Urea Project, Aceh in Indonesia, as accepted at the 5th meeting of the ASEAN Economic Ministries", (Pattaya, Thailand, Sep. 2-4, 1977)
C: Provided by each member countries during this study.
Indonesia : AFS
Malaysia : C. Itoh
Thailand : DAE
Philippines : FPA

Table II-1-21. DIFFERENCES IN SUPPLY/DEMAND PROJECTION ON UREA, ASEAN COUNTRIES BETWEEN THE STUDY AND 'FEASIBILITY STUDY ON THE ASEAN AMMONIA-UREA PROJECT, ACEH IN INDONESIA, AS ACCEPTED AT THE 5TH MEETING OF THE ASEAN ECONOMIC MINISTERS'

(Urea 000 ton)

		1982	1983	1984	1985
Supply	Indonesia	+94	+80	+78	+34
	Malaysia	-275	-40	-66	-18
	Thailand	-14	-14	-16	-17
	Philippines	-291	-317	-253	-148
	Singapore	-15	-15	-15	-15
	Total	-501	-306	-272	-164
Demand	Indonesia	-295	-378	-467	-571
	Malaysia	-34	-38	-40	-43
	Thailand	-128	-136	-144	-153
	Philippines	-228	-263	-302	-347
	Singapore	-15	-15	-15	-15
	Total	-700	-830	-968	-1,129
Balance	Indonesia	+389	+458	+545	+605
	Malaysia	-241	-2	-26	+25
	Thailand	+114	+122	+128	+136
	Philippines	-63	-54	+49	+199
	Singapore	0	0	0	0
	Total	+199	+524	+696	+965

Computed from Tab. II-1-19 and II-1-20.

Table II-1-22. PROJECTED SUPPLY/DEMAND BALANCE OF UREA, ASEAN REGION – ALTERNATIVE CASE

(Urea 000 ton)

		1982	1983	1984	1985	1986	1987
Supply	Indonesia	2,788	2,858	2,914	2,913	2,912	2,911
	Philippines	-13	-13	-14	-14	-15	-15
	Malaysia	-15	356	380	428	427	426
	Thailand	-14	-14	-16	-17	-18	-18
	Singapore	-15	-15	-15	-15	-15	-15
	Total	2,731	3,172	3,249	3,295	3,291	3,289
Demand	Indonesia	1,722	1,796	1,858	1,905	1,965	2,019
	Philippines	312	328	344	362	378	394
	Malaysia	112	119	128	136	144	152
	Thailand	29	37	46	56	66	77
	Singapore	2	2	2	2	2	2
	Total	2,177	2,282	2,378	2,461	2,555	2,644
Balance		544	890	861	834	736	645

Notes:
1. This alternative case is forecasted on the following assumptions:
   1) Demand for urea in Indonesia and the Philippines will increase by 10% compared with the projected demand in Tab. II-1-19.
   2) The NH_3/Urea plant under planning in the Philippines will not be materialized in the above projection period.
2. Negative figures in "Supply" means that the demand for industrial urea exceeds urea production.

Table II-1-23. ESTIMATED EXPORT REQUIREMENT OF INDONESIAN UREA

(Urea 000 ton)

	1983	1984	1985	1986	1987
Based on the original projection:					
Urea Balance in Indonesia					
Supply	2,858	2,914	2,913	2,912	2,911
Demand	1,633	1,689	1,732	1,786	1,835
Export Requirement	1,225	1,225	1,181	1,126	1,076
Demand from ASEAN countries (excld. Indonesia)	191	155	116	118	124
Export Requirement for outside ASEAN	1,034	1,070	1,065	1,008	952
Based on the alternative projection:					
Urea Balance in Indonesia					
Supply	2,858	2,914	2,913	2,912	2,911
Demand	1,796	1,858	1,905	1,965	2,019
Export Requirement	1,062	1,056	1,008	947	892
Demand from ASEAN countries (excld. Indonesia)	205	219	233	247	261
Export Requirement for outside ASEAN	857	837	775	700	631

Table II-2-1. FORECAST ON WORLD DEMAND FOR NITROGEN FERTILIZER

	1975 (Actual)*		1980			1985			1990		
	N 1,000 ton	% of world total	N 1,000 ton	% of world total	Annual growth rate %	N 1,000 ton	% of world total	Annual growth rate %	N 1,000 ton	% of world total	Annual growth rate %
Asia	10,277	23.7	14,833	26.1	7.6	18,296	26.9	4.3	21,421	27.7	3.2
Oceania	185	0.4	286	0.5	9.1	356	0.5	4.5	424	0.5	3.6
West Europe	7,743	17.9	9,340	16.4	3.8	10,852	16.0	3.1	12,369	16.0	2.7
East Europe	11,870	27.4	16,134	28.4	6.3	18,952	27.9	3.3	20,513	26.6	1.6
North America	9,947	23.0	11,479	20.2	2.9	13,528	19.9	3.3	15,579	20.2	2.9
Central America	1,223	2.8	1,418	2.5	3.0	1,588	2.3	2.3	1,703	2.2	1.4
South America	799	1.9	1,497	2.6	13.4	1,900	2.8	4.9	2,129	2.8	2.3
Africa	1,247	2.9	1,863	3.3	8.4	2,481	3.7	5.9	3,080	4.0	4.4
World	43,285	100.0	56,850	100.0	5.6	67,953	100.0	3.6	77,218	100.0	2.6

Note: *: FAO "Annual Fertilizer Review"

Table II-2-2. N FOR INDUSTRIAL USE, REGION-WISE

(N 000 ton)

(ASIA)

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
OTHER NH3 PRODUCTS	87.8	94.7	101.2	107.2	112.9	118.1	123.1	127.8	132.3	136.6	140.6	144.5	148.2	151.8	155.2
OTHER IND. NH3	255.2	248.3	241.9	236.0	230.4	225.2	220.2	215.6	211.1	206.9	202.9	199.1	195.4	191.9	188.5
OTHER IND. UREA	311.1	322.8	333.6	343.7	353.2	362.0	370.4	378.3	385.8	392.9	399.7	406.2	412.5	418.4	424.1
NITRIC ACID	381.6	409.7	447.4	448.5	449.2	450.5	451.4	451.8	453.3	453.8	454.5	454.7	455.6	456.7	456.8
AMMONIUM NITRATE	27.4	28.2	29.0	29.7	30.3	31.1	31.9	32.4	33.1	33.9	34.5	35.0	35.7	36.4	37.1
ACRYLONITRIL	344.1	387.3	412.9	412.9	414.9	414.9	414.9	414.9	414.9	414.9	414.9	414.9	414.9	414.9	414.9
CAPROLACTAM	132.8	143.0	154.7	154.7	154.7	154.7	154.7	154.7	154.7	154.7	154.7	154.7	154.7	154.7	154.7
TOTAL	1540.1	1634.0	1720.6	1732.6	1745.7	1756.6	1766.7	1775.6	1785.3	1793.7	1801.9	1809.4	1817.2	1824.9	1831.4

(OCEANIA)

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
OTHER IND. NH3	10.3	10.4	10.5	10.6	10.7	10.8	10.9	11.0	11.1	11.1	11.2	11.3	11.3	11.4	11.5
NITRIC ACID	21.0	21.1	21.2	21.2	21.3	21.3	21.3	21.3	21.4	21.4	21.5	21.5	21.5	21.6	21.6
AMMONIUM NITRATE	23.2	24.2	25.1	25.9	26.7	27.5	28.2	28.9	29.4	30.1	30.7	31.2	31.7	32.2	32.7
TOTAL	54.5	55.7	56.8	57.7	58.7	59.5	60.4	61.2	62.0	62.6	63.4	64.0	64.5	65.2	65.8

(WEST EUROPE)

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
OTHER IND. UREA	569.5	592.5	613.8	633.8	652.4	669.9	686.4	701.9	716.7	730.8	744.2	757.0	769.3	781.2	792.4
NITRIC ACID	776.0	834.6	840.7	895.4	895.4	886.8	886.9	887.0	890.3	890.4	890.4	890.4	893.9	893.7	893.7
AMMONIUM NITRATE	53.9	54.3	54.7	55.3	55.7	56.1	56.4	56.9	57.3	57.3	57.7	58.0	58.2	58.4	58.8
ACRYLONITRIL	412.0	439.1	474.0	551.5	587.1	587.1	587.1	587.1	587.1	587.1	587.1	587.1	587.1	587.1	587.1
CAPROLACTAM	180.5	187.5	213.3	213.3	213.3	213.3	213.3	213.3	213.3	213.3	213.3	213.3	213.3	213.3	213.3
TOTAL	1991.6	2108.0	2196.6	2349.2	2403.9	2413.2	2429.9	2446.1	2464.7	2478.9	2492.7	2506.0	2521.8	2533.4	2545.3

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Table II-2-2. N FOR INDUSTRIAL USE, REGION-WISE (CONT'D.)

(EAST EUROPE) (N 000 ton)

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
OTHER IND. UREA	15.4	16.0	16.1	16.7	17.1	17.5	17.8	18.2	18.5	18.8	19.1	19.4	19.6	19.8	20.1
NITRIC ACID	503.7	515.5	589.1	663.4	746.2	746.2	749.2	749.2	752.1	752.1	755.0	755.0	755.0	758.7	759.2
AMMONIUM NITRATE	2.8	2.9	3.0	3.0	3.1	3.2	3.3	3.4	3.4	3.4	3.5	3.5	3.6	3.6	3.7
ACRYLONITRIL	112.8	130.9	130.9	185.6	185.6	185.6	185.6	185.6	185.6	185.6	185.6	185.6	185.6	185.6	185.6
CAPROLACTAM	95.9	95.9	95.9	95.9	95.9	95.9	95.9	95.9	95.9	95.9	95.9	95.9	95.9	95.9	95.9
TOTAL	730.9	761.4	834.6	965.1	1048.3	1048.7	1052.1	1052.5	1055.8	1056.1	1059.5	1057.7	1060.0	1063.2	1063.5

(NORTH AMERICA)

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
ANIMAL FEEDS	164.7	167.9	170.9	173.8	176.4	178.8	181.2	183.4	185.5	187.4	189.3	191.1	192.9	194.5	196.1
OTHER IND. UREA	216.0	222.8	229.1	235.0	240.5	245.7	250.5	255.2	259.5	263.7	267.7	271.5	275.1	278.6	281.9
NITRIC ACID	2205.2	2357.8	2410.1	2422.7	2403.4	2415.5	2418.0	2420.4	2432.0	2434.2	2436.7	2439.7	2444.7	2451.4	2453.2
AMMONIUM NITRATE	183.6	186.7	189.6	192.3	194.8	197.2	199.4	201.6	203.5	205.4	207.2	208.9	210.7	212.2	213.8
ACRYLONITRIL	308.1	399.1	399.1	417.2	417.2	417.2	417.2	417.2	417.2	417.2	417.2	417.2	417.2	417.2	417.2
CAPROLACTAM	96.0	114.3	114.3	114.3	114.3	114.3	114.3	114.3	114.3	114.3	114.3	114.3	114.3	114.3	114.3
TOTAL	3173.5	3448.5	3513.0	3555.1	3546.5	3568.6	3580.5	3591.9	3612.1	3622.2	3631.9	3641.2	3659.7	3668.2	3676.4

(CENTRAL AMERICA)

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
NITRIC ACID	3.1	3.1	2.5	2.5	2.5	2.5	2.3	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
ACRYLONITRIL	7.1	11.8	21.9	21.9	21.9	21.9	21.9	21.9	21.9	21.9	21.9	21.9	21.9	21.9	21.9
CAPROLACTAM	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2
TOTAL	17.4	22.1	31.6	31.6	31.6	31.6	31.4	31.6	31.6	31.6	31.6	31.7	31.7	31.7	31.7

(SOUTH AMERICA)

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
OTHER IND. UREA	2.7	2.9	3.0	3.2	3.3	3.5	3.7	3.8	4.0	4.2	4.3	4.5	4.6	4.9	5.0
NITRIC ACID	16.5	16.6	28.2	28.3	28.4	51.4	28.7	28.8	28.8	29.0	29.0	29.0	29.0	[illegible]	29.2
ACRYLONITRIL	0.0	29.5	47.3	47.3	47.3	47.3	47.3	47.3	47.3	47.3	47.3	47.3	47.3	47.3	47.3
CAPROLACTAM	3.3	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6
TOTAL	22.5	58.6	88.3	88.4	88.7	111.9	89.3	89.5	89.7	90.1	90.2	90.5	90.6	[illegible]	91.1

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Table II-2-2. N FOR INDUSTRIAL USE, REGION-WISE (CONT'D.)

(AFRICA) (N 000 ton)

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
NITRIC ACID	34.5	38.9	38.9	38.9	38.9	39.5	40.0	40.3	40.5	40.7	40.8	41.0	41.2	41.2	41.3
AMMONIUM NITRATE	2.5	2.5	2.7	2.8	2.9	3.0	3.1	3.2	3.4	3.5	3.6	3.7	3.9	3.9	4.0
TOTAL	37.0	41.4	41.6	41.7	41.8	42.5	43.1	43.5	43.9	44.2	44.4	44.7	45.1	45.1	45.3

(WORLD)

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
ANIMAL FEEDS	164.7	167.9	170.9	173.8	176.4	178.8	181.2	183.4	185.5	187.4	189.3	191.1	192.9	194.5	196.1
OTHER NH3 PRODUCTS	87.8	94.7	101.2	107.2	112.9	118.1	123.1	127.8	132.3	136.6	140.6	144.5	148.2	151.3	155.2
OTHER IND. NH3	265.5	258.7	252.4	246.6	241.1	236.0	231.1	226.6	222.2	218.0	214.1	210.4	206.7	203.3	200.0
OTHER IND. UREA	1114.7	1157.0	1195.6	1232.4	1266.5	1298.6	1328.8	1357.4	1384.5	1410.4	1435.0	1458.6	1481.1	1502.4	1523.5
NITRIC ACID	3941.6	4197.3	4377.1	4520.9	4585.3	4613.7	4597.8	4601.3	4620.9	4624.1	4629.9	4632.3	4644.3	4654.5	4656.5
AMMONIUM NITRATE	293.4	298.8	304.1	309.0	313.5	318.1	322.3	326.4	330.1	333.6	337.2	340.5	343.9	346.7	350.1
ACRYLONITRIL	1184.1	1397.7	1486.1	1636.4	1674.0	1674.0	1674.0	1674.0	1674.0	1674.0	1674.0	1674.0	1674.0	1674.0	1674.0
CAPROLACTAM	515.7	557.5	595.0	595.0	595.0	595.0	595.0	595.0	595.0	595.0	595.0	595.0	595.0	595.0	595.0
TOTAL	7567.5	8129.7	8483.1	8821.3	8965.1	9032.6	9053.4	9091.9	9145.1	9179.3	9215.6	9247.2	9290.6	9322.9	9350.4

Table II-2-3. FORECAST ON WORLD SUPPLY OF NITROGEN FERTILIZER

	1975 (Actual)*		1980			1985			1990		
	N 1,000 ton	% of world total	N 1,000 ton	% of world total	Annual growth rate %	N 1,000 ton	% of world total	Annual growth rate %	N 1,000 ton	% of world total	Annual growth rate %
Asia	8,850	20.2	16,057	24.9	12.7	20,878	25.0	5.4	22,395	26.1	1.4
Oceania	180	0.4	182	0.3	0.2	379	0.5	15.8	370	0.4	-0.5
West Europe	8,932	20.4	10,601	16.4	3.5	12,618	15.1	3.5	12,905	15.0	0.5
East Europe	13,873	31.6	20,539	31.8	8.2	28,145	33.7	6.5	28,172	32.8	0.02
North America	10,178	23.2	13,134	20.3	5.2	13,945	16.7	1.2	12,653	14.7	-1.9
Central America	727	1.7	1,994	3.1	22.4	2,734	3.3	6.5	3,245	3.8	3.5
South America	481	1.1	813	1.3	11.1	2,301	2.8	23.1	3,188	3.7	6.7
Africa	611	1.4	1,237	1.9	15.2	2,453	2.9	14.7	2,949	3.5	3.8
World	43,832	100.0	64,557	100.0	8.1	83,453	100.0	5.3	85,877	100.0	0.6

Note: *: FAO "Annual Fertilizer Review"

Table II-2-4. FORECAST ON WORLD PRODUCTION CAPACITY OF NITROGEN FERTILIZER

	1975 (Actual)*		1980			1985			1990		
	N 1,000 ton	% of world total	N 1,000 ton	% of world total	Annual growth rate %	N 1,000 ton	% of world total	Annual growth rate %	N 1,000 ton	% of world total	Annual growth rate %
Asia	15,588	22.8	26,547	26.0	11.2	33,367	27.1	4.7	34,758	27.6	0.8
Oceania	410	0.6	451	0.4	1.9	761	0.6	11.0	745	0.6	-0.4
West Europe	15,239	22.2	17,551	17.2	2.9	19,878	16.1	2.5	19,940	15.9	0.1
East Europe	17,436	25.4	27,786	27.2	9.8	34,141	27.7	4.2	34,135	27.1	-3.5
North America	16,000	23.4	22,270	21.8	6.8	22,233	18.1	-0.03	20,463	16.3	-1.7
Central America	1,263	1.8	2,901	2.8	18.1	3,786	3.1	5.5	4,677	3.7	4.3
South America	1,220	1.8	1,548	1,5	4.9	4,309	3.5	22.7	5,670	4.5	5.6
Africa	1,367	2.0	3,125	3.1	18.0	4,647	3.8	8.3	5,393	4.3	3.0
World	68,523	100.0	102,179	100.0	8.3	123,122	100.0	3.8	125,781	100.0	0.4

Note: *: UNICO's estimate

Table II-2-5. SUPPLY/DEMAND BALANCE FORECAST OF NITROGEN WORLD TOTAL – CASE I

		1975/76*	76/77	77/78	78/79	79/80	80/81	81/82	82/83	83/84	84/85	85/86	86/87	87/88
ASIA	CAPACITY	15588	17012	19149	23317	24684	26547	28248	28980	29850	31051	33367	34602	34376
	SUPPLY	8850	10033	11222	13049	13997	16057	17111	17922	19105	19703	20878	21268	21818
	DEMAND	10271	11360	12307	13181	14025	14833	15594	16315	17009	17669	18296	19049	19663
	BALANCE	-1421	-1327	-1085	-132	-28	1224	1517	1607	2096	2034	2582	2219	2155
OCEANIA	CAPACITY	410	451	451	451	451	451	451	599	761	761	761	745	745
	SUPPLY	180	182	183	184	183	182	181	254	265	276	379	372	371
	DEMAND	185	233	246	260	273	286	300	314	328	342	356	368	383
	BALANCE	-5	-51	-63	-76	-90	-104	-119	-60	-63	-66	23	4	-12
WEST EUROPE	CAPACITY	15239	15481	16081	17042	17307	17551	17741	18642	19601	19708	19878	20022	20020
	SUPPLY	8932	9792	10141	10670	10602	10601	11110	11685	12055	12170	12618	12866	12870
	DEMAND	7743	8132	8431	8736	9037	9340	9644	9947	10248	10553	10852	11156	11461
	BALANCE	1189	1660	1710	1934	1565	1261	1466	1738	1807	1617	1766	1710	1409
EAST EUROPE	CAPACITY	17436	19375	20716	22376	25763	27786	30177	32853	34031	34059	34141	34135	34135
	SUPPLY	13873	13924	15303	16606	18964	20539	22664	24694	25698	27106	28145	28121	28126
	DEMAND	11870	12807	13724	14586	15388	16134	16810	17430	17993	18500	18952	19362	19722
	BALANCE	2003	1117	1579	2020	3576	4405	5854	7264	7705	8606	9193	8759	8404
NORTH AMERICA	CAPACITY	16000	16573	18582	20936	22161	22270	22169	22210	21978	21795	22233	22871	22443
	SUPPLY	10178	9194	10208	10977	12025	13134	13565	14017	13829	13673	13945	13954	13677
	DEMAND	9947	9838	10248	10658	11068	11479	11889	12299	12709	13118	13528	13938	14348
	BALANCE	231	-644	-40	319	957	1655	1676	1718	1120	555	417	16	-671
CENTRAL AMERICA	CAPACITY	1263	1487	2730	2765	2901	2901	2901	3269	3638	3638	3786	3933	3915
	SUPPLY	727	782	1061	1204	1986	1994	2092	2344	2365	2386	2734	2743	2738
	DEMAND	1223	1219	1273	1326	1374	1418	1459	1495	1529	1559	1588	1615	1641
	BALANCE	-496	-437	-212	-122	612	576	633	849	836	827	1146	1128	1097
SOUTH AMERICA	CAPACITY	1220	1241	1264	1531	1548	1548	1807	2566	3461	3855	4309	4765	4765
	SUPPLY	481	572	623	619	624	813	923	1223	1467	1747	2301	2617	2667
	DEMAND	799	1067	1174	1287	1393	1497	1594	1682	1764	1834	1900	1957	2007
	BALANCE	-318	-495	-551	-668	-769	-684	-671	-459	-297	-87	401	660	660
AFRICA	CAPACITY	1367	1401	1409	1807	2636	3125	3422	3926	4457	4729	4647	4647	4647
	SUPPLY	611	613	759	936	1144	1237	1606	1996	2180	2338	2453	2608	2607
	DEMAND	1247	1388	1502	1619	1740	1863	1984	2110	2232	2357	2481	2608	2729
	BALANCE	-636	-775	-743	-683	-596	-626	-378	-114	-52	-19	-28	0	-122
WORLD TOTAL	CAPACITY	68523	73021	80382	90225	97451	102179	106916	113045	117777	119596	123122	125720	125046
	SUPPLY	43832	45092	49500	54245	59525	64557	69252	74135	76964	79399	83453	84549	84874
	DEMAND	43285	46044	48905	51653	54298	56850	59274	61592	63812	65932	67953	70053	71954
	BALANCE	547	-952	595	2592	5227	7707	9978	12543	13152	13467	15500	14496	12920

Note: *: Actual

Table II-2-6. SUPPLY/DEMAND FORECAST OF NITROGEN, WORLD TOTAL – CASE II

(N 000 ton)

		1980/81	81/82	82/83	83/84	84/85	85/86	86/87	87/88
ASIA	CAPACITY	25972	27734	28456	28814	30115	32203	33485	33485
	SUPPLY	15497	16466	17120	18055	18805	19795	20193	20931
	DEMAND	14840	15601	16323	17017	17678	18306	19059	19673
	BALANCE	657	865	797	1038	1127	1489	1134	1258
OCEANIA	CAPACITY	437	421	583	745	745	745	718	718
	SUPPLY	175	167	247	257	268	371	358	357
	DEMAND	286	300	314	328	342	356	368	383
	BALANCE	-111	-133	-67	-71	-74	15	-10	-26
WEST EUROPE	CAPACITY	16411	16825	17628	18413	18139	18075	17562	16852
	SUPPLY	9741	10372	10859	11109	10873	11181	10926	10396
	DEMAND	9340	9644	9947	10248	10553	10852	11156	11461
	BALANCE	401	728	912	861	320	329	-230	-1065
EAST EUROPE	CAPACITY	27786	30177	32853	34031	34059	34141	34135	34135
	SUPPLY	20539	22664	24694	25698	27106	28145	28121	28126
	DEMAND	16134	16810	17430	17993	18500	18952	19362	19722
	BALANCE	4405	5854	7264	7705	8606	9193	8759	8404
NORTH AMERICA	CAPACITY	21294	21310	20963	20591	20094	19763	19470	17524
	SUPPLY	12373	12894	13042	12745	12343	12014	11287	9822
	DEMAND	11479	11889	12299	12709	13118	13528	13938	14348
	BALANCE	894	1005	743	36	-775	-1514	-2651	-4526
CENTRAL AMERICA	CAPACITY	2901	2901	3251	3620	3620	3768	3915	3915
	SUPPLY	1994	2092	2330	2351	2372	2720	2729	2738
	DEMAND	1418	1459	1495	1529	1559	1588	1615	1641
	BALANCE	576	633	835	822	813	1132	1114	1097
SOUTH AMERICA	CAPACITY	1548	1807	2566	3461	3855	4309	4765	4765
	SUPPLY	813	923	1223	1467	1747	2301	2617	2667
	DEMAND	1497	1594	1682	1764	1834	1900	1957	2007
	BALANCE	-684	-671	-459	-297	-87	401	660	660
AFRICA	CAPACITY	3125	3422	3926	4457	4729	4647	4647	4647
	SUPPLY	1237	1606	1996	2180	2338	2453	2608	2607
	DEMAND	1863	1984	2110	2232	2357	2481	2608	2729
	BALANCE	-626	-378	-114	-52	-19	-28	0	-122
WORLD TOTAL	CAPACITY	99474	104597	110226	114132	115356	117651	118697	116041
	SUPPLY	62369	67184	71511	73862	75852	78980	78839	77644
	DEMAND	56857	59281	61600	63820	65941	67963	70063	71964
	BALANCE	5512	7903	9911	10042	9911	11017	8776	5680

Table II-2-7. SUPPLY/DEMAND BALANCE FORECAST OF NITROGEN, EAST ASIA

(N 000 TON)

		1975/76*	76/77	77/78	78/79	79/80	80/81	81/82	82/83	83/84	84/85	85/86	86/87	87/88
CHINA	CAPACITY	4966	5724	6958	8778	9020	9109	9272	9434	9596	9759	9921	10007	10002
	SUPPLY	3097	3559	4141	5218	5672	5977	6200	6263	6380	6499	6615	6689	6755
	DEMAND	4323	4655	4973	5278	5566	5836	6085	6313	6519	6704	6869	7142	7285
	BALANCE	-1226	-1096	-832	-60	106	141	115	-50	-139	-205	-254	-453	-530
JAPAN	CAPACITY	3632	3666	3650	3718	3512	3417	3417	3337	3337	3237	3237	3163	2937
	SUPPLY	1557	2059	2004	1880	1716	1800	1790	1710	1703	1606	1598	1525	1318
	DEMAND	638	773	783	794	804	814	824	834	844	854	864	874	885
	BALANCE	919	1286	1221	1086	912	986	966	876	859	752	734	651	433
KOREA DPR.	CAPACITY	680	838	863	863	863	863	863	863	863	863	863	863	863
	SUPPLY	260	362	391	469	483	483	483	483	483	483	483	483	483
	DEMAND	264	283	295	305	314	322	329	334	339	343	346	349	352
	BALANCE	-4	79	96	164	169	161	154	149	144	140	137	134	131
KOREA R.	CAPACITY	688	688	893	1179	1179	1179	1179	1179	1179	1179	1179	1179	1179
	SUPPLY	541	595	706	725	745	1001	1001	1000	1000	1000	1000	1000	1000
	DEMAND	468	452	460	467	472	477	480	482	484	486	487	489	491
	BALANCE	73	143	246	258	273	524	521	518	516	514	513	511	509
MONGOLIA	CAPACITY	0	0	0	0	0	0	0	0	0	0	0	0	0
	SUPPLY	0	0	0	0	0	0	0	0	0	0	0	0	0
	DEMAND	3	3	3	3	3	3	4	4	4	4	4	4	4
	BALANCE	-3	-3	-3	-3	-3	-3	-4	-4	-4	-4	-4	-4	-4
TAIWAN	CAPACITY	334	339	357	580	580	580	580	573	573	573	693	819	819
	SUPPLY	203	185	185	147	153	308	308	303	303	303	370	379	389
	DEMAND	232	190	193	196	198	200	202	203	205	206	207	208	209
	BALANCE	-29	-5	-8	-49	-45	108	106	100	98	97	163	171	180
EAST ASIA	CAPACITY	10300	11255	12721	15118	15154	15149	15311	15386	15548	15611	15896	16026	15800
	SUPPLY	5658	6760	7427	8439	8769	9569	9782	9759	9869	9890	10066	10076	9945
	DEMAND	5928	6356	6707	7043	7357	7652	7924	8170	8395	8597	8777	9066	9226
	BALANCE	-270	404	720	1396	1412	1917	1858	1589	1474	1293	1289	1010	719

Note: *: Actual

Table II-2-8. SUPPLY/DEMAND BALANCE FORECAST OF NITROGEN, SOUTHEAST ASIA

(N 000 TON)

		1975/76*	76/77	77/78	78/79	79/80	80/81	81/82	82/83	83/84	84/85	85/86	86/87	87/88
ASEAN	CAPACITY	460	460	753	1113	1270	1370	1670	1940	2249	2323	2532	2667	2667
	SUPPLY	274	248	462	776	922	1070	1312	1539	1803	1895	2067	2171	2197
	DEMAND	619	702	860	972	1073	1164	1235	1298	1357	1409	1452	1504	1552
	BALANCE	-345	-454	-398	-196	-151	-94	77	241	446	486	615	667	645
BURMA	CAPACITY	65	65	65	65	65	65	65	113	162	162	162	162	162
	SUPPLY	47	51	51	51	51	51	51	81	86	90	128	128	128
	DEMAND	35	47	53	61	71	83	96	106	116	126	136	150	161
	BALANCE	12	4	-2	-10	-20	-32	-45	-25	-30	-36	-8	-22	-33
VIETNAM	CAPACITY	0	22	54	54	54	54	54	135	216	216	216	216	216
	SUPPLY	40	8	10	13	32	32	32	63	73	83	133	133	133
	DEMAND	204	221	235	248	261	271	282	290	298	305	312	317	323
	BALANCE	-164	-213	-225	-235	-229	-239	-250	-227	-225	-222	-179	-184	-190
SOUTHEAST ASIA	CAPACITY	525	547	872	1232	1389	1489	1789	2188	2627	2701	2910	3045	3045
	SUPPLY	361	307	523	840	1005	1153	1395	1683	1962	2068	2328	2432	2458
	DEMAND	858	970	1148	1281	1405	1518	1613	1694	1771	1840	1900	1971	2036
	BALANCE	-497	-663	-625	-441	-400	-365	-218	-11	191	228	428	461	422

Note: *: Actual

Table II-2-9. SUPPLY/DEMAND BALANCE FORECAST OF NITROGEN, SOUTHWEST ASIA

(N 000 TON)

		1975/76*	76/77	77/78	78/79	79/80	80/81	81/82	82/83	83/84	84/85	85/86	86/87	87/88
AFGHANISTAN	CAPACITY	58	58	58	58	58	58	58	58	58	58	58	58	58
	SUPPLY	39	40	43	43	43	43	43	43	43	43	43	43	43
	DEMAND	28	35	42	49	56	63	70	78	85	92	99	106	113
	BALANCE	11	5	1	-6	-13	-20	-27	-35	-42	-49	-56	-63	-70
BANGLADESH	CAPACITY	217	217	217	217	352	487	487	622	757	757	757	757	757
	SUPPLY	131	134	134	134	185	201	218	352	368	385	469	469	469
	DEMAND	151	151	184	207	233	259	284	309	335	358	381	402	422
	BALANCE	-20	-17	-50	-73	-48	-58	-66	43	33	27	88	67	47
INDIA	CAPACITY	2583	3029	3245	4017	4566	5020	5330	5330	5340	6332	7599	8085	8085
	SUPPLY	1508	1641	1832	2207	2450	2808	3099	3201	3405	3797	4099	4328	4872
	DEMAND	2031	2400	2653	2907	3161	3415	3666	3919	4175	4434	4695	4966	5241
	BALANCE	-523	-759	-821	-700	-711	-607	-567	-718	-770	-637	-597	-638	-369
NEPAL	CAPACITY	0	0	0	0	0	0	0	0	0	0	0	0	0
	SUPPLY	0	0	0	0	0	0	0	0	0	0	0	0	0
	DEMAND	8	19	23	28	33	37	41	44	47	49	51	52	53
	BALANCE	-8	-19	-23	-28	-33	-37	-41	-44	-47	-49	-51	-52	-53
PAKISTAN	CAPACITY	357	357	357	503	785	920	920	920	920	920	920	920	920
	SUPPLY	316	295	295	382	487	518	648	760	760	760	760	760	760
	DEMAND	442	468	510	552	594	636	682	728	774	820	866	911	956
	BALANCE	-126	-173	-215	-170	-107	-118	-34	32	-14	-60	-106	-151	-196
SRI LANKA	CAPACITY	0	0	0	0	73	147	147	147	147	147	147	147	147
	SUPPLY	0	0	0	0	27	35	45	91	91	91	91	91	91
	DEMAND	38	57	60	63	66	69	72	75	78	81	84	87	90
	BALANCE	-38	-57	-60	-63	-39	-34	-27	16	13	10	7	4	1
SOUTHWEST ASIA	CAPACITY	3215	3661	3877	4795	5834	6632	6942	7077	7222	8214	9481	9967	9967
	SUPPLY	1994	2110	2304	2766	3192	3605	4053	4447	4667	5076	5461	5691	6235
	DEMAND	2698	3130	3472	3806	4143	4479	4815	5153	5494	5834	6176	6524	6875
	BALANCE	-704	-1020	-1168	-1040	-951	-874	-762	-706	-827	-758	-715	-833	-640

Note: *: Actual

Table II-2-10. SUPPLY/DEMAND BALANCE FORECAST OF NITROGEN, MIDEAST

(N 000 TON)

		1975/76*	76/77	77/78	78/79	79/80	80/81	81/82	82/83	83/84	84/85	85/86	86/87	87/88
IRAN	CAPACITY	306	306	306	441	576	728	901	901	901	901	901	901	901
	SUPPLY	126	159	159	184	193	267	351	360	448	448	448	448	448
	DEMAND	194	202	220	238	256	274	291	307	324	341	357	374	390
	BALANCE	-68	-43	-61	-54	-63	-7	60	53	124	107	91	74	58
IRAQ	CAPACITY	54	54	162	270	270	540	810	810	810	810	810	810	810
	SUPPLY	24	29	63	71	87	233	253	294	440	440	440	440	440
	DEMAND	25	36	44	52	62	72	84	96	108	121	133	146	157
	BALANCE	-1	-7	19	19	25	161	169	198	332	319	307	294	283
ISRAEL	CAPACITY	68	68	68	68	68	191	314	314	314	314	314	314	314
	SUPPLY	45	39	39	39	39	82	96	110	182	182	182	182	182
	DEMAND	37	37	38	39	40	41	42	43	44	45	46	47	48
	BALANCE	8	2	1	0	-1	41	54	67	138	137	136	135	134
KUWAIT	CAPACITY	545	545	545	545	545	545	545	545	545	545	681	817	817
	SUPPLY	259	332	332	332	332	332	332	332	332	332	393	401	415
	DEMAND	0	0	0	0	0	0	0	0	0	0	0	0	0
	BALANCE	259	332	332	332	332	332	332	332	332	332	393	401	415
QATAR	CAPACITY	244	244	244	244	244	366	488	488	488	488	488	488	488
	SUPPLY	87	64	130	130	130	179	188	195	261	261	261	261	261
	DEMAND	0	0	0	0	0	0	0	0	0	0	0	0	0
	BALANCE	87	64	130	130	130	179	188	195	261	261	261	261	261
SAUDI ARABIA	CAPACITY	163	163	163	163	163	163	163	286	410	410	533	657	657
	SUPPLY	100	98	98	98	98	98	98	151	162	174	302	313	325
	DEMAND	6	4	4	4	5	5	5	6	6	6	7	7	7
	BALANCE	94	94	94	94	93	93	93	145	156	168	295	306	318
SYRIAN AR.	CAPACITY	41	41	41	41	41	199	313	313	313	313	313	313	313
	SUPPLY	24	24	24	24	24	95	105	121	190	190	190	190	190
	DEMAND	42	45	50	54	59	64	68	73	78	82	87	91	94
	BALANCE	-18	-21	-26	-30	-35	31	37	48	112	108	103	99	96
TURKEY	CAPACITY	127	128	150	400	400	536	672	672	672	744	1043	1264	1264
	SUPPLY	172	111	123	126	128	444	458	470	592	642	807	834	919
	DEMAND	453	530	572	609	641	668	690	709	724	736	745	753	759
	BALANCE	-281	-419	-449	-483	-513	-224	-232	-239	-132	-94	62	81	160

Continued on next page.

Table II-2-10. SUPPLY/DEMAND BALANCE FORECAST OF NITROGEN, MIDEAST (CONT'D.)

(N 000 TON)

		1975/76*	76/77	77/78	78/79	79/80	80/81	81/82	82/83	83/84	84/85	85/86	86/87	87/88
ABU DHABI	CAPACITY	0	0	0	0	0	0	0	0	0	0	0	0	0
	SUPPLY	0	0	0	0	0	0	0	0	0	0	0	0	0
	DEMAND	0	0	0	0	0	0	0	0	0	0	0	0	0
	BALANCE	0	0	0	0	0	0	0	0	0	0	0	0	0
OMAN	CAPACITY	0	0	0	0	0	0	0	0	0	0	0	0	0
	SUPPLY	0	0	0	0	0	0	0	0	0	0	0	0	0
	DEMAND	0	0	0	0	0	1	1	1	1	1	1	1	1
	BALANCE	0	0	0	0	0	-1	-1	-1	-1	-1	-1	-1	-1
OTHER MIDEAST	CAPACITY	0	0	0	0	0	0	0	0	0	0	0	0	0
	SUPPLY	0	0	0	0	0	0	0	0	0	0	0	0	0
	DEMAND	30	50	52	55	57	59	61	63	64	66	67	69	70
	BALANCE	-30	-50	-52	-55	-57	-59	-61	-63	-64	-66	-67	-69	-70
MIDEAST	CAPACITY	1548	1549	1679	2172	2307	3278	4206	4329	4453	4525	5080	5564	5564
	SUPPLY	837	856	968	1004	1031	1730	1881	2033	2607	2669	3023	3069	3180
	DEMAND	787	904	980	1051	1120	1184	1242	1298	1349	1398	1443	1488	1526
	BALANCE	50	-48	-12	-47	-89	546	639	735	1258	1271	1580	1581	1654

Note: *: Actual

Table II-2-11. SUPPLY/DEMAND PROJECTION OF UREA, MAJOR ASIAN COUNTRIES EXCLUDING ASEAN COUNTRIES

(Product 000 ton)

		1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
CHINA	CAPACITY	5204	8852	9304	9480	9833	10187	10539	10891	11246	11422	11422
	SUPPLY	2846	5009	5887	6491	6928	7054	7311	7565	7822	7983	8128
	DEMAND	3418	5067	5777	6338	6799	7110	7470	7805	8122	8524	8766
	BALANCE	-572	-58	+110	+153	+129	-56	-159	-240	-300	-541	-638
BURMA	CAPACITY	135	135	135	135	135	235	333	333	333	333	333
	SUPPLY	107	107	107	107	107	170	176	185	265	265	265
	DEMAND	115	133	154	180	209	230	252	274	296	326	350
	BALANCE	-8	-26	-47	-73	-102	-60	-76	-89	-31	-61	-85
VIETNAM	CAPACITY	109	109	109	109	109	109	109	109	274	439	439
	SUPPLY	76	82	82	82	82	82	82	82	181	313	330
	DEMAND	460	485	511	530	552	567	583	597	610	620	632
	BALANCE	-384	-403	-429	-448	-470	-485	-501	-515	-429	-307	-302
INDIA	CAPACITY	6139	8104	8698	8850	8850	9287	10112	11112	11612	11612	11612
	SUPPLY	3187	4135	5044	5540	5670	5798	6126	6672	7203	7494	7567
	DEMAND	4351	5044	5694	6167	6524	6986	7533	7746	7701	7979	8534
	BALANCE	-1164	-909	-650	-627	-854	-1188	-1407	-1074	-498	-485	-967
PAKISTAN	CAPACITY	618	618	1192	1192	1192	1852	1852	2198	2198	2198	2198
	SUPPLY	593	593	1024	1052	1110	1605	1638	1964	1981	2015	2015
	DEMAND	942	884	1024	1052	1110	1157	1273	1394	1520	1633	1767
	BALANCE	-349	-291	0	0	0	448	365	570	461	382	248
AUSTRALIA	CAPACITY	248	248	248	248	248	413	578	578	578	578	578
	SUPPLY	130	130	130	130	130	204	211	220	307	307	307
	DEMAND	156	166	178	190	217	280	308	331	364	394	415
	BALANCE	-26	-36	-48	-60	-87	-76	-97	-111	-57	-87	-108

Table II-3-1. SALES PLAN OF UREA FROM ACEH PLANT, INDONESIA

(Urea 000 ton)

		1982	1983	1984	1985	1986	1987
Production (A)		427	456	513	513	513	513
Shipment for:							
Domestic Market							
Aceh	BG	17	18	19	21	21	22
N. Sumatra	BL	0	132	140	146	154	160
Domestic Total		17	150	159	167	175	182
ASEAN Countries							
Philippines	BG	76	47	35	21	20	20
	BL	176	109	80	49	47	47
	Total	252	156	115	70	67	67
Malaysia	BG	108	-	-	-	-	-
Thailand	BG	36	26	31	37	42	48
Singapore	BL	14	9	9	9	9	9
ASEAN Total		410	191	155	116	118	124
Total (B)		427	341	314	283	293	306
Export Requirement for outside ASEAN (A - B)		0	115	199	230	220	207

Table II-3-2. DEMAND PROJECTION OF UREA IN ACEH AND N. SUMATRA PROVINCES

	1982	1983	1984	1985	1986	1987
Aceh (000 ton)	17	18	19	21	21	22
% of Indonesia Total*	1.1	1.1	1.1	1.2	1.2	1.2
N. Sumatra (000 ton)	124	132	140	146	154	160
% of Indonesia Total*	7.9	8.1	8.3	8.4	8.6	8.7
Sumatra Total	326	348	368	385	404	420
% of Indonesia Total	20.8	21.3	21.8	22.2	22.6	22.9
Indonesia Total	1,565	1,633	1,689	1,732	1,786	1,835

Notes: The percentage of Indonesia total is figured out on the following each provinces' percentages of Sumatra total:

Aceh	5.2%
N. Sumatra	38.0%

Table II-3-3. PUSRI DISTRIBUTION SYSTEM

1) 4 Special bull carriers of 7.500 dwt. with self unloading gear.

2) 59 Inland Supply Depots, ranging capacities from 3.000 to 10.000 tons of each warehouses.

3) 175 rail wagons of 30 ton of carrying capacity.

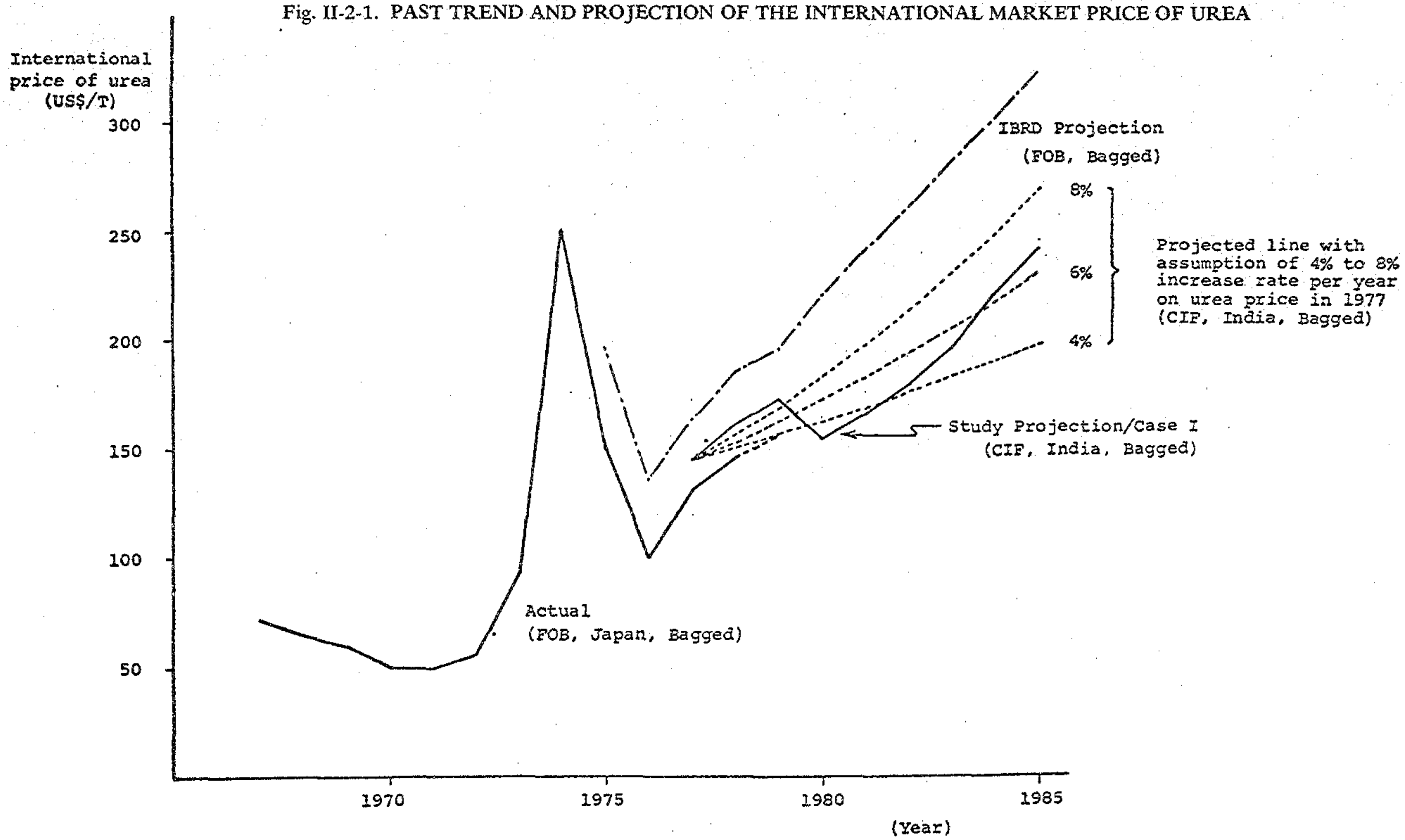
4) 7 locomotives.

5) Expansion projects of unit Packing station:

- Jakarta with capacity of bagging.	300.000 ton/year
- Cilacap	400.000 ton/year
- Surabaya	400.000 ton/year
- Padang	100.000 ton/year
- Medan	150.000 ton/year
- Makasar	100.000 ton/year

Source: Dept. of Chemical Industry, Indonesia

Fig. II-2-1. PAST TREND AND PROJECTION OF THE INTERNATIONAL MARKET PRICE OF UREA



Source: Tab. 2-16

PART III

STUDY ON NATURAL GAS SUPPLY

Chapter 1 General

Part III compiles the outcome of the study with regard to:

- Availability of natural gas to be used for feedstock and fuel in this project, referring to gas reserves, gas supply programs and gas supply/demand balance

- Gas supply conditions

- Price of gas to be supplied for the project

The study was made on the basis of data and information provided by the Indonesian Government. Since the Evaluation Team was not in a position to make an independent analysis of the gas reserve estimate presented by the government authorities, and since the time schedule programmed for the performance of this study was too tight to attempt such an approach, the verification of gas reserves, which is the basis for studying the availability of gas, was made only by means of clarifying and delineating the background of the reserve estimate officially adopted by the Indonesian Government. Therefore the appropriateness of the estimate was judged from qualitative viewpoints.

Examination of the gas supply for the project was made by the scrutinization of gas supply programs and the gas supply/demand projection formulated by government authorities in Indonesia, taking into account the LNG which has been committed for supply to Japan and the West Coast of the U.S.A. The examination was made also on the adequacy of the gas production and processing facilities installed at the Arun gas field and also of the gas facilities at the LNG plant as to whether these are capable of maintaining the projected gas supply, including contemplated gas cycling.

The study concerning gas supply conditions was conducted with stress on conditions of the supplied gas at the branching point from the LNG plant as well as at the ASEAN Aceh fertilizer plant, i.e., such conditions of supplied gas as pressure, temperature, composition and heating value.

The field survey was conducted with the cooperation of the Indonesian counterpart by covering such localities as the Jakarta, Palembang, Medan, and Arun gas fields, as well as the

LNG plant. Table III-1 shows a list of the data and written information concerning the natural gas which had been provided by the Indonesian counterpart for the purpose of this study. The Evaluation Team recognizes that these data and information are permitted use only for the purpose of this study in light of the fact that such materials are confidential information in possession of the Indonesian Government. In order to clarify the proceedings concerning acquirement of the materials concerned, Annex III-1 (A Summary of Minutes of the Meeting and Records of Activities) shows the records of the activities conducted by the members of the Evaluation Team in charge of gas study (the Gas Team) during field survey in Indonesia.

The subsequent study was undertaken after the return of the Evaluation Team to Japan on the basis of the data and information obtained in the course of the field survey mentioned above. The objective of the study was to delineate the background of the gas supply plan for this project, the outcome of which will be described in the following chapters.

Chapter 2 Natural Gas Reserve

The Gas Team received an explanation from the authorities of the Indonesian Government that the extent of gas supply to be made to the ASEAN Aceh fertilizer plant will be amply met by the supply from the Arun gas field, so that no other gas fields need be considered as additional sources of supply. In the following paragraphs, descriptions will be made concerning the natural gas reserve at the Arun gas field.

2-1 Current status of development of Arun gas field

The Arun gas field was discovered by P.T. Mobil Oil Indonesia in 1971. This field is located in the North Aceh district of Sumatra Island. It is a retrograde condensate gas reservoir. Up to the present, 20 wells have been drilled. In addition to well "A-1" drilled for exploratory tests, 12 wells have been drilled for appraisal, and six wells for development. Another well was drilled for the purpose of gas injection. Of the 12 appraisal wells, four wells (A4, A8, A9, and A13) were abandoned, since they were dry holes located outside the gas-containing structure. The status of the wells as of end-February 1978 is as follows:

– Production well:	3 wells (A16, A17, A18)
– Injection well:	4 wells (A7, A11, A12, A20)
– Terminated production well:	2 wells (A15, A21)
– Suspended gas well:	6 wells (A1, A2, A3, A5, A6, A10)
– Suspended well:	1 well (A14)
– Abandoned well:	4 wells (A4, A8, A9, A13)

Table III-2 shows the date completed, the classification and the current status of these wells. Figure III-1 illustrates the location map of the wells up to A17.

2-2 Background of reserve estimate

The authorities of the Indonesian Government indicated the "initial wet gas in place" of the Arun gas field as being 17.19 TSCF. This estimation was made by Degolyer and MacNaughton in 1974 on the basis of data compiled concerning the 12 appraisal wells which had been drilled up to that time. After 1974, additional eight wells were drilled in the same structure. According to an explanation made by Mobil Oil Indonesia as the results of examination of the data concerning these additional wells, they deemed the above estimate still valid in light of the fact that this data did not indicate differences from previous well data to such a significant extent that a revision of the original estimate concerning the initial wet gas in place shown above was required.

Figures III-1 and III-2 show the structure of the top of the Arun Limestone and the net pay iso-patch respectively, which were the bases for the reserve estimation.

Table III-3 summarizes net pay thickness, porosity, water saturation, log depth, and gas-water contact regarding each of the wells, these were the bases for the estimation as well.

2-3 Estimated reserve

The series of figures enumerated below are the estimates of the initial gas in place, defined in four different terms of the gas, which have been derived from the estimates made by Degolyer and MacNaughton. These figures have been computed by employing the volumetric method and on the basis of the basic factors described in Section 2-2. Table III-4 shows the respective gas analyses which were used as the bases for the estimation:

(1) Initial wet gas in place (containing water of 1.01 TSCF or 5.9%) = 17.19 TSCF

(2) Initial dry gas in place (containing carbon dioxide and nitrogen of 2.24 TSCF or 14.08%) = 16.18 TSCF

(3) Initial hydrocarbon in place (including condensate) = 13.76 TSCF

(4) Initial dry hydrocarbon in place (not including condensate) = 13.10 TSCF

Table III-5 gives average properties of the Arun gas field which were employed as the bases for the calculations.

As will be described later, the gas to be supplied to the ASEAN Aceh fertilizer plant is planned to be withdrawn from the outlet of the first stage flush drum of the LNG plant. Consequently the supplied gas will contain carbon dioxide and nitrogen but no condensate. The initial gas in place in such terms is estimated to be 15.52 TSCF.

In accordance with an explanation made by the Indonesian counterpart, a recovery rate in the range from 90 to 95% may be applicable. The Evaluation Team applied the lowest in the given range to the computation of recoverable gas reserve and thus estimated the recoverable gas reserve at 14 TSCF. This was used as the basis for the subsequent discussion concerning the supply/demand balance of available gas.

Chapter 3 Gas Supply Program and Gas Supply Demand Balance

3-1 Gas supply program

The Indonesian Government has already decided to appropriate 4.48 TSCF and 4.3 TSCF of gas on a FOB basis with a priority for the export of LNG for a period of 20 years destined respectively to Japan and the West Coast of the U.S.A. The gas to be supplied to this fertilizer complex, therefore, shall be the remainder after supplying for the LNG.

As has been stated in Section 2-3 above, the gas of the Arun field is wet gas. On the basis of 17.19 TSCF of the initial wet gas in place adopted by the Indonesian authorities, the initial condensate in place at the Arun field is estimated to be approximately 720 million STB.

Mobil Oil Indonesia has a plan to recover 620 million STB of condensate by partial gas cycling, although the quantity of condensate recoverable by natural depletion is estimated at 570 million STB.

The cycling operation was already started during the last half of 1977 on a small scale. By January of 1978, 38 BSCF of gas was produced, and 22 BSCF of dry gas was injected into the gas reserviors.

Their plan is to set up gas production facilities consisting of four clusters each having a processing capacity of 0.6 BSCFD of gas when completed, the production facilities will have a capacity of processing 24 BSCFD of gas which exceeds by 0.6 BSCFD the capacity of the LNG plant rated at 1.8 BSCFD. The gas produced in excess of 0.6 BSCFD is to be injected into the gas layer by using three units of compressors installed at the field. The gas cycling operation will be continued until 1992 when the reservoir pressure may drop to 3,000 psig on the average as against 7,100 psig of the initial reservoir pressure. By the implementation of such a gas cycling program, an increase in condensate recovery by 70 million STB is planned.

Eight wells located on the west wing of the field will be used for gas injection, while the production wells will be located on the east wing running in a direction from north to south with an interval distance of 1,000 feet. In order to maintain production at a rate of 1.8 to 2.4 BSCFD for a period of 20 years, the four clusters have been designed to meet 64 production wells (i.e., one cluster for 16 production wells), in consideration of an allowance for additional wells which should be drilled to cope with a possible decline in the future in the deliverability of each well. This will occur due to pressure drop in the reservior.

The formulated drilling plan is designed to drill all the production wells wiht an angle from the inside of the clusters towards the drilling points in the reservoir located with an interval of 1,000 feet running from south to north on the east wing of the structure. Figure III-3 shows the location of the injection wells together with the layout of the production facilities. Table III-6 gives a summary of the production tests of the wells.

3-2 Supply/demand balance

As mentioned in Section 3-1 above, the LNG project will supply 8.78 TSCF of gas on a FOB basis. Thus the total gas requriement for LNG is estimated to be 10.33 TSCF, when including additional gas estimated as 15% of the total, which is required for fuel consumed in the process of gas liquefaction, boil-off at the storage-tanks, consumption in auxiliary facilities, etc.

The above-mentioned requirement, however, was measured in terms of dry hydrocarbon, excluding contained carbon dioxide and nitrogen as defined in Section 2-3. Thus the corresponding requirement in terms of dry gas containing carbon dioxide and nitorgen is estimated to be 12.76 TSCF.

On the other hand, as discussed in Section 2-3, the recoverable reserve of dry gas containing carbon dioxide and nitrogen is estimated to be 14.00 TSCF. As it is estimated that 0.2 TSCF of gas may be consumed at the Arun gas field for gas injection and also for fuel to run the production facilities for 20 years, 13.80 TSCF of dry gas will be available.

Consequently, the dry gas available after that appropriated for supply to LNG is estimated to be 1.02 TSCF. The 20-year requirement of dry gas for the fertilizer complex is only 0.4 TSCF. The above supply/demand, therefore, reveals that the available gas still has a surplus of 1.16 TSCF after appropriation for supply to this fertilizer complex.

It should be noted here that the above supply/demand balance was discussed on the basis of reserve figures which the Indonesian Government had officially adopted in accordance with the estimation made by Degolyer and MacNaughton as mentioned earlier.

The Evaluation Team is not in a position to discuss the accuracy of the estimation made by Degolyer and MacNaughton, since the Team did not undertake any independent estimation. Nevertheless, in view of the fact that this estimate had been made on the basis of the data collected concerning 12 appraisal wells, and also in light of the well-qualified expertise and experience of Degolyer and MacNaughton, the Evaluation Team surmises that the above estimation is fairly accurate. At the same time, in light of an engineering practice applied to the estimation made at that stage, it should be reasonable to still deem it as being in an accuracy of around ± 10%.

When cosidering the gas balance discussed above, the gas reserves of the Arun gas field can be seen as having an allowance of about 8% against the 20-year gas supply required for the LNG plant and this fertilizer complex. If the most pessimistic view is taken, it must therefore be concluded that the gas reserves might be rather marginal for future supply.

Even in such an event, however, an adequate quantity of gas will be assured for supply at least for a period of 12 years, which has been decided on as the minimum economic life of this fertilizer complex. Furthermore, there are new gas fields being developed as well in this area, so that any shortage of gas after the 12 years can possibly be supplemented with gas supplied from these new fields. From these viewpoints, the Evaluation Team observes that there seem to be no underlying problems on the availability of gas to ensure the feasibility of the project.

Chapter 4 Gas Supply Conditions

4-1 Gas supply route

The Arun gas is condensate-containing gas having an initial bottom pressure of 7,100 psig and an initial bottom temperature of 35.2°F. Table III-4 shows the components of the gas.

Four clusters will be installed at the Arun gas field. (Ref. Figure III-4) Separation of condensate contained in the produced gas and then gas processing will first be conducted at the gas processing facilities of these clusters. Condensate separation will be made by pressure-reduction and cooling of produced gas. Details of these gas processing facilities are described in Annex III-2.

Of 2.4 BSCFD of produced gas, 0.6 BSCFD will be cycled into the gas layer through injection wells after being compressed by three units of gas compressors. The gas cycling operation will be continued over about 12 years until around 1992 when it is assumed that the bottom pressure in the gas layer may drop to 3,000 psig.

1.8 BSCFD of the gas will be transmitted to the LNG plant located 4.8 km west of the town of Lhok-Seumawe, through a 42" pipeline laid in a distance of approximately 30 km from the field to the LNG plant. The gas will be fed for transmission at an inlet pressure of 1,100 psig. The separated condensate, after water removal, will be transmitted to the LNG plant through a 16" pipeline which has been laid parallel with the gas pipeline. Details of the pipeline system are described in Annex III-3.

4-2 Branching for the gas supply

The gas and condensate transmitted to the LNG plant will be mixed after adjusting the pressure at 800 psig, and then will be fed to the first stage flush drum in which they will be separated again. The gas after separation from the condensate will be pre-treated in the pre-treatment unit, including six trains of CO_2 removal facilities, and then will be liquefied. The details are described in Annex III-4.

As for the branching of gas to be supplied to the fertilizer complex, the Evaluation Team examined three alternative cases enumerated below. As a result, the Evaluation Team selected Case 2, that is, to branch the gas from the 36" pipe, into which the gas is gathered after the first stage flush drum, from the standpoint that this branching point is the most optimum for both the fertilizer plant and the LNG plant. This view has been accepted by the Indonesian authorities. The following summarizes an outline of three alternative cases selected for examination, and the result of comparisons regarding the branching of gas from the LNG plant.

Case 1: To branch the gas from the 42" gas pipeline at the inlet of the first stage flush drum. In this case, it is supposed that gas pressure will fluctuate from 1,100 to 825 psig, and the gas component will vary as well due to this fluctuation. Since the supplied gas contains condensate in a quantity higher than in the other cases, pig operation for the clearance of the gas pipeline is required infrequently. Therefore, this case may bring more condensate loss than the others.

Case 2: To branch the gas from the 36" gas gathering pipeline following the first stage flush drum. In this case, pressure of the supply gas will be stable at 790 psig, and the quantity of condensate contained in the gas will be small. Furthermore, the branching at this point will secure the gas supply at a stable pressure of 790 psig and will also contain a smaller quantity of condensate, while having no affect on the LNG plant.

Case 3: To branch the gas after the removal of acids contained in the gas. This case is not feasible in light of the facts that:

a) As the pre-treatment unit including acid removal has been designed in a series with the liquefaction unit, the LNG plant has no excess capacity to pre-treat additional gas exceeding that fed for liquefaction, and

b) Gas supply to the fertilizer plant may occasionally be interfered with by the operation of the LNG plant because the operation of each train is controlled to meet a program for the production of LNG.

4-3 Gas supply conditions and gas price

After the first stage flush drum in the LNG plant, the gas will be transmitted to the fertilizer complex through a branch pipeline, and then delivered to the complex after metering. The gas metering and delivery system to be applied to this project will be similar to that adopted in PUSRI's fertilizer complex in Palembang, South Sumatra which will be introduced in Annex III-5.

4-3-1 Gas properties

(1) Composition of gas

Constituent	Mol. %
Carbon dioxide (CO_2)	15.18
Nitrogen (N_2)	0.36
Methane (CH_4)	74.91
Ethane (C_2H_6)	5.63
Propane (C_3H_8)	2.31
Iso-butane ($i\text{-}C_4H_{10}$)	0.48
Normal-butane ($n\text{-}C_4H_{10}$)	0.59
Iso-pentane ($i\text{-}C_5H_{12}$)	0.20
Normal-pentane ($n\text{-}C_5H_{12}$)	0.14
Hexane plus (C_6 plus)	0.20

(2) Impurities

Hydrogen sulfide (H_2S)	80 ppm
Organic sulfur	non-detective
Mercury (Hg)	less than 160 ppb in weight

(3) Moisture content

Dew point	85°F (790 psia)

(4) Condensate content

Pentane plus (C_5 plus)	1,172 ℓb/MMSCF

4-3-2 Temperature and pressure of gas to be supplied

- Temperature: 65 – 85°F
- Pressure: 450 psig

Delivery pressure of gas at the plant gate has been set at 450 psig , assuming a gas pressure of 400 psig at the inlet of the first reformer in the ammonia plant and also taking into account pressure loss which will arise in the process of CO_2 removal and pre-treatment of gas. Whether the plant site is selected at Kuala Genkeh or Kuala Jangka, it is possible to maintain the above-mentioned gas delivery pressure if adequate plan and design are made for the pipeline.

4-3-3 Gross heating value

- 0.973 MMBTU/MSCF

4-3-4 Gas price

In compliance with an agreement made at the ASEAN Economic Ministers Meeting, the gas price has been set from US\$0.60 to US\$0.65/MMBTU (on a fixed price basis) at the plant gate.

Chapter 5 Observation and Recommendation on the Contemplated Natural Gas Supply

As pointed out in the general discussion made in Chapter 1 of this Part, the present study was made to verify the adequacy of the natural gas supply to the ASEAN Aceh fertilizer plant contemplated by the Indonesian counterpart.

As for the reserve estimates of the Arun gas field, which is the source of gas supply, those made by Degolyer and MacNaughton have been taken as the basis for this study. The examination of the adequacy of the gas supply programs including gas cycling has also been made on the basis of the gas field production behavior forecast made by Degolyer and MacNaughton.

In order to make an in-depth appraisal on the above-mentioned estimates, it is necessary to collect data and information regarding seismic survey, geological survey, well logs, core analyses, liquid materials, well test, pressure test, production test, etc., and the bases of these data, to conduct the study of the following items:

(1) Clarification of the characteristics of the gas field
(2) Establishment of simulation models
(3) *Forecast on production behavior*

The simulation models which will be established as in (2) above should be modified and revised from time to time when new information is obtained in accordance with progress in the gas field development stage, so that the simulation models will be assimilated more and more closely into the actual status of the gas field. Depending on the nature of new information, the characteristics of the gas field clarified by the study of (1) above are also reviewed and revised as necessary.

The production behavior of the gas field is a function of the production rate, injection rate, time consumed, gas field pressure, etc. Therefore, the adequacy of the supply program must be scrutinized at each implementation by conducting case studies on the basis of the revised model as above.

At this stage, a maximum accuracy of ± 10% in the estimation of the reserve described in 3-2 above seems to be inevitable. This accuracy range is caused by various assumptions made when analyzing such items as seismic data, geological data, various well log data, core data, various well test data, etc. Along with the progress of the development, these data will have to be reviewed and revised as necessary on the basis of newly discovered facts.

The appropriateness of the recovery rate quoted as '90% to 95%' in accordance with the information provided by the Indonesian counterpart as discussed in 2-3 above, and also the appropriateness of the recovery amount of the condensate based on the gas cycling planned by the Indonesian authorities as discussed in 3-1 above can be clarified only after a case study is made by employing the above-mentioned simulation model developed for the Arun gas field. Therefore, it is impossible to make an appraisal of the aforesaid estimations unless such studies are executed independently.

The Indonesian authorities estimated that, of 720 million STB of the initial condensate in place, 570 million STB of condensate can be recovered by natural depletion, while 620 million STB of condensate can be recovered by presently planned partial cycling.

If an increase in condensate output is desired, it may be necessary to increase the rate of injection gas as against produced gas. In this case, the processing capacity of production facilities at the Arun gas field will be one of the problems. As the gas injected for cycling will eventually be taken out as produced gas, the scale of cycling should not theoretically affect the reserve.

If the cycling amount is increased to the extent that it is more than presently planned, however, the gas to be supplied to the LNG plant will have to reduced. As discussed in 3-1, production facilities of the Arun gas field have a processing capacity of 2.4 BSCFD. When compared to the gas treatment capacity of 1.8 BSCFD at the LNG plant, the production facilities of the field still have a capacity allowance for processing 0.6 BSCFD of additional gas. Since the field production facilities enable the injection of 0.6 BSCFD of gas by three compressors (each having an injection capacity of 0.2 BSCFD), the present plan for gas cycling will have no affect on the contemplated gas supply. Nevertheless, it would be important to keep conducting appropriate forecasts on the production behavior of the Arun gas field so that a stable gas supply can be maintained in order to meet the enormous gas demand of the LNG plant, which is about 27 times more than that for the fertilizer complex.

Although it is not a precondition for deciding the implementation of this project, it is recommended from the above standpoint that the detailed analysis proposed here be conducted as a basis for adequately maintaining an optimum gas supply for long periods.

Table III-1. LIST OF DATA PROVIDED TO SUB GAS TEAM

		Date of Receiving
1.	Data of Arun Gas	February 7, 1978
2.	Calculation of OGIP	February 10, 1978
3.	Location of Facilities - Arun Field Development Project	February 10, 1978
4.	Summary of Petrophysical Parameters - Arun Field	February 10, 1978
5.	Reservoir Gas Analysis - Arun Field	February 10, 1978
6.	Original Gas in Place, Arun Field	February 10, 1978
7.	Summary of Well Tests - Arun Field	February 10, 1978
8.	Top Structure - Arun Reservoir	February 10, 1978
9.	Net Pay Isopach - Arun Reservoir	February 10, 1978
10.	Facility Location Map of Arun Gas Field	February 18, 1978
11.	Plot Plan Point "A", Arun Gas Field	February 18, 1978
12.	Typical Cluster Plot Plan, Arun Field	February 18, 1978
13.	Well Data Including Completion Date, Well Classification and Current Status in Arun Gas Field	February 18, 1978
14.	PVT Analysis, Arun A-1	February 18, 1978
15.	Field Location Map, Pertamina Unit I	February 21, 1978
16.	Typical Facility Design, Arun Field	February 27, 1978
17.	Gas Supply Condition, Arun LNG Plant	February 27, 1978
18.	Existing Pipeline, Arun Gas Transmission Line	February 27, 1978
19.	Specification of Turbines for Electricity at LNG Plant	March 27, 1978
20.	Specifications of Compressors for Cycling	March 27, 1978
21.	Consumption for Utilities	March 27, 1978
22.	Gas Supply Schedule to LNG Plant	March 27, 1978
23.	Capacity of Condensate Separators at LNG Plant	March 27, 1978

Table III-2. ARUN FIELD WELL STATUS
(February 1978)

WELL NAME	DATE COMPLETED	CLASSIFICATION	CURRENT STATUS
Arun - A1	4 December '71	Wildcat	Suspended Gas Well
Arun - A2*	13 July '72	Appraisal	Suspended Gas Well
Arun - A3*	28 December '72	Appraisal	Suspended Gas Well
Arun - A4	12 March '73	Appraisal	Abandoned (Dry Hole)
Arun - A-5*/GIW-8	2 June '73	Appraisal/Gas Injection	Suspended Gas Well Reworking
Arun - A6*/GIW-3	27 May '73	Appraisal/Gas Injection	Suspended Gas Well
Arun - A7*/GIW-5	3 October '73	Appraisal/Gas Injection	On Injection Service
Arun - A8*	29 August '73	Appraisal	Abandoned (Dry Hole)
Arun - A9*	6 February '74	Appraisal	Abandoned (Dry Hole)
Arun - A10*	20 March '74	Appraisal	Suspended Gas Well
Arun - A11*/GIW-6	28 March '74	Appraisal/Gas Injection	On Injection Service
Arun - A12/GIW-1	12 September '74	Appraisal/Gas Injection	On Injection Service
Arun - A13	14 March '75	Appraisal	Abandoned (Dry Hole)
Arun - A14/C-III-9	4 August '77	Development	Suspended
Arun - A15/C-III-2	24 February '77	Development	Shut-In Prod. Well
Arun - A16/C-III-4	31 May '77	Development	On Production
Arun - A17/C-III-6	22 July '77	Development	On Production
Arun - A18/C-III-8	19 September '77	Development	On Production
Arun - A20/GIW-4	15 November '77	Gas Injection	On Injection Service
Arun - A21/C-II-9	8 January '78	Development	Shut-In Prod. Well

8/Feb. '78

Wells cored

Table III-3. SUMMARY OF PETROPHYSICAL PARAMETERS

ARUN "A" LIMESTONE RESERVOIR, ARUN FIELD, INDONESIA
(September 1, 1977) (All nets are true vertical)

Well	Elevation (ft)	INTERVAL Log Depth (ft)	INTERVAL Subsea (ft)	Net Pay (ft)	Avg. ϕ (%)	Avg. Sw (%)	Net/ Gross	Effective G/W Contact (ft)	REMARKS
A-1	56	9,467-10,548	9,411-10,492	1,011	16.8	13.7	0.941		
A-2	40	9,514-10,194	9,474-10,154	634	17.6	17.0	0.932		
A-3	59	9,931-10,666	9,872-10,607	733	15.2	14.2	1.000	10,666(-10,607)	
A-5	48	10,252-10,654	10,204-10,606	406	14.9	16.3	1.000	10,654(-10,606)	
A-6	64	10,021-10,431	9,957-10,367	391	16.6	21.8	0.954		A-6: Base of Arun formation @10,643(-10,579)
		10,431-10,643	10,367-10,579	31	13.6	48.9	0.146		
Complete Interval		10,021-10,643	9,957-10,579	422	16.4	23.5	0.678		
A-7	68	10,150-10,610	10,082-10,542	460	15.5	17.0	1.000		A-7: Formation 100% wet below 10,658(-10,590)
		10,610-10,658	10,542-10,590	11	18.9	40.8	0.229		
Complete Interval		10,150-10,658	10,082-10,590	471	15.6	17.5	0.927		
A-11	77	10,356-10,698	10,279-10,621	310	13.0	25.1	0.906	10,698(-10,621)	
A-12	35	9,488-10,032	9,453- 9,997	544	17.5	13.0*	1.000		
A-14	61	10,982-11,583	9,446- 9,970	510	-	-	0.973		A-14: Partial penetration, no porosity logs run. Note on final log reads: cable faulty add 34 ft at base (11,018ft) and 25 ft at top (9,050ft). Log depths are apparent readings.
A-15	63	10,140-11,218	9,375-10,259	826	-	-	0.975		
A-16	63	9,742-10,700	9,395-10,306	842	16.8	-	0.924		
A-17	63	10,188-11,138	9,519-10,346	817	18.0	-	0.988		

* Estimate

Table III-4. RESERVOIR GAS ANALYSIS
ARUN "A" LIMESTONE RESERVOIR
ARUN FILED, INDONESIA
(September 1, 1977)

Component	Wet-Gas Composition, Mol %
H_2S	< 0.01
Water Vapor	5.90
CO_2	13.65
N_2	0.33
C_1	67.65
C_2	5.31
C_3	2.42
iC_4	0.58
nC_4	0.77
iC_5	0.38
nC_5	0.28
C_6	0.43
C_{7+}	2.30
	100.00

Mol Wt C_{7+}	147	
Specific Gravity at 60°F, C_{7+}	0.811	
Reservoir Temperature, °F	352	@10,050 feet subsea
Dewpoint Pressure at 352°F, psia	4,600	
H_2S Content, ppm	50-100	
Mercaptans	0	
Compressibility Factor, Z	1.140	@ 7,115 psia and 352°F.
Mercury	150-200 micrograms/cubic meter of separator gas; essentially all elemental mercury.	

Table III-5. BASIC DATA FOR ORIGINAL GAS IN PLACE
ARUN FIELD, INDONESIA

	D&M PROVED
PRODUCTIVE AREA, ACRES	23,405
AVERAGE NET PAY, FT	450
RESERVOIR VOLUME, ACRE-FT	10,535,510
AVERAGE POROSITY, %	16.5
AVERAGE WATER SATURATION, %	16.5
GAS PORE VOLUME, ACRE-FT	1,451,530
RESERVOIR TEMPERATURE, °F	352
INITIAL RESERVOIR PRESSURE, PSIA	7,115
COMPRESSIBILITY FACTOR, Z	1.140
PRESSURE BASE, PSIA	14.696
TEMPERATURE BASE, °F	60
INITIAL WET GAS VOLUME FACTOR, SCF/RCF	272.0
INITIAL WET GAS IN PLACE, TCF	17.194
WATER VAPOR CONTENT, MOL %	5.9
INITIAL DRY GAS IN PLACE, TCF	16.180
CO_2 PLUS N_2 CONTENT, MOL %	14.08
INITIAL HYDROCARBON GAS IN PLACE, TCF	13.759

Table III-6. SUMMARY OF WELL TESTS
ARUN "A" LIMESTONE RESERVOIR, ARUN FIELD, INDONESIA
(September 1, 1977)

Well	Interval (ft)	Thickness Tested (ft)	Tubing Size (in.OD)	Choke Size (in)	Test Rate ($10^6 ft^3$/day)	AOF Rate ($10^6 ft^3$/day)	Pressure (psig) Bottom-hole Flowing	Pressure (psig) Wellhead	Wellhead Temperature (°F)
A-1	9,953-58	5	2	32/64	14.8	20.5	-	3,180	-
	10,410-15	5	2	32/64	-	45.0	-	-	-
A-2	9,953-10,185	652	3-1/2	64/64	51.3	560	6,929	3,095	-
A-3	9970-75 } 10,474,79 }	10	2-7/8	48/64	16.5	29	4,774	1,926	-
A-5	-	280	3-1/2	48/64	30.4	-	6,965	3,080	-
A-6	10,028-338	310	3-1/2	48/64	30.3	160	5,835	3,592	250
A-7	10,179-450	271	2-7/8	48/64	30.7	170	6,617	3,060	248
A-10	10,153-289	136	3-1/2	40/64	32.2	70?	-	4,819	-
A-11	10,391-500	109	3-1/2	64/64	38.9	44	-	2,545	246
A-12	9,475-9,990	515	7	70/64*	94.0) 215.5	700	-	4,725	312
		515	7	80/64*	121.5)	-	-	4,750	-
		515	7	?	326.0	-	-	3,500	-
A-14	-	500	7	32/64	22.7	-	-	5,190	253
A-15	-	851	7	No tests - Needs mechanical repair					
A-16	-	928	7	?	200.0	-	-	4,500	310
A-17	-	836	7	?	265.0	-	-	4,500	310

* Two flow lines were used.

Fig. III-1. TOP STRUCTURE, FT.SS ARUN RESERVOIR, INDONESIA

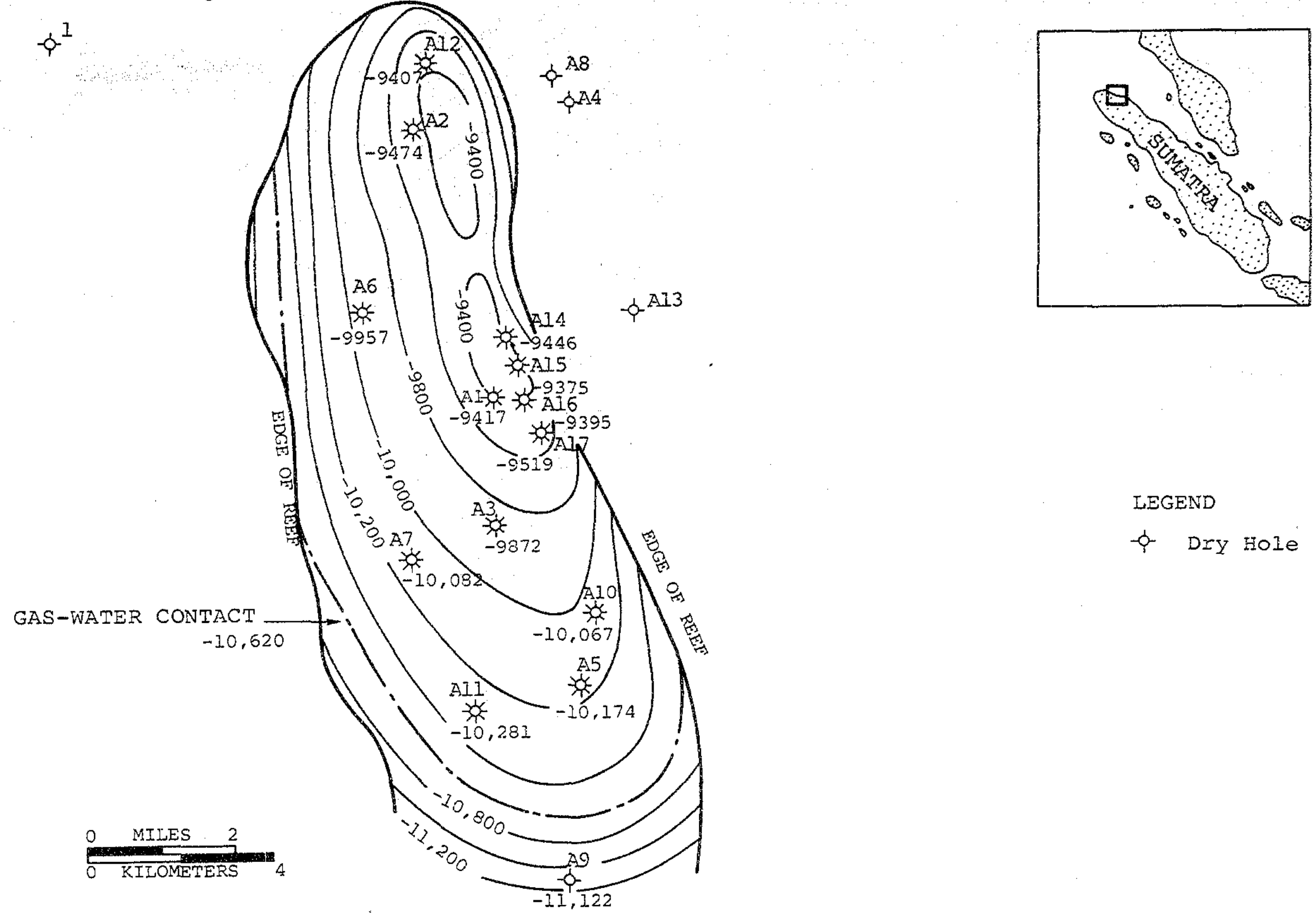


Fig. III-2. NET PAY ISOPACH, FT. ARUN RESERVOIR, INDONESIA

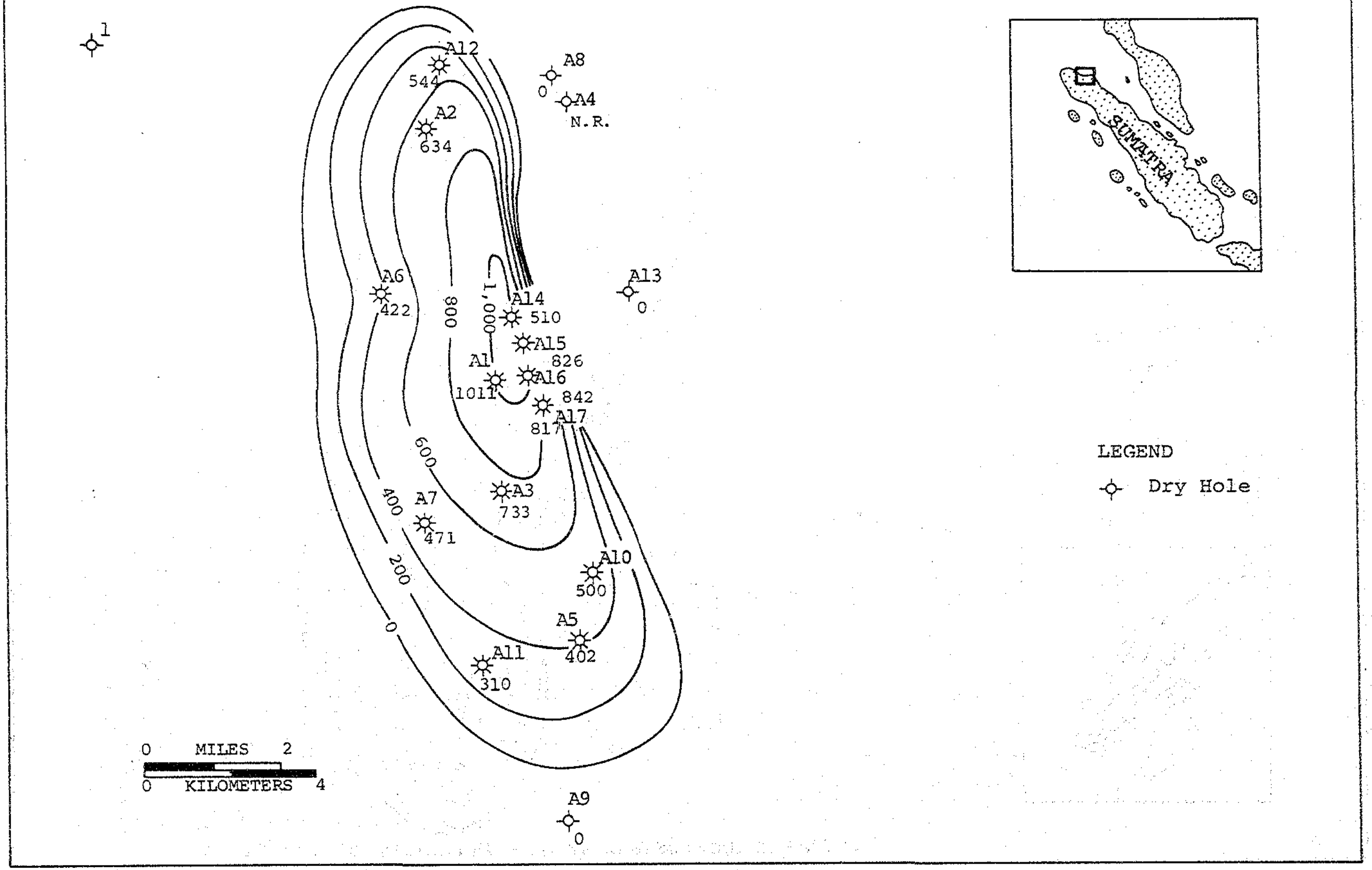


Fig. III-3. LAYOUT OF PRODUCTION FACILITIES ARUN GAS FIELD, INDONESIA

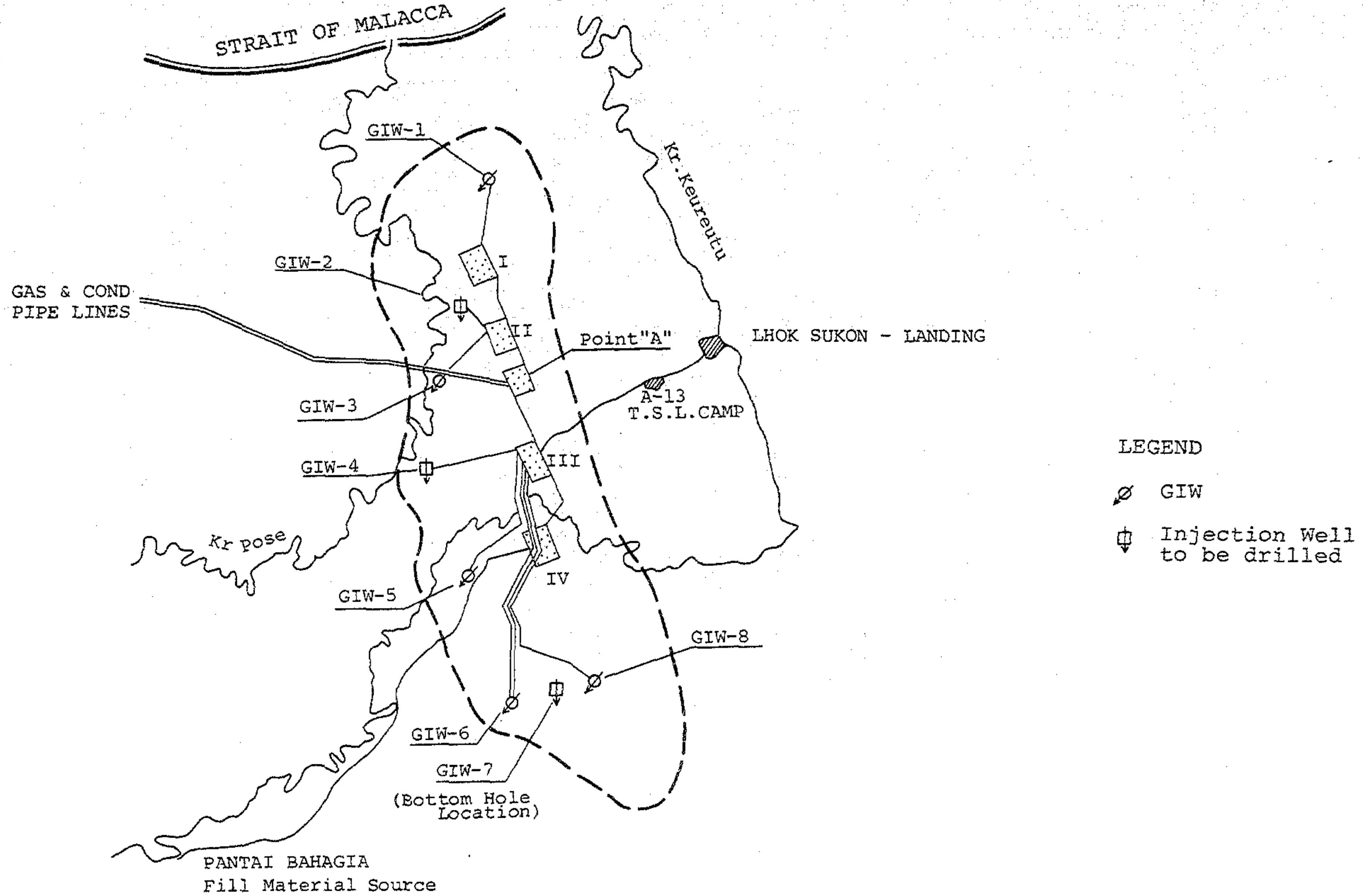
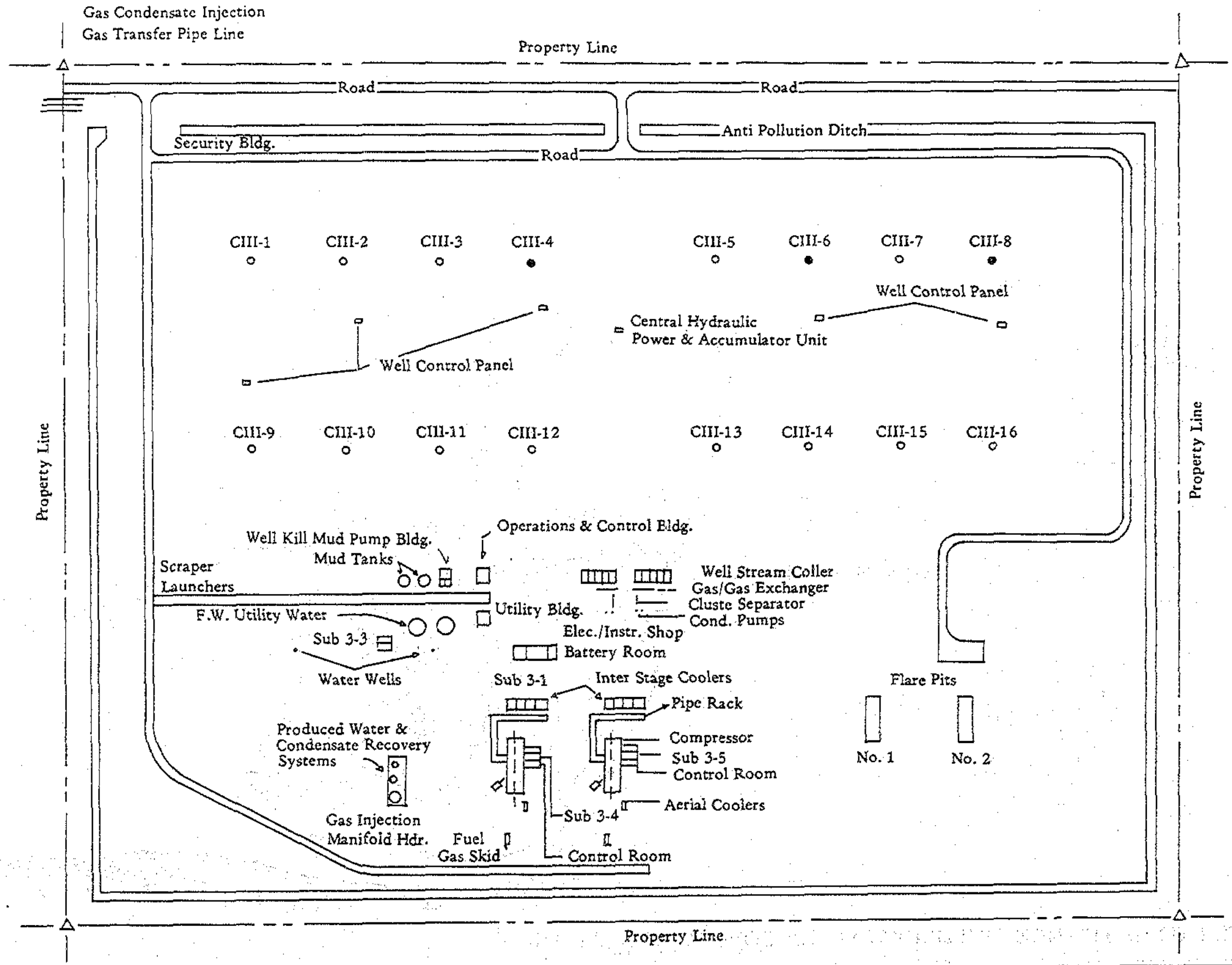


Fig. III-4. TYPICAL CLUSTER PLOT PLAN



PART IV

TECHNICAL INVESTIGATION OF THE FERTILIZER COMPLEX

Chapter 1 General

The proposed fertilizer complex will be built to produce urea aiming the supply of produced urea primarily to ASEAN countries, including Indonesia, and also to those outside the ASEAN region. Natural gas from the Arun gas field will be the feedstock for ammonia, which shall be fully converted into urea.

The major aspects for technical investigation of the complex include the following (Refer to Part III regarding the gas supply):

a) Investigation of the plant site
   - Evaluation and selection of the plant site

b) Definition of project scope
   - Product items, and concept and scale of plant facilities
   - Treatment of raw materials, and concept and scale of utility facilities
   - Concept of infrastructure and other auxiliary facilities

c) Conceptual design of plant facilities
   - Design standard
   - Plant layout
   - Conceptual design of facilities
   - Conceptual design of infrastructure and other auxiliary facilities

d) Project implementation
   - Contract form for plant construction
   - Construction schedule

e) Management of the plant
   - Organization and manning plan
   - Training of staff

Part IV describes in detail each of the above aspects.

Chapter 2 Selection of the Plant Site

Initially in this chapter, criteria for selecting the candidate sizes will be clarified. On the basis of the criteria, candidate sites will be selected. These candidate sites will be comparably studied in detail in order to finally arrive at selection for the envisaged plant.

2-1 Criteria for selection of candidate sites

In order to set up criteria for selection of candidate sites, the following four items are the fundamental requirements of the site for the construction of the plant:

a) Natural gas equivalent to about 60 MMSCFD will be necessary as the raw material and also as the fuel for the process, boilers and electric power generators.

b) About 1 m^3/sec. of river water is necessary as boiler feed water, cooling water, fire-fighting water, drinking water, etc.

c) As to the land for constructing the plant, an area of about 1 km^2 is required.

d) In view of the fact that a greater part of the product will be destined for export, the site must be facing deep sea sufficient for accommodating ocean-going vessels.

Therefore, the candidate sites should fulfill the above requirements.

In relation to the supply source of natural gas, the site should be selected in the vicinity of Lhokseumawe town, Aceh Province; however, the most important factors for the selection of the site are:

a) Supply conditions of natural gas

b) Availability and proximity of water resources

Prior to the field survey made by the Evaluation Team, the Indonesian Feasibility Study Team conducted a site survey around the proposed area to ascertain that the Peusangan River is the only river which has a sufficient flow rate to supply the plant with an adequate quantity of water.

The Evaluation Team reached the same conclusion as the Indonesian Counterpart Team through field investigation as well as analysis of the data acquired during their stay in Indonesia.

On the other hand, produced urea from the plant is mainly destined for export using ocean-going vessels. In this regard, the project must construct its own harbor in the complex, since there is no port in the vicinity which is able to accommodate ocean-going vessels. Consequently the proposed site should be located in an area where adequate physical conditions exist for the construction of such a harbor.

Summarizing the above requirements and factors, the criteria for the selection of candidate sites are set up as follows:

a) The site must be geophysically close to the Arun LNG plan (to reduce gas pipeline length).

b) The site must be in close vicinity to the Peusangan River (to reduce water pipeline length).

c) An area of 1 km^2 is available with hard soil bearing capacity.

d) The distance from the coastline to the seawater depth of –10 m must be sufficiently short.

e) The site must be in the vicinity of existing highways in order to facilitate the transportation of construction materials, machinery, and equipment during the construction period, and also the transportation of product urea after the commencement of the plant's commercial operation.

2-2 Selection of plant candidate sites

Reference is made to Figure IV-1 which represents the topography of the area in which the Arun gas field, Arun LNG plant, town of Lhokseumawe, Peusangan River, etc., are included. In this paragraph, at first, the outline of the area will be generally described, and will include the findings of the Evaluation Team. Then, in order to facilitate selection of the candidate sites, this area shall be divided into eastern and western portions with the Arun LNG plant in the center.

2-2-1 Area to the East of the Arun LNG Plant

This portion of the area may be further divided into its eastern and western parts with the town of Lhokseumawe in the center.

(1) Area to the east of Lhokseumawe

This part covers the area between the town of Lhokseumawe, located north of the Arun gas field, and the town of Lhoksukon.

The topography and geography of this area reveal that a marshy coastal plain is formed on an alluvial sedimentation, and the area close to the coastline forms a mangrove marsh affected by tidal flooding. The hinterland of the coastline is an active rice cultivation area. Another point to be noted about this area is that there are two rivers running through the central part of the plain, i.e., the Keureutu and the Peutu. In addition, two other rivers, the Jamboaye and the Arakudo, are flowing in an area about 30 km east of Lhoksukon. Flooding of one or more of these four rivers has always been reported during every rainy season.

On the other hand, the bathymetric chart of the area shows that a depth of 10 meters is available about 1,000 meters off the coastline. Further, the drifting sand carried by the above-mentioned rivers is affecting the topography of this coast greatly. It is reported that the sand sedimentation along the coastline towards the north of Lhoksukon amounts to approximately 20 cm/y. This sand sedimentation is causing this coastline to extend itself towards the ocean at a rate of about 1 m/y.

In view of above facts, this portion of the area seems to have the following definite disadvantages, thereby making itself unqualified as a candidate plant site:

(a) The availability of hard soil is low.

(b) It is difficult to secure a coastline with a sufficient water depth without adverse effects of sand sedimentation.

(2) Area to the west of Lhokseumawe

This area constitutes a portion existing between the town of Lhokseumawe and the

Arun LNG plant. Although this area is a suitable candidate site with conditions of soil and water depth similar to the west of the Arun LNG plant which is to be described later, the Aceh provincial government is maintaining a policy that no industrial project should be plotted in this area because of the following reasons:

(a) This area should be kept as land for future expansion of Lhokseumawe city.

(b) This area should be maintained as a buffer zone against industrial pollution from the LNG plant as well as from new industrial projects being planned, including this fertilizer project.

Therefore, this area should be disqualified as a candidate site for this project.

2-2-2 Area to the west of the Arun LNG plant

This area covers a coastal area stretching from the Arun LNG plant site to the town of Bireuen which is located about 36 km west of the LNG plant site.

The geological composition of this area is an alluvial plain consisting of either clay or sand, and the coastal area is generally a clean line of sand. In general, a water depth of -10 m is available at about 500 m away from the coastline towards the sea.

In order to select a candidate site within such an area having these general topographic and geological features, it is necessary to additionally provide the following factors as selection criteria:

a) The prevailing current in the vicinity of this coastline is moving from northwest to southeast.

b) The Peusangan River provides 40 m^3/sec. of water flow even during the dry season. The Mane River, which is located to the east of the Peusangan River, provides 17.3 m^3/sec. of water flow during the rainy season, although this river is reported to become dry during the dry season.

c) The sand carried by the rivers mentioned in b) above will cause a sand sedimentation at the coastline in collaboration with the current explained in a) above. Therefore, if the plant site is to be selected on the east side of both of these two rivers, it will be necessary to secure an ample geographic distance (e.g., about 10 km) from the rivers.

d) An air strip owned by PERTAMINA is located about 8 km to the southwest of the Arun LNG plant. Possible expansion of this air strip in the future must be taken into consideration so that selection of a candidate site within the aerodromic circle limited by international aviation regulations would be avoided.

In view of these factors, the following two areas may be selected as the final candidate sites for the project:

a) Area adjacent to the west side of the Arun LNG plant

b) Area to the west of the Peusangan River

As representative of these two candidate areas, the following locations may be selected (refer to Figure IV-1):

Site A : Kuala Jangka
Site B : Kuala Geukeh

2-3 Outline of the candidate sites

In the foregoing paragraph, the following two locations were selected as the final candidate sites:

Site A : Kuala Jangka
Site B : Kuala Geukeh

In this paragraph, an outline of these two candidate sites will be described.

2-3-1 Kuala Jangka

At present, this area includes a village area located at approximately 50 km to the west of Lhokseumawe. The advantages available in this area are as follows:

a) Land with hard soil bearing capacity is available.
This area is mostly a coastal plain consisting of villages, paddy fields, palm trees, salt ponds, and fish cultivation ponds.

b) This area is geographically close to the Peusangan River, so that the length of the required water pipeline will be shorter.

c) The water depth along the coast is ample. About 400 m towards the sea will provide a depth of -10 m, and about 500 m will find a water depth of -20 m.

However, this area also has the following disadvantages:

a) The length of natural gas pipeline will be longer.

b) The distance of the connecting road to the highway will be longer.

c) The housing colony and other related facilities of the project will have to be built on a complete grassroots basis, since the area is less developed in view of these facilities.

2-3-2 Kuala Geukeh

This area is adjacent to the western boundary of the Arun LNG plant with the small Geukeh River in between. This area is 15 km from the town of Lhokseumawe on the map and 20 km to the west of the town on the highway. In this area, an old railway 1 km in length and a highway 1.8 km in length are running parallel to the coast line. This area is also a coastal plain area having villages, palm trees and fish cultivation ponds. The geological and marine conditions are approximately the same as those of Kuala Jangka; however, this area has the advantage of possible sharing of the welfare facilities which belong to the LNG plant.

2-3-3 Comparison of candidate sites

The following section summarizes a comparison study made to clarify the facts about the two candidate sites as selected in the foregoing portion.

Both sites A and B are rural areas involving coconut fields, fish cultivation farms (salt ponds in Site A), marshes, etc. Tables IV-1 and IV-2 give the results of a detailed comparison made between these two sites conducted on the basis of various criteria. It is rather difficult to give a decisive verdict on either of the two; however, the following points should be noted:

(1) Site A: Kuala Jangka

(a) The scope of village evacuation may be smaller than in the case of Site B.

(b) Site A has ample physical allowances to cope with a possible large-scaled industrial plan (on the basis of natural gas and forest resources).

(c) Since the development of this area is still in a primitive stage, various infrastructural costs will amount to a higher level (e.g. roads, communication facilities and urbanization).

(2) Site B: Kuala Geukeh

(a) Although land availability is enough to meet future expansion of the proposed complex, the physical limitation of the land may not allow possible large-scaled industrialization. (There would be no problem in this respect, however, if the western boundary of the LNG plant becomes available for future industrial development.)

(b) The existing LNG plant which is adjacent to this site already has various infrastructural facilities and welfare facilities which may be available for this project in the form of sharing. The possible geographic proximity, therefore, of the plant and the housing colony seems advantageous for future urbanization plans.

2-3-4 Cost comparison

A cost comparison study was conducted concerning the following four points of the qualitative comparison table (Table IV-1), for which comparative cost analysis is possible: (Ref. Table IV-3)

a) Length of foundation pile according to depth of bearing stratum

b) Scale of water intake plant and length of water pipeline required

c) Length of gas pipeline required

d) Length of connecting road

Concerning the differences in land procurement prices and in harbor requirements (such comparison studies as the calculation of the required length of breakwater on the basis of the bathymetric chart, etc.), it has been assumed that there would be no difference in terms of cost because of the fact that no sufficient data were made available to carry out any valid comparison, and also because the difference, if any, would be small.

Cost comparison was conducted on the basis of calculating the direct cost of work, i.e., the quantity of necessary materials, equipment, machinery, man-hours of direct construction work, etc.

As a result, it has been revealed that there is no significant difference in cost between these two candidate sites. (Table IV-3) In view of the results of qualitative and cost comparison, it has been deemed that there is no decisive element on the basis of which a final selection between the two candidate sites can be made.

On the other hand, both the Indonesian Government and the Aceh Provincial Government have already decided that Site B, i.e., Kuala Geukeh, is to be the site for the envisaged plant of this project. The results of the survey conducted by the mission did not reveal any decisive element to contradict the Indonesian governmental decision. Therefore, all the studies and investigations to be conducted in the following chapters will assume that Kuala Geukeh will be the finally selected site for the envisaged plant.

Chapter 3 Scope of the Project

3-1 General

In this Chapter, the scope of the ammonia/urea complex to be built in this project is defined. The required facilities shall be classified into the following broad categories:

a) Process plant
b) Utility facilities
c) Storage and warehouse facilities
d) Shipping facilities
e) Maintenance facilities
f) Offices and other buildings
g) Other ancillary facilities to the plant
h) Infrastructure

The description of each facility is made according to the above classification.

3-2 Product items and production capacity

The final product of this project is prilled urea. In order to produce urea by using natural gas as the raw material, the gas must first be reformed into hydrogen and carbon dioxide. The hydrogen together with atmospheric nitrogen will then synthesize ammonia. This synthesized ammonia and the already separated carbon dioxide are used to produce urea. In this process, ammonia and carbon dioxide are produced as intermediate products; however, these shall not be marketed as such. In other words, all the ammonia and carbon dioxide produced shall be converted to urea, which is the final product. Specifications of the product urea are shown in Table IV-4.

As to the capacity of the process plant, the following capacities have been selected as planned by the Indonesian Government:

a) Ammonia plant: 1,000 T/D
b) Urea plant: 1,725 T/D

These capacities are standard capacities on a single stream with which a number of ammonia/urea complexes have been built in the world.

3-3 Process plant

3-3-1 Process description

The following described process is a typical one of ammonia/urea manufacturing facilities. This does not purport to be a restrictive recommendation for these processes, however.

A number of both ammonia processes and urea processes have already been developed in the world, and each process has gained ample experience in actual application. Many plants have been constructed in a number of countries all over the world on the basis of these proven processes. These processes are considered to be almost perfect and complete in themselves as know-how, so that competitive comparison among them is unable to identify any difference. In view of these circumstances, and at this feasibility study stage, process recommendations will not be made, since it is supposed that well-qualified contractors will be selected in the implementation stage.

(1) Ammonia plant (Figure IV-2)

(a) The natural gas received is metered and then divided into two flows, one as the raw material and the other as the fuel.

(b) The raw material gas enters the pre-treatment process where hydrogen sulfide and carbon dioxide are removed.

(c) The pre-treated gas is mixed with steam and passed through the catalyst-filled tubes of the primary reformer where steam reacts with the gas to produce hydrogen, carbon monoxide and carbon dioxide.

(d) From the primary reformer the gas flows through a secondary reformer where it is mixed with air in a quantity required to reform the remaining unconverted hydrocarbons and provide the required amount of nitrogen to produce ammonia.

(e) Leaving the secondary reformer, the process gas flows through catalyst beds where the remaining steam reacts with carbon monoxide to produce additional hydrogen and carbon dioxide.

(f) The process gas, consisting of hydrogen, nitrogen and carbon dioxide, and small amounts of carbon monoxide, methane and argon, is scrubbed with an activated potassium carbonate solution to remove the carbon dioxide. The potassium carbonate solution is regenerated and the carbon dioxide is recovered and used to produce urea by reaction with ammonia.

(g) The remaining carbon dioxide and carbon monoxide are removed from the process gas by conversion to methane by reaction with hydrogen in the presence of a catalyst.

(h) The final synthesis gas contains hydrogen and nitrogen in the ratio of 3 to 1, and also small amounts of methane and argon which are harmless and are continuously purged from the ammonia synthesis system.

(i) The purified synthesis gas is compressed to about 150 atm. and recirculated through a converter, where, in the presence of a catalyst at elevated temperature, the hydrogen and nitrogen react to produce ammonia.

(2) Urea plant (Figure IV-3)

(a) The produced ammonia and the by-product carbon dioxide are reacted at a pressure of about 220 atm. and an elevated temperature to produce ammonium carbamate which is subsequently dehydrated to form urea. An exess of ammonia is used for the reaction, and the products leaving the reactor are urea, ammonium carbamate, water and free ammonia.

(b) The effluent from the reactor flows to decomposers where the pressure is reduced and heat is applied to convert ammonium carbamate back to ammonia and carbon dioxide. The ammonia and carbon dioxide are recycled back to the reactor as carbamate solution.

(c) The final urea solution is concentrated by evaporation of the water under a vacuum where crystallization of the urea occurs.

(d) The wet urea crystals are centrifuged to remove most of the water, dried by contact with hot air and transported pneumatically to the top of the prill tower. There, the dried crystals are heated to the molten state and sprayed downward through the tower where the prills are formed.

(e) The prills are collected on a fluidized cooler at the bottom of the tower where they overflow to a vibrating screen to remove oversize material.

(f) The urea product leaving the screen is transported to the bulk storage building.

3-3-2 Basic consumption of raw material and utilities

Table IV-5 shows the basic consumption of raw material and utilities of a typical process plant. The specifications of the utility facilities have been formulated on the basis of these data.

3-4 Utility facilities

The utility facilities necessary for the ammonia/urea complex may be classified into the following broad categories:

a) Water-related facilities to provide process water, cooling water, boiler feed water, fire-fighting water, drinking water, etc.

b) Boiler units to provide steam for heat duty and turbine duty.

c) Electric power generation and distribution facilities for driving and lighting.

The following sections will outline these facilities:

3-4-1 Water facilities

(1) Water intake facility

This is a facility to intake and pump the river water which will be utilized as the basis for various usages of water in the plant.

The river water will be pumped through the pipeline to be laid between the facility and the plant, and then will be received at water treatment facilities in the plant. The water will be utilized in the plant after respective treatments at the water treatment facilities for each purpose.

The river water must be secured constantly for the whole economic life-span of the plant with sufficient quantity and quality. To meet this requirement, the location of this facility is to be established upsteam of the bridge over the highway on the Peusangan River, which is approximately 25 km to the west of the proposed plant site. The quality of river water at this spot is shown in Table IV-6.

(2) Water treatment facilities

The river water, which is to be sent from the water intake facility, has high turbidity, so that it must be treated accordingly for each usage in the plant. Three major usages are for potable water, for fire and cooling water, and for process and boiler feed water.

3-4-2 Boiler facilities

The steam is required in the fertilizer complex for various purposes. These purposes are classified into three categories as follows:

a) Process steam to be the source of hydrogen in the ammonia plant

b) Heating steam for heat exchangers employed by various plants in the complex

c) Turbine steam for driving rotating machines at various plants in the complex

As for the supply sources of the steam in the complex, there are three major sources:

a) Waste heat boiler and an auxiliary boiler in the ammonia plant

b) Waste heat boiler in the power generation plant

c) Package boiler(s)

In due consideration of these requirements and supply sources, the boiler system should be designed accordingly, including pressure, temperature, and capacity; however, inter-plant arrangements should be limited to the extent that these arrangements will not cause deficiency in the plant on-stream factor.

3-4-3 Electric power generation facilities

In the vicinity of the proposed plant site, there is no power station capable of providing the power requirements of the envisaged complex. Therefore, it is necessary that the complex itself install a power generation plant.

There are two alternatives for the design of a power generation – one is a generator to be driven by a steam turbine and the other is one to be driven by a gas turbine. The selection among these alternatives should be made in view of total thermal efficiency and operability.

On the other hand, an emergency power generator is to be installed in order to minimize trouble in the plants when the main power generator shuts off unexpectedly.

3-5 Storage and shipping facilities

In this category, storage for intermediate and final products should be included, as well as shipping facilities for these products.

Requirements for the design of these facilities among others are as follows:

a) Since the intermediate products of ammonia and carbon dioxide are to be fully converted to urea, shipping facilities for these products will be excluded from the project scope.

b) The mode of shipping the final product is considered to be as follows:

- About 30,000 tons of bagged product, which is equivalent to the projected domestic demand of the Aceh region, is to be distributed by truck.
- The balance of the product is to be shipped from the complex as bulk. Therefore, the demand of bagged product for other than the Aceh region will be supplied through the bulk terminal of P.T. PUSRI at the port of Belawan and/or Padang where the bulk urea will be bagged for domestic distribution and for export.

Capacity of Bulk Terminal (at Belawan and Padang)

Receiving capacity	500 T/H of bulk urea
Bulk urea storage	12,500 T

Bagging unit	50 kg/bag, 12 bag/min./unit x 3 units
Bagged urea storage	12,500 T

3-6 Other auxiliary facilities

In this category, facilities are included, such as maintenance facilities for stable operation, warehouses for machinery and spare parts, buildings for administration offices and control rooms, etc., and a housing colony and its related welfare facilities. These facilities are to be designed so as to maintain the plant at a high on-stream factor, since the site is located in a remote area especially far from the capital city of Indonesia, Jakarta.

3-7 Infrastructure

Related infrastructures such as road, railroad, if necessary, and harbor must be included in the project scope, since the project involves transport of various kinds of materials and equipment. In the construction stage, at first, construction equipment and materials will move into the plant site and then equipment and machinery will arrive from foreign countries. After commercial operation of the plant has begun, the product should be distributed by truck as well as ship.

In order to accommodate these transport requirements, these infrastructures should be constructed independently at the expense of the project, or existing facilities should be relied on.

As for the railway around the area, an old railway exists although there are no plans to rehabilitate the system in the near future. On the other hand, it is the Evaluation Team's conclusion that the railway will not be needed, since domestic distribution of the product in the Aceh region will surely be conducted by truck transport.

As for the harbor, there are two harbors in the vicinity; one is Lhokseumawe port a public port, and the other is LNG port for special purposes. So far as the public port of Lhokseumawe is concerned, facilities of the port are insufficient to meet the requirements of the project. On the other hand, LNG port is so designed as to accommodate the LNG tankers, which require such special precautions against hazards that the sharing of this facility with the fertilizer project is considered to be impossible. Therefore, the project should construct a harbor to fill its own requirements.

As for the road, the Indonesian Government is now implementing a highway betterment project for the highway between Medan and Banda Aceh with the target of completion by the end of 1978. Therefore, the project is only to construct the connecting road to the highway from the plant site.

Chapter 4 Conceptional Design of the Plant

4-1 General

Initially in this chapter, design criteria will be clarified on the basis of the scope of the project defined in Chapter 3, as well as on the plant site location at Kuala Geukeh. Subsequently, the result of conceptional design will be described in detail.

4-2 Design standard

4-2-1 Status of the plant site

The Kuala Geukeh site is located on the northeastern coast of Aceh Province in the northern part of Sumatra Island. The geographic location of the site is 5°-15' N.L. and 97°-02' E.L., about 15 km west of Lhokseumawe. The site is facing the mouth of the Geukeh River. (Ref. Figure IV-1)

The selected site covers an area of about 1 km inland from the coastline inclusive of the west bank of the Geukeh River. The south side of this area is bordered by the railway and the highway. The area surrounding the site consists of alluvial lowlands of less than 3 m above sea level, and shows the character of a beach ridge plain in which alternating strips of ridges (shore hills) and dales (lowlands between hills) run parallel to the shore line, the elevational difference between the ridges and dales amounting to 1 m to 3 m. The ridges are generally covered with palm trees, and villages are scattered therein. The dale area forms marshy fields, many of which are used as fish cultivating ponds. Following sections will describe soil, meteorological and oceanographic conditions of the proposed plant site.

4-2-2 Soil conditions

a) Soil

The soil structure of this area consists of the following layers from the surface downward:

- Loose sand and self-organic material
- Dense sand and medium sand with layers or lenses of silt and clay
- Silt and clay
- Sandstone, coral or silt stone

b) Soil bearing capacity

–	Bearing capacity, for shallow foundations:	5 T/m^2
–	Bearing capacity after compaction:	15 T/m^2
–	Depth of bearing stratum:	-12 m

c) Seismic factor: 0.10

d) Tidal difference

(1)	Highest astronomical tide	+2.22 m
(2)	Mean high water spring	+1.88 m
(3)	Mean high water neap	+1.32 m
(4)	Mean sea level	+1.01 m
(5)	Mean low water neap	+0.70 m
(6)	Mean low water springs	+0.14 m
(7)	Indian spring low water	±0.00 m
(8)	Lowest astronomical tide	+0.20 m

4-2-3 Meteorological and oceanographic conditions

a) Temperature:

Dry bulb:	Max. 35°C
	Min. 22°C
	Mean 26°C
Wet bulb:	Max. 29°C

b) Relative humidity:

	Max. 92%
	Min. 59%
	Mean 82%

c) Prevailing wind direction:

Day:	East by northeast – East
Night:	South by southeast – South

d) Wind velocity:

Monthly average:	Max. 11 – 14 m/sec. (1%) Min. 7.7 m/sec.
Maximum:	30 m/sec.

e) Precipitation:

Average annual precipitation: (50% of the above precipitated between October and January)	1,500 mm
Maximum 24 hours precipitation: (Maximum 24 hours precipitation over past 47 years)	180 mm

f) Waves (50 years return):

Wave height:	3.0 m
Cycle:	0.9 sec.
Direction:	Northwest

g) Current: 0.72 m/sec.

4-2-4 Site level

The site level shall be I.S.L.W. + 4.5 m in consideration of the wave height and tidal elevation.

4-3 Plant facilities

4-3-1 Plant facilities

The capacity of each unit of the plant facilities has been determined as shown in Table IV-7 on the basis of the basic consumption of raw material and utilities as discussed in the foregoing chapter.

The overall material balance of the complex on the basis of the thus determined capacity is as follows: (Ref. Table IV-4)

Input

(a)	Natural gas:	2,420 MSCF/H
(b)	Air:	38,000 Nm^3/H
(c)	Water:	1,220 m^3/H
(d)	Diesel oil*	540 lit./H

* For the power generation unit at the water intake facilities and also for tug boats in the harbor

Output

(a)	Urea:	71.88 T/H

On the basis of the material balance above, the capacities of each facility are decided. The capacities of the main facilities in the envisaged complex are shown in Table IV-7.

The facilities in the complex can be broadly classified into the following:

a. Process plants
b. Utility plants
c. Storage and loading facilities
d. Other auxiliary facilities

The outline of these facilities will be explained hereafter.

4-3-2 Process plants

Process plants in the project consist of a 1,000 T/D ammonia plant and a 1,725 T/D urea plant, each built by a single train.

The processes to be employed for both ammonia and urea plants are considered to be perfectly commercially proven so that no radical innovation will be anticipated. There are a few processes with which many plants have been constructed throughout the world and the reliability of these processes has been proven in each installation. Therefore, no fundamental technical problem will be involved, so far as process engineering is concerned; consequently, the performance of the constructed plant is solely dependent upon the experience of the engineering contractor who builds the plants and the equipment and machinery installed in the complex.

In the design and construction of the process plants, performance of the work must rely on the know-how of the process owner as well as on the know-how of the engineering contractor who makes the detail design and engineering of the plant. Therefore, the arrangement of the process plants will be different depending on the selected process and the selected contractor. However, as far as the fundamental scope of the plant and the investment cost of the plant are concerned, no big difference will be identified.

Under these circumstances, a conceptual process will be considered for both the ammonia and the urea plant for this evaluation study, since an engineering contractor will be selected through competitive bidding for the design and engineering of the plant and will design the process plant in detail. This ammonia process plant will include gas-receiving facilities and an acid removal unit in which carbon dioxide and sulfur compounds contained in the gas will be removed.

4-3-3 Utility facilities

In this category, all the utility facilities to sustain the stable operation of the process plant will be included. The outline of these facilities will be explained hereafter.

(1) Water treatment facilities

The water fed from the water intake facilities will be held in a tank to which chemicals will be added for treatment. After further addition of chemicals, the water will be sent into a clarifier in which the floating substances will be coagulated and sedimented. The water sent out from the clarifier will then go through filters to produce filtered water.

The filtered water will be divided into three flows:

(a) A system for drinking water with hygienic treatment

(b) A system for cooling water and fire hydrant water without further treatment

(c) A system for process water and boiler feed water with ion-exchange columns

(2) Electric power generation facilities

The Aceh region has no power generation station capable of providing the power requirements of about 15 MW of the envisaged complex. Therefore, it is necessary that the complex itself carry out in-plant power generation. The power generation method shall be the gas turbine generation in consideration of the overall thermal efficiency of electric power generation and waste heat utilization. The waste heat shall be recovered in the form of steam.

As for the emergency power source, a set of diesel-engined power generators is to be installed.

(3) Boiler facilities

The steam in the fertilizer complex is classified into three categories:

(a) Process steam to be the source of hydrogen in the ammonia plant

(b) Heating steam for heat exchangers employed by various plants of the complex

(c) Turbine steam for driving rotating machines at various plants of the complex

For the ammonia plant, a steam system is so designed, unless otherwise required, that a self-balance will be attained between the waste heat boiler and the auxiliary boiler within the plant during operation, and an external package boiler will be used only for start-up and in case of emergency. The steam for the urea plant and for the utility plant shall be supplied by the gas turbine waste heat boiler and the package boiler.

4-3-4 Storage and shipping facilities

(1) Ammonia storage tank

Since no shipment of ammonia is contemplated, an ammonia storage tank shall be installed as a buffer tank between the ammonia plant and the urea plant, to continue the operation of the ammonia plant when the urea plant is shut down unexpectedly, as well as to continue the operation of the urea plant when the synthesis loop of the ammonia plant is stopped in an emergency. Therefore, the capacity of this ammonia storage tank is designed for 5,000 tons at atmospheric pressure.

(2) Urea storage

The urea storage is for bulk urea only. Storage capacity is designed for 50,000 tons. Since the marketing and distribution of the product from the project is planned to be handled by the Indonesian Government who will assign P.T. PUSRI as an executing agency, the product from the project will be put into PUSRI's channel as discussed in Part II. Storage will include a reclaimer for the handling of bulk urea and shovel loaders for bagging facilities.

(3) Bagging facilities

As was discussed in Chapter 2, the shipping plan of the bagged product from the project is only 30,000 tons for domestic consumption in the Aceh region. Therefore, only one unit is sufficient for the bagging facilities with a capacity of 12 bags/min. for 50 kg bags.

(4) Loading facilities

The product from the project is planned to be shipped as per the following pattern:

(a) 30,000 T/Y to be shipped as bagged product by truck

(b) 540,000 T/Y to be loaded on the ships as bulk product

In general, the maximum capacity available for the bulk urea loader is considered to be 600 T/H with the actual performance capacity of 510 T/H. Therefore, in this project, a unit of bulk urea loader will be installed with the maximum capacity mentioned above.

On the other hand, for the loading facilities for the bagged urea, no bagged urea storage is required, since the bagging speed is more than that of truck loading and the bagged product is directly loaded on to the trucks from the bagging unit. In order to support this operation, three sets of portable conveyors will be installed.

4-3-5 Other auxiliary facilities

In this category, all the supporting facilities for stable operation of the plant will be included. The outline of these facilities is as follows:

(1) Maintenance facilities

Operation stability of an industrial complex depends heavily on the adequacy of the facilities and maintenance systems. In the case of this project, major repair shall be carried out by servicemen from the vendors of the machines in question as has been the usual practice in Indonesia. Only routine repair work shall be undertaken by plant personnel.

Welding machines, large and small lathes and other machine tools shall be installed to cover mechanical repairs. Coil winders of various sizes of electric motors must also be equipped. All the necessary test machines and measuring instruments such as calibrators, etc., should be provided.

(2) Office buildings, etc.

For office purposes and also for storing various items mentioned above, it is necessary to have a number of buildings within the complex. Table IV-7 shows a list of all the necessary buildings. These structures are either independently built or installed in combination with other buildings. The buildings listed here include all the required fire-fighting facilities.

(3) Pollution control facilities

At present, Indonesia does not have laws or regulations controlling industrial waste. In the following, the possible waste generated from this project will be stipulated by categorizing the waste into gas, liquid, and solid substances:

(a) Gaseous effluent

The raw material natural gas contains only a slight amount of sulfur. Therefore, no serious pollution problem will be caused by sulfur-type waste. No particular pollution control installation is deemed necessary.

(b) Liquid effluent

Possible sources of pollution in this category are cooling water waste (containing heavy metallic ion and oil), filter washing water in the urea plant, and sand-containing slurry generated from the filter of the water treatment facilities. Adequate treatment devices for each of these waste water sources shall be installed.

(c) Solid effluent

The dust urea which will be scattered from the urea prilling tower will be controlled by installing a device to regulate the volume of the powder particle to approximately 50 mg/m^3 at the outlet of the prilling tower.

4-3-6 Layout of the plant facilities

Plant layout on the basis of the foregoing conceptual design is as shown in Figure IV-4. Figure IV-5 shows the conceptual design duly applied to the case of the Kuala Geukeh site. Figure IV-6 illustrates a conceptual design drawing of envisaged urea storage.

4-4 Water intake facilities

Water intake facilities will be installed on the bank of the Peusangan River. The river water is pumped up into a settling pond where coarse sand will be settled by sedimentation. This pond has been so designed that natural sedimentation of sand particles of over 75 microns will be satisfactorily carried out in consideration of high turbidity which may take place during the rainy season. The water after settling is extracted by a turbine pump and then transported to the plant which is located about 30 km to the east of the pond.

Water transportation is carried out through a steel pipeline. (Refer to Table IV-6 concerning the water quality.) Electric power for lighting and for driving the water intake pump and the water transfer pump will be generated by a diesel generator.

Therefore, the water intake facilities shall consist of the following installations:

a) Water intake pump
b) Water transfer pump
c) Settling pond

d) Power generator and its auxiliary equipment

e) Buildings

The overall layout and a conceptual design of the water intake facilities are as shown in Figures IV-7 and IV-8 respectively.

The pipeline to be used shall be 24 inches in diameter, covering a total distance of 30 km. The right of way for the installation of this pipeline shall cover a width of 6 m. After the installation, 1 m of earth from the top of the pipe shall be restored upon the pipeline.

4-5 Housing colony

The province of Aceh does not have a sufficient number of local engineers. Therefore, much of the personnel for plant operation, maintenance, and administration will have to be recruited from Medan, Java, etc. In order to retain well-qualified engineers, managerial experts, etc., adequate environmental conditions in addition to sufficient remuneration must be provided for incentive to come to the site. The minimum requirements of housing facilities are:

a)	Staff housing:	150 houses
b)	Non-staff housing:	150 houses

The utilities for these houses such as water supply, electric power, etc., shall be extended from the fertilizer plant. However, a mosque, school, and hospital are excluded from the scope of this project. These installations are to be provided by the Government of Indonesia in cooperation with the Aceh Provincial Government and the management of the LNG plant.

Figure IV-9 is a layout of the housing colony. By referring to the housing colony design employed by PUSRI and Pupuk Kujang, 300 houses (150 for staff housing and 150 for non-staff housing) shall be constructed in accordance with the job classification of the plant personnel which will be described later.

Figure IV-9 also shows the following installations only for reference, as these are excluded from the scope of this project:

a) School

b) Hospital

c) Mosque

d) Market and related facilities

4-6 Infrastructure

The following items are the major infrastructure requirements relating to this project:

a) Port facilities
b) Connecting road to highways

4-6-1 Port facilities

The final product urea of this project will be, for the most part, shipped on ocean-going vessels to be exported to overseas markets centering on ASEAN countries. Part of the product urea will also be delivered to the Indonesian domestic market. The following conclusions have been drawn as a result of a survey on the available port facilities on the part of ASEAN member importing countries as well as other destination countries outside the ASEAN region, on the loading and transportation system within Indonesia, and on the types of ships available in this area of Indonesia.

Necessary conditions required of port facilities relating to this project:

a) The standard capacity of the vessels calling at the port of this project for loading urea shall range from 7,500 DWT to 10,000 DWT.

b) Therefore, the necessary water depth for accommodating such vessels shall be at least -10 m.

c) The loading work of bulk urea will be carried out by the bulk loader defined in Section 4-3-4 of this chapter.

The design prerequisites of the port facilities in this project are as follows:

a) About 2.7 million m^3 of sand will be necessary for land preparation of the site. (Removing the present surface soil, and piling an additional sand layer to a level of 4.5 m above the standard sea level.) However, there is no land sand available in this amount in the vicinity of this site. Therefore, it is necessary to use sea sand for this purpose.

b) The meteorological and oceanographic conditions in this area become particularly rough during the monsoon season, lasting from December to February.