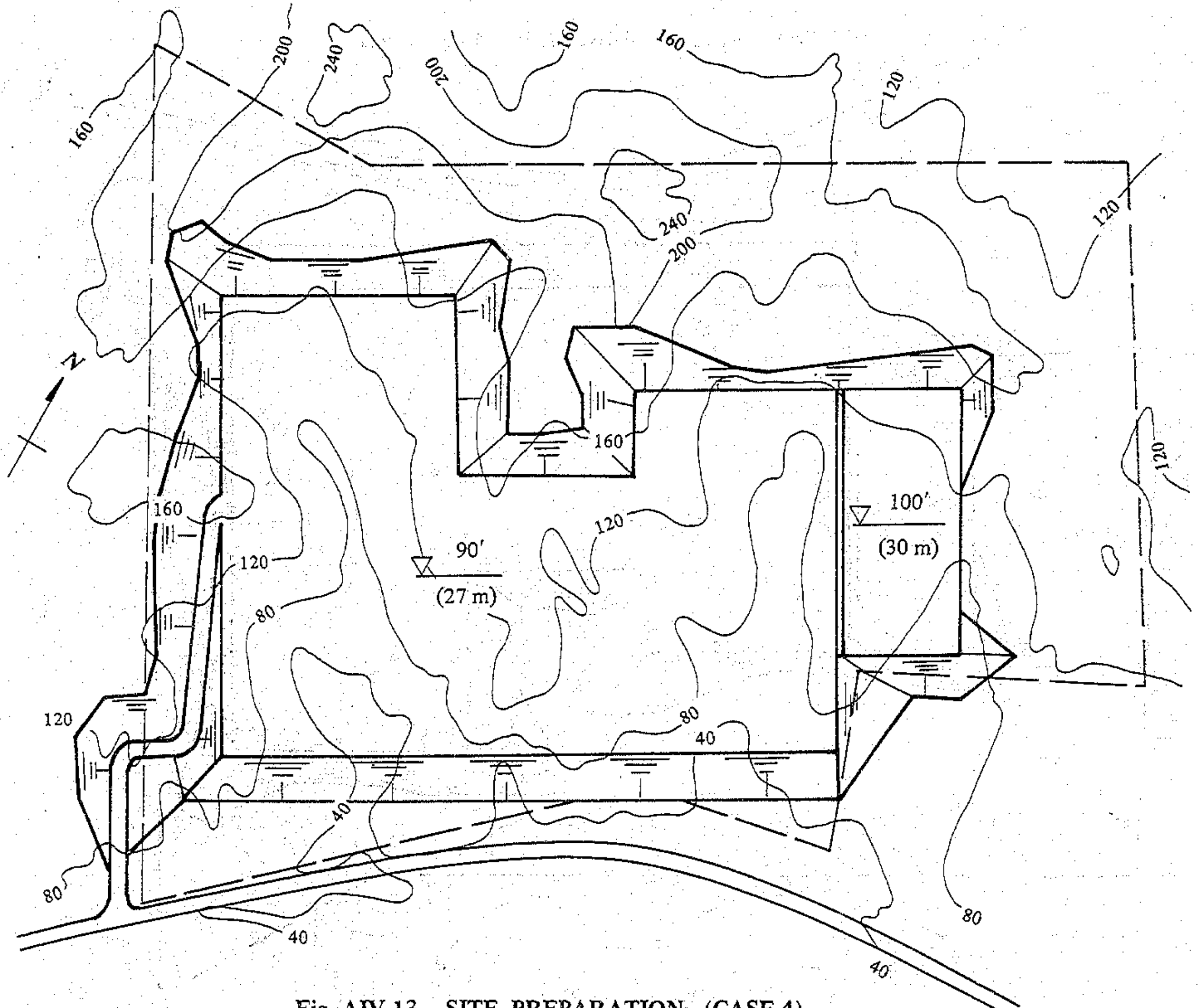



Fig. AIV-13 SITE PREPARATION (CASE 4)

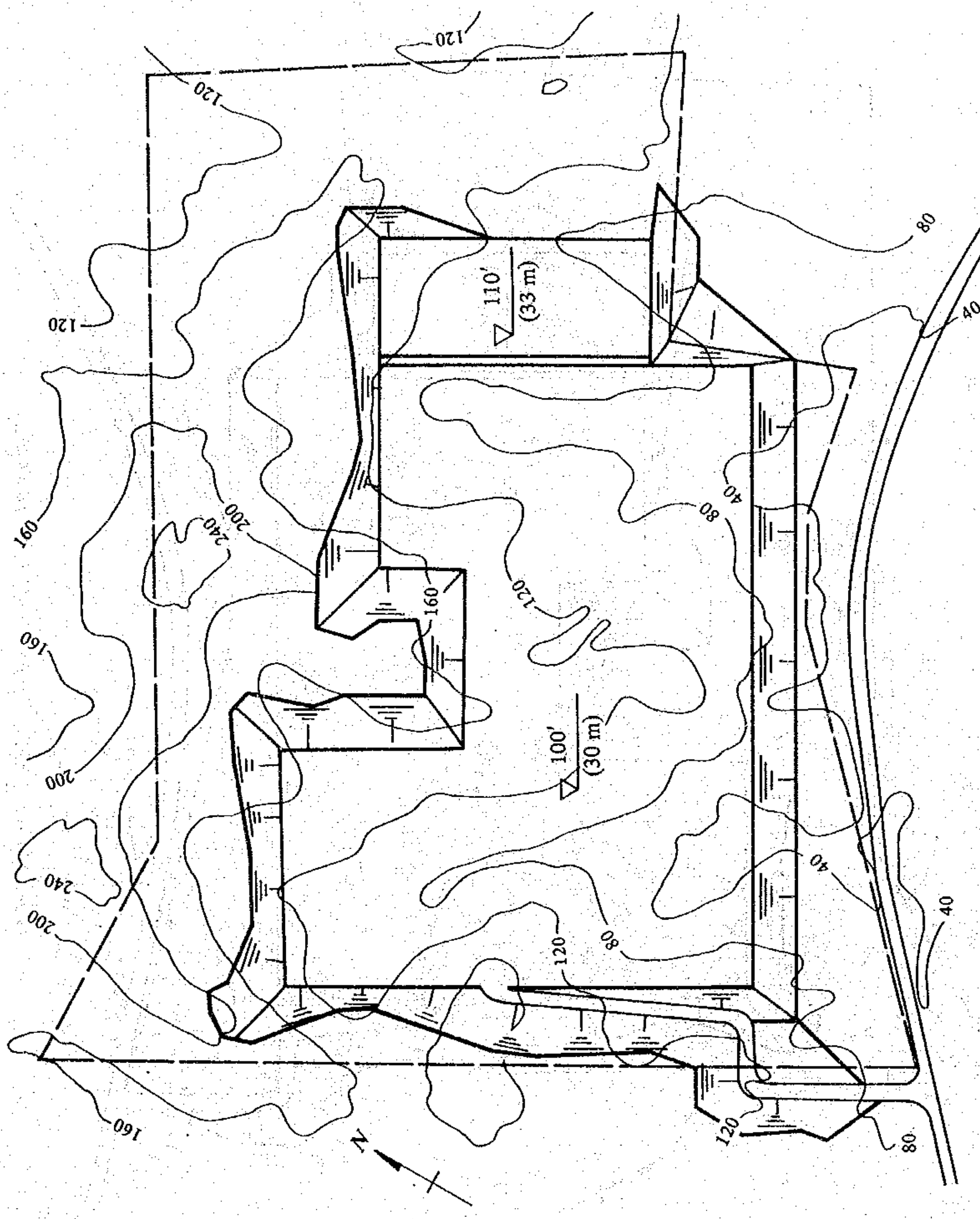



Fig. AIV-14 SITE PREPARATION (CASE 5)

# APPENDIX IV-5 STUDY ON REDUCTION OF SOFT WATER USE BY USE OF SEAWATER FOR COOLING

## 5-1 General

About 80% of the make-up water used in the ammonia and urea plants will be consumed for cooling purposes. When soft water is difficult to obtain, or high in cost, it is necessary to study the measures of reducing the consumption of soft water for cooling. The ways of accomplishing this are to make maximum use of seawater, or to use air cooling, or a combination of them.

Because the cost of soft water for this Project would be relatively high, at US$ 0.28/ $m^3$, study was made of one of the three approaches cited above, namely the use of seawater, to determine the economic benefit it could provide.

In this study it was assumed that seawater, once used for cooling, would be discharged into the ocean; the once-through method.

## 5-2 Savings in the Volume of Soft Water Required, and Volume of Seawater Used

Even when seawater is used for cooling, soft water may be used in part, because seawater, in combination with the high temperatures, would sometimes have an adverse effect on the materials used in the heat exchanger.

For general process considerations, the following cooling water balance may be expected.

| | Soft water required for cooling (Make-up water) |
|---|---|
| When cooling is to be by use of soft water alone | 785 $m^3/h$ (100%) |
| When cooling is to be with maximum use of seawater | 174 $m^3/h$ ( 22%) |
| Balance | 611 $m^3/h$ ( 78%) |

By use of seawater, savings of 611 $m^3/h$ of soft water, which corresponds to a 78% of soft water make-up needed in the case of cooling only by soft water, may be attained, and because the total soft water requirement of the Complex is estimated to be 985 $m^3/h$ in the former case, this corresponds to a savings of 62% of the total soft water requirement for that case.

When the seawater is 30°C at the point of intake and is discharged at 40°C ($\Delta t$ = 10°C), the volume used by the once-through method becomes 16,800 $m^3/h$ ( = 4.7 $m^3$/sec.). Intake, transportation and discharge facilities for the seawater must be designed on the basis of this volume. The conceptual design of these facilities is described in the subsequent paragraphs.

## 5-3 Study of Seawater Intake and Discharge Facilities

Seawater use facilities comprise intake and discharge systems; three cases were studied for each system, and compared as described below to determine the alternative to be recommended (see Fig. AIV-15).

### 5-3-1 Design conditions

1) Intake

| | | |
|---|---|---|
| Intake volume: | | 4.7 $m^3$/sec. |
| Transfer velocity: | | 2.5 m/sec. |
| Intake temperature: | | 30°C |
| Intake level: | | - 7.000 MSL (m) |
| Complex site level: | | + 30.000 MSL (m) |

2) Discharge

| | | |
|---|---|---|
| Discharge volume: | | 4.7 $m^3$/sec. |
| Discharge velocity: | | 1.0 m/sec. |
| Discharge temperature: | | 40°C |
| Discharge level: | Sea | ± 0.000 MSL (m) |
| | River | ± 0.000 MSL (m) |
| Complex site level: | | +30.000 MSL (m) |

### 5-3-2 Case study

1) Intake system

Case 1: An intake pump is installed adjacent to the MLNG plant's seawater intake pump. The pipeline from there to the site is buried and follows the Tg. Kidurong road.

Case 2: An intake pump is installed west of the North Reclaimed Area. The pipeline from there to the site is buried and follows the Tg. Kidurong road.

Case 3: An intake pump is installed northwest of the South Disposal Area. The pipeline from there to the site, first follows the earth dike and then goes northward following the temporary road made in order to build the dike.

The merits and demerits of each case are given in Table AIV-6, which also has an overall appraisal of each case.

2) Discharge system

Case 4: Water is discharged by gravity directly to the S. Plan Besar which flows on the south side of the site.

Case 5: A discharge mouth is provided on the south side of the South Disposal Area, and water is discharged by gravity.

Case 6: Water is pumped to an elevated point on the north side of the site, and discharged by gravity into the sea through a pipeline beneath the MLNG plant site.

The merits and demerits of these cases are also given in Table AIV-6, together with an overall evaluation.

### 5-3-3 Selection of the recommendable alternative

On the basis of comparison of the above cases, and on the assumption that the planning can be made with good coordination and cooperation with and from other projects, especially the MLNG project, in the Bintulu area, it is recommended that Case 1 be adopted for water intake and that Case 4 be adopted for water discharge, and these two cases were used for further study.

In the recommended cases, both intake and discharge of seawater is in the harbor; because the mouth of the S. Plan Besar to which warm water will be discharged and the MLNG pump station's intake point are more than 2 km apart, it is believed that no water temperature problem will arise. However, it is necessary to fully study the possibility of influence of the warm water on the S. Plan Besar and harbor.

## 5-4 Effects on Capital Requirements and Utilities Cost

### 5-4-1 Increase/decrease in capital cost of utilities facilities in the Complex

The following increase/decrease in the cost of utilities facilities in the Complex would result when seawater is used rather than using only soft water (beginning-1984 prices are used).

(1) Because higher grade specifications become required for the heat exchanger, the cost of the heat exchanger is increased.

(2) Seawater is temporarily stored within the Complex, and fed to the plants by a pump. However, because it is still necessary to use some soft water for cooling, the number of pumps is increased by use of two kinds of water, and equipment and construction costs are thereby increased.

(3) Two separate piping systems for cooling water are needed in the Complex, so pipe and pipe installation cost is increased accordingly.

(4) Because it is thought that the seawater would be used in a once-through system, cooling tower capacity can be reduced, and equipment cost is lowered accordingly.

The above increase/decrease in capital costs can be figured as follows:

| | | | (US$ '000) |
|---|---|---|---|
| (1) | Heat exchanger | (increase) | 2,230 |
| (2) | Pumps | (increase) | 1,870 |
| (3) | Piping | (increase) | 850 |
| (4) | Cooling tower | (decrease) | 6,890 |
| | Total | (decrease) | 1,940 |

Thus, use of seawater for cooling will reduce Complex construction cost by US$1,940,000.

### 5-4-2 Seawater intake, transportation and discharge facilities

The following items are needed as additions in the event that seawater is used for cooling.

(1) Dredging at the seawater intake point

(2) Intake station

(3) Piping

(4) Seawater storage pond (within the Complex site)

(5) Discharge facilities

Based on the plan for intake and discharge of seawater as recommended in Section 5-3 above, construction cost for these systems was estimated, for which three cases were set up by setting the distance of the seawater transportation pipeline as 2 km, 3 km and 4 km, but applying the same system for all cases regarding intake and discharge facilities as recommended previously. The thus-estimated costs are as follows:

(Cost in US$ '000)

| | Distance seawater is transported | | |
|---|---|---|---|
| | 2 km | 3 km | 4 km |
| Civil work | 4,320 | 4,780 | 5,250 |
| Pump installation | 1,590 | 1,660 | 1,740 |
| Piping | 3,270 | 4,900 | 6,530 |
| Total | 9,180 | 11,340 | 13,520 |

### 5-4-3 Change in consumption of utilities

There would be changes in the consumption of electric power, soft water and seawater, accompanying the use of seawater for cooling. It is presumed that power consumption inside of the Complex would be virtually unchanged even if seawater is used for cooling. This is because the only factor which would change with regard to power consumption would be the circulation volume of cooling water in the Complex, but if difference in cooling water temperature between inlet and discharge is the same whether or not seawater is used, the net volume of water circulated would be about the same no matter whether seawater or soft water is used for cooling. In the case of use of seawater for cooling, the additional power is required outside of the Complex to transport seawater from the pumping station to the Complex site. Power consumption when the seawater volume is 16,800 $m^3/h$, the elevation of the intake is $-7$ m, and the elevation of the Complex grade is 30 m would be as follows:

| Distance | Power requirement (increment) |
|---|---|
| 2 km | 3,530 KWH/h |
| 3 km | 3,770 KWH/h |
| 4 km | 4,000 KWH/h |

The volume of soft water used, when seawater cooling as described in Section 5-2 above is used, will be decreased by 611 $m^3/h$. On the other hand, in this case, 16,800 $m^3/h$ of seawater is required for use.

## 5-5 Economic Analysis

### 5-5-1 Comparison of utilities cost

Assuming that the utilities costs are US\$0.28/$m^3$ for soft water, US\$0.06/KWH for electricity, and zero for seawater at the intake point, the comparison of costs when only soft water and when maximum seawater are used is as follows:

| | | Distance seawater is transported | | |
|---|---|---|---|---|
| | | 2 km | 3 km | 4 km |
| (1) | Increment in power use (KWH/h) | 3,530 | 3,770 | 4,000 |
| (2) | Unit power cost (US\$/KWH) | | 0.06 | |
| (3) | Increment in power cost (US\$/h)<br>(1) x (2) | 212 | 226 | 240 |
| (4) | Reduction in soft water cost | 611 $m^3/h$ x US\$0.28/$m^3$ = US\$171/h | | |
| (5) | Increase in utilities cost (US\$/h)<br>(3) - (4) | 41 | 55 | 69 |
| (6) | Annual increase in utilities cost*<br>(US\$ '000/y) | 325 | 436 | 547 |

( *: Change in annual utilities cost = (5) x 7,920 h/y)

Thus, in the event that seawater is used for cooling, there would be an annual increase in utilities cost of US\$325,000 to US\$547,000.

The reason for the increase is mainly the additional power needed to pump the seawater to the elevation of 30 m above sea level; this accounts for 58% to 65% of the above increment in power requirements.

### 5-5-2 Comparison of construction cost

The difference in construction cost which would result from use of seawater for cooling, based on the changes given in 5-4 above, would be as follows:

(Unit: US$ '000)

| | | Distance seawater is transported | | |
|---|---|---|---|---|
| | | 2 km | 3 km | 4 km |
| (1) | Seawater intake, transportation and discharge facilities | 9,180 | 11,340 | 13,520 |
| (2) | Reduction of cost of various facilities within the Complex | 1,940 | 1,940 | 1,940 |
| (3) | Net increase in facilities cost (1) - (2) | 7,240 | 9,400 | 11,580 |
| (4) | Converted to annual cost *1) | 724 | 940 | 1,158 |
| (5) | Converted to hourly cost *2) | US$91/h | US$119/h | US$146/h |

Notes: *1) Annual cost was calculated by taking 10% of the total, in relation to item (3), of: 15-years straight-line depreciation; repair and maintenance cost of 1.5%; and average interest burden of (1/2 x 5% x 70%), i.e., 70% is borrowed.

*2) To obtain the hourly cost, the annual cost (4) was divided by 7,920 hours of operation per year.

Thus, with regard to construction cost too, the use of seawater will result in an increase in costs incurred.

### 5-6 Overall Evaluation and Conclusion

(1) The combined cost of electric power for pumping and transporting seawater to the elevation of 30 m above sea level, in the present calculations, is greater than the savings attained by reducing the use of soft water, and use of seawater for cooling will not result in a reduction of the cost of utilities. Further, the use of seawater for cooling would need larger investment costs than the case of using soft water for cooling.

(2) In the Project as it is planned herein (for example, assuming the seawater is transported 2 km), the increment in construction cost, converted as in the above table to hourly cost, is US$91/h, while the reduction in the cost of soft water is US$171/h, so that if the power consumption is less than that difference (US$80/h, corresponding to 1,333 KWH/h), there is merit for using seawater for cooling.

(3) If the finished grade of the Complex site is assumed to be 0 m above sea level, and the distance for seawater transportation is assumed to be 2 km, and power consumption is calculated on that basis, it is found to be 1,236 KWH/h, which is about 100 KWH/h lower than the marginal power consumption of 1,333 KWH/h calculated above. In cost calculation, a 100 KWH/h corresponds to about US$6/h. Moreover, the annual cost is attained by multipling US$6/h by annual operation hours, and then the cost can be converted to a construction cost by dividing by 0.1. (Annual cost is postulated to be 10% of construction cost.) Eventually, power cost of 100 KWH/h will be equivalent to about US$500,000 in construction cost. Consequently, if it is possible to prepare the site of the Complex at sea level elevation, it is possible to attain some economies for using seawater. However, in the case of this Project, such economic benefit cannot be expected.

(4) As may be seen above, in this Project, the cost merit cannot be obtained by the use of seawater for cooling, and it will be necessary to use soft water for the cooling. Even if the volume of seawater used is low, because of the cost of constructing intake and transportation facilities, the unit cost of the seawater would be high, and the economics of the Project would suffer.

(5) Use of air cooling deserves study if its use will reduce the soft water requirement. However, the air cooling cannot entirely eliminate the need for soft water, and for evaluation of the net result of reduced water use and increased construction cost, it

is necessary to develop the optimum cooling system design. It is recommended that this be fully studied before the implementation stage, and at the time of tendering.

## Table AIV-6 COMPARISON OF CASE STUDIES FOR SEAWATER INTAKE AND DISCHARGE

| | Construction | Merits | Demerits | Overall Evaluation |
|---|---|---|---|---|
| INTAKE CASE 1. | 1. Burying steel pipeline with a length of 3.3 km.<br>2. Construction of intake pump station.<br>3. Dredging work at the suction of the intake pump. | 1. Greater part of delivery pipe length follows Tg. Kidurong road.<br>2. Adequate land is available at side of road. Slope to site is moderate. | 1. Cooperation of MLNG must be obtained in order to obtain site for pump, etc.<br>2. Because the area of the pump will be in the LNG Pier Security Area, construction in this Area must be completed before LNG Pier operations begin. | Need exists for cooperation of MLNG and coordination with MLNG's construction schedule. |
| INTAKE CASE 2. | 1. Burying steel pipeline with a length of 2.2 km.<br>2. Construction of intake pump station.<br>3. Dredging work at the suction of the intake pump. | 1. Greater part of delivery pipe length follows Tg. Kidurong road.<br>2. Adequate land is availabe at side of road. Slope to site is moderate. | 1. To obtain required depth for intake, considerable dredging is necessary about 0.7 km length from the intake pump station.<br>2. Because the area of the pump will be in the LNG Pier Security Area, construction in this Area must be completed before LNG Pier operations begin. | Need exists for coordination with MLNG's construction schedule. |
| INTAKE CASE 3. | 1. Burying steel pipeline with a length of 4.2 km.<br>2. Construction of intake pump station (piling foundation).<br>3. Expansion of width of the earth dike for the pipeline route.<br>4. Crossing the river Plan Besar. | 1. Construction can be made outside of the LNG Security Area.<br>2. Intake mouth will be at suitable depth without dredging work.<br>3. The earth dike of the South Disposal Area can be used as a road for construction. | 1. Total length of pipeline is great.<br>2. Intake pump station requires piling foundation.<br>3. Construction of a bridge across the river Plan Besar will be necessary.<br>4. Measures related to setting of pipeline are needed. | Although construction would not be influenced by other construction work, the extent of construction required is great. |
| DISCHARGE CASE 4. | 1. Construction of box culvert with a length of 0.5 km.<br>2. Construction of a discharge mouth. | 1. Length of discharge channel is minimized.<br>2. Common-use of discharge channel with drainage ditch for the Complex is possible. | Because the water is at about 40°C, some influence is expected to be imparted to the river Plan Besar and ocean. | Close attention is needed to insure that there would be no adverse influence of the high discharge water temperature at a intake point which will be finally selected. |
| DISCHARGE CASE 5. | 1. Burying a steel pipeline with a length of 3.8 km.<br>2. Crossing the river Plan Besar.<br>3. Construction of a discharge mouth. | 1. Construction can be made outside of the LNG Security Area.<br>2. Influences by hot water discharging will be minimized. | 1. Total length of pipeline is great.<br>2. Need to exercise caution so that there is no interference with future expansion of the South Disposal Area.<br>3. Need to construct a bridge. | Although construction would not be influenced by port construction work and LNG Security Area, the extent of construction required is great. |
| DISCHARGE CASE 6. | 1. Burying a steel pipeline with a length of 1.8 km.<br>2. Construction of a intermediate tank and pump.<br>3. Consturction of a discharge mouth | Because discharge is in outer waters of sea, any influence by hot water discharge is not expected. | 1. As the pipeline is crossed LNG plant site, cooperation of MLNG is needed.<br>2. Because a pipe must traverse an area higher in elevation than the Complex site, intermediate storage and pumping is needed. | Coordination with MLNG's construction schedule, and cooperation by MLNG for both construction and operation is required. |

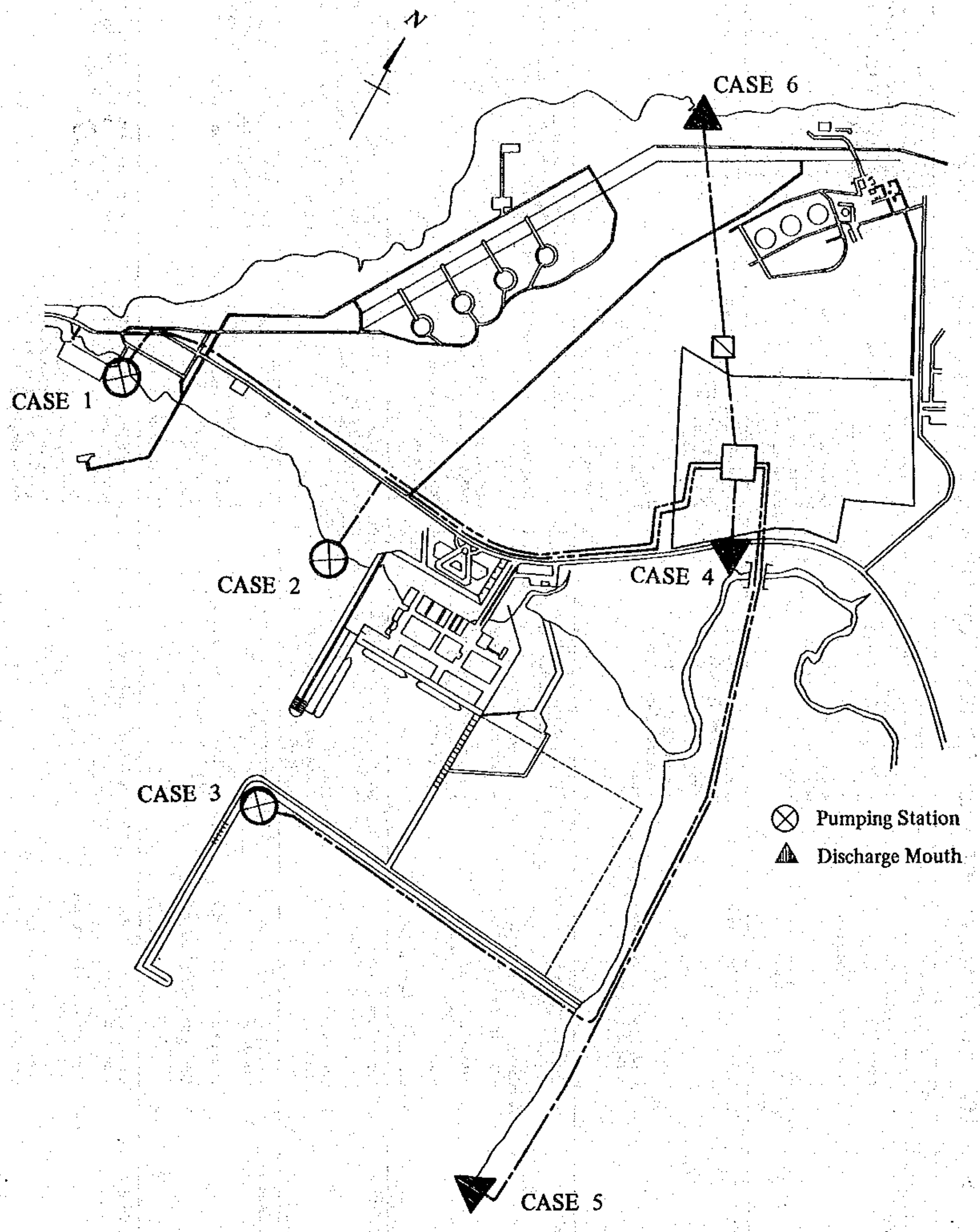



**Fig. AIV-15 WATER INTAKE CASE STUDY MAP**

# SUPPLEMENT

# 1 INTRODUCTION

A number of measures related to the marketing and distribution of products must be taken for the smooth implementation of this Project. Some measures are already being realized by the executing agency and while it is believed that the remaining measures too will be taken, the Evaluation Study Team, for purposes of confirmation, presents in the folloiwng pages its observations and recommendations concerning marketing and distribution aspects of this Project.

## 2. PRESENT CONDITIONS OF THE FERTILIZER DISTRIBUTION SYSTEM IN MALAYSIA

### 2-1 Structure of the Market, and Distribution Mechanism

In contrast to most other developing countries where the distribution of fertilizer is under the overall control of a state agency or public corporation, in Malaysia basically the distribution function is provided by the private sector. As a consequence of inter-firm competition at each stage of distribution, the arrangements for distribution are relatively well organized, and in general the price is formed at what may be considered suitable levels.

Within this distribution system for several years there has been continued increase in the quantity of fertilizer (or its share in total fertilizer distribution) provided by the government or governmental agencies as part of their efforts at implementing schemes in accordance with agricultural policies intended to increase farm household income.

The end-users of fertilizer may be categorized into several groups according to the nature of their farm management, and there is a different fertilizer distribution mechanism for each type, viz.:

(i) Large-scale estates: Estate operators designate agencies responsible for purchases of all agricultural materials and supplies, and these agencies make purchases directly from importers or distributors.

(ii) Government schemes, or farmers participating in government schemes: Either the government organization managing a scheme makes purchases directly and supplies fertilizer to the scheme and farmers, or purchases are made through governmental procurement agencies from distributors who participate in bidding for the contract, and fertilizer is then supplied to the scheme and farmers.

(iii) Small-scale estates, and farmers not participating in schemes: Purchases are made from local dealers and retailers. There are dealers and retailers who are a part of importer's or distributor's networks, and other dealers and retailers who are to some extent independent businessmen.

The distribution mechanism presents fundamentally the same in West Malaysia, Sabah and Sarawak (see Fig. 1).

The number of importers and distributors is not known, but it can be noted that there are seven major importers each of which covers the entire country with their marketing networks, and more than ten importers/distributors each of who covers selected regions. (The number of such firms varied according to the source of information given to the Evaluation Study Team.)

It is estimated that the major importers handle more than 90% of total imports, and of them ICI markets more than half of the total volume which is distributed.

The estate group agencies (also called "agency houses") have 40 to 50 estates under their umbrellas, and purchase fertilizer for the member estates from distributors.

In the case of the large estates, there are some which buy directly from distributors.

There are the following two types of fertilizer supply in relation to government scheme:

(i) Land development and replanting schemes:

These include FELDA, FELCRA, RISDA and many other state land development schemes. It is mandatory for the participants to follow recommendations for fertilizer application at the following stages of respective schemes: That is, in the case of the land development schemes, the development phase at which the scheme is managed by the government agency itself, or at the phase at which the farmers have not repaid their loans yet, and in the case of replanting schemes, the phase at which replanting grants are being provided. It is because of this reason that all fertilizer is bought by the agencies by competitive bidding, and distributed through their regional and branch offices.

(ii) Smallholder schemes (mostly for growing padi):

To the smallholders growing padi, for promoting use of fertilizer, subsidies for fertilizer purchases are provided. This type of subsidies is undertaken by consortia which, under the supervision of the Ministry of Agriculture, are formed by farmers associations, KPM, MADA, KADA and other institutes which implement scheme programs. In this case, fertilizer is purchased by state-level farmers' associations from distributors through competitive bidding and delivered through village level outlets to their participating or member farmers, as well as non-member farmers in their respective regions.

Fertilizers to be supplied to tobacco growers are mostly purchased by the National Tobacco Board, through competitive bidding, and distributed to the growers. In some instances, tobacco growers receive the fertilizer through the village level outlet of the farmers' associations.

Dealers, scattered in all regions of the country, are engaged in selling fertilizer to small-scale estates and smallholders who do not participate in the above schemes and arrangements. While there are some dealers who are under the umbrella of one or another distributor, most of them are independent, and buy from whatever distributor is best at that given time. Dealers are located in most major towns. The large-scale dealers have sub-dealers (also called "stockists") under them, at the village level.

## 2-2 Distribution System

### (1) Warehouses

Inventory of fertilizer in Malaysia is mostly stocked by importers, who use public and private warehouses. The majority of these warehouses are located in Port Kelang, Butterworth, Malacca, Johore Baru, Kulai, Kota Kinabalu, and Kuching, in addition to which warehouses in Singapore are also used. At the present time, there are no apparent shortages of warehouse space.

Warehouses owned by retailers and the branch or field offices of scheme agencies are in a small storage capacity (about 25 to 50 tons or less). The general practice is for fertilizer to be delivered directly to farmers from importer's warehouses.

Up to the present time, there was no need for a large capacity of warehouses at retail level, because most consumption of fertilizer was by estates and government schemes, it was relatively easy for importers to predict fertilizer requirements in each season, and therefore they could deliver fertilizer to those consumers in time even without inland depots. Hereafter, however, with the increase in fertilizer use by smallholders, and the increased difficulty it creates in anticipating each season's fertilizer requirements, it will become necessary to increase storage capacity at retail level.

Retailers are relatively evenly distributed in the west coast region of West Malaysia, but in East Malaysia as well as the east coast region of West Malaysia, they are present only in scattered locations. Although farmers' associations are formed with the purpose of overcoming the problem of remote farmers' being poorly serviced by private retailers, they confront the same economic problem posed by the remote locations as do private retailers.

(2) Bagging

Fertilizer is imported in bag or in bulk. Since it is generally less costly to import fertilizer in bulk and fill bags at the port, much of Malaysia's imports of urea is imported in that way. Imported urea are bagged at port warehouse, immediately after landing, and then stored.

Materials of the bags used are either paper bag, polyethylene film bag or polypropylene woven bag with an inner bag.

The size of the bags used varies. In East Malaysia 50 kg bags are most common, and in West Malaysia 20 - 25 kg bags are commonly used for urea, and 40 kg bags including the weight of bag are used for compound fertilizer, as well as 50 kg bags. Farmers often complain that 50 kg bags are too heavy.

(3) Transportation

The most common means of transporting fertilizer is by truck. Railway transport is sometimes used between major depot centers. In Sarawak, coastal and/or river boats are also used.

In West Malaysia, the road network is well developed and no difficulties are encountered in transporting fertilizer by truck.

However, the final step of transporting fertilizer from the delivery point at the village to the users' farms is primarily by motorbicycle or bicycle, so that it is often difficult to transport large quantities, and this serves to discourage farmers from using fertilizer.

Because the road networks in Sabah and Sarawak are not well developed, inconvenience and difficulty are encountered in transporting fertilizer. Fertilizer cost is increased by this condition, and the result is a restraint on growth of fertilizer use.

## 2-3 System for Research on Methods and Techniques of Fertilizer Use, and Related Extension Activities

Estates either have their own fertilizer specialist, or can avail themselves of the services of agriculture consultants, so the level of both knowledge and use of fertilizer techniques in general is high. Therefore, the purpose of the government's study and extension activities regarding techniques for applying fertilizer is primarily oriented toward the smallholders.

Research and study are performed by RRIM in the case of rubber, and MARDI in the case of other crops. Efforts related to rubber and oil palm are often conducted with cooperation provided by specialists from the estates, who have extensive experience.

Extension work is performed by a number of agencies. RISDA is concerned with rubber, FELDA is concerned with oil palm, and the Department of Agriculture is concerned with other crops. At present the number of extension workers belonging to the Department of Agriculture, on the average, is rated at one person for 2,000 farms. They visit groups of farmers, each group being composed of about 50 farmers, about once every two weeks. The Department plans to increase the number of extension workers to the extent that each worker will be responsible for about 800 farms.

## 2-4 Fertilizer Purchase Subsidies and Financing

The smallholders except for those who are recipients of institutional finance and subsidies described below, show a considerably high degree of reliance on loans or credit from local money lenders, middlemen, food retailers and others, for their living expenses and farm management expenses, including the cost of fertilizer.

The fertilizer purchase subsidies and institutional financing available are as follows:

(i) Farmers participating in land development schemes: Differences are observed depending on the type of scheme, but in the case of FELDA, which is the largest scheme, long-term loans can be obtained from FELDA for land development, farm management, and household expenses.

(ii) Replanting subsidy: In the case of the rubber replanting scheme, which is the largest replanting scheme, for the years up to the time that replanted crops start to yield, when the replanting replaces old rubber with rubber or designated other crops, farmers are provided a grant totalling M$1,200 per acre. In the case of replanting of rubber, a total of M$1,200 per acre is provided over a period of six years, and the payment for fertilizer, in the same manner as farm operating costs, is deducted from this money and the remainder of the subsidy is given to the farmer in cash. The payment of grants is done year by year on the basis of investigation to insure that fertilizer application was properly performed.

The same arrangement is used in the case of the replanting and rehabilitation subsidy scheme, for pineapple.

(iii) Agricultural input diversification program: Grants, to the extent of M$1,000 per acre, are provided for encouragement of use of agricultural inputs on maize, groundnut, tobacco, fruit trees, cocoa and coconut. Arrangements resemble those of the replanting and rehabilitation scheme and the implementing agency is the Department of Agriculture. The money is provided with the objective of improving productivity through facilitating the acquisition of machines and tools, fertilizer, and agricultural chemicals, as well as the improvement of irrigation systems.

(iv) National fertilizer subsidy scheme: For farmers growing padi, a subsidy of M$60 per acre per year with the upper limit of the acreage per household being 6 acres, is paid. The agency implementing this scheme is the Department of Agriculture; the Farmers Organization Authority is in charge, and at the farmers level, farmers associations participate in implementation. This scheme has been implemented since 1979, for West Malaysia.

In the case of Sabah, the Padi Board is the means of implementing the scheme and the subsidy has been provided for 60% (in the main season) to 80% (in the off-season) of fertilizer costs for the irrigated area in which padi is grown. Here the scheme has been implemented since fiscal 1979.

(v) Short-term tobacco production and marketing scheme: Tobacco growers can borrow funds for purchase of equipment, materials and supplies, and repay the loan by having it deducted from payment received for tobacco. The National Tobacco Board is implementing this scheme.

Thus, a considerable number of programs are being implemented for the provision of subsidies and loans for a number of crops, and considerable progress has been made in facilitating the purchase of fertilizer. In particular it is believed that the increase in the amounts of replanting grants, and the considerable increase in subsidies for padi, will have strong impact on promotion of fertilizer use.

Nevertheless, the Evaluation Study Team notes that the following problems may be identified.

(i) For farmers participating in a replanting scheme, there are no credit facilities after the replanted crop begins to yield, and they must secure required funds or credit by their own means.

(ii) For farmers who are not participating in schemes, farmers associations or farmers cooperatives are the vehicle through which subsidies may be obtained, but in regions where there are no such organizations, farmers cannot obtain subsidies.

With regard to the amounts available as subsidies, in view of present fertilizer prices, they may be said to be adequate, but in the event that fertilizer prices rise in the future, or there is a significant increase in fertilizer use, it will be necessary to increase the subsidies accordingly, in order that the effects of the program are not diluted.

# 3. RECOMMENDATIONS FOR MARKETING SYSTEM, FOR FERTILIZER PRODUCED BY THE COMPLEX

## 3-1 Bagging, Warehousing and Transportation System

### 3-1-1 Bagging

A large part of the urea produced at the Complex will be shipped in bulk. The remainder has to be bagged in Bintulu, and it will be necessary to have bagging facilities in Bintulu. However, in order to select the scale of bagging facilities to be installed in Bintulu, it is necessary to study in more detail in regard to the following:

(i) Export volume by destination for the ASEAN region: According to the agreement made by the ASEAN Economic Ministers, import demand for urea in the ASEAN region, except for Malaysia and Indonesia, is to be satisfied in equal shares by the products of the present Project in Malaysia, and the project in Indonesia. However, in order to economize transportation cost, the question of how much quantities and to which destinations by each country are exported, should be examined. Therefore the decision on the scale of bagging facilities has to be concluded after the quantities to be exported to the Philippines and Thailand are defined in more concrete.

(ii) Ascertaining the desires of importing countries to receive bulk shipments: In the Philippines at the present time the importation of urea in bulk form is increasing. Therefore, it is feared that it would be unnecessarily dangerous to have to decide at the present time without detailed negotiations with the Philippines as to what percentage of urea should be exported in bags.

In West Malaysia and Sabah, the majority of urea is imported in bulk and bulk cargo handling facilities in ports there are being expanded. Therefore, it is recommendable to transport urea in bulk to West Malaysia and Sabah, from the standpoint of rationalization of transportation. It is also recommended to investigate the possibility of bulk transport for Sarawak (refer to Attachment I).

### 3-1-2 Receiving warehouse facilities in Malaysian ports

(1) Urea

The present needs are met by public pierside warehouses and distributors' warehouses. However, not only is it necessary for warehouses to be expanded so as to meet increasing demands, but also inventory control for urea should be done well in order to ensure timely delivery of urea to farmers, since after commencing commercial operation of the Complex the inventory would be maintained by only one company, whereas in the past many importers have competed in maintaining warehouse stocks.

(2) Ammonia

(i) Butterworth: FFC is now constructing facilities there which enable to receive aqua ammonia directly from tankers through a pipeline. It is possible to convert these facilities for the receiving of liquid ammonia, so there is no need to construct a portside tank for receiving the liquid ammonia shipped from the Complex.

(ii) Port Dickson: It will be possible to use the existing liquid ammonia unloading facilities. However, it will be necessary for a small-scale aqua ammonia production facility to be built to satisfy the needs of users of that form of ammonia.

### 3-1-3 Transport system

(1) Urea transport

Urea from the Complex will replace imported urea. Therefore, in West Malaysia, it is economical to utilize existing transportation system for the time being, and to expand the transportation system along with the increase in the volume transported in the future.

In view of rationalization of handling and transportation, it will be desirable to build urea bulk carriers for use for marine transport from Bintulu to the Peninsula and exports, in case that the proportion of bulk transport is large against the total volume transported (for details see Attachment I).

(2) Ammonia transport

Given the sales volume anticipated, it is not economical to have a liquid ammonia tanker for exclusive use. However, it seems hard to secure a chartered ship for transport of liquid ammonia at present in the Southeast Asian region. It is recommended to make a conclusion concerning this point after detailed examination on the availability of the chartered ship.

When the volume to be shipped increases, it will be necessary to have a liquid ammonia tanker in view both of rationalization of transport and of reduction of transportation cost (for detail see Attachment II).

**3-2 Recommendations Concerning the Marketing System**

PETRONAS Project Team plans to establish a new marketing company to be engaged in marketing of the Complex's products in Malaysia. On the presumption that this is the arrangement used, it is desirable that there be study and investigation of the following points related to the marketing plan.

(i) The new company, or the organization to prepare for it, should be established, and marketing policies and systems should be determined, at the earliest possible time.

In particular it is important that function of the organization be determined by discussion with various organizations and agencies in the field of agriculture.

(ii) There should be test marketing, and a check of problems which may arise in connection with marketing, to insure that actual marketing and transportation can be accomplished properly.

In order to obtain greater assurance that urea can be marketed as intended, it is desirable that attention be given to the following:

(i) Use of NPK fertilizer in Malaysia is increasing; therefore, in order to increase the demand for urea accordingly steps must be taken to insure that there will be an increase in the use of urea as raw material for NPK fertilizer in Malaysia. However, at present there is a large gap between the quality of domestically-produced mixed fertilizer and complex fertilizer (domestically-produced and imported), and despite a differential in price, farmers prefer to use complex fertilizer. Since at present there is no complex fertilizer plant in Malaysia which can use urea, urea as raw material for NPK fertilizer is demanded only by the mixtures. Therefore, it is desirable that study be made of the possibility of improving the level of quality of mixed fertilizer, as well as the possibility of new construction of a bulk blending plant or a plant which can use urea to make complex fertilizer.

(ii) At present, neither urea as straight fertilizer nor urea as part of NPK fertilizer is being used for rubber or inland-region oil palm. The reason for this is the farmers' anxiety over volatilization loss. The RRIM is experimenting with development of rubber-coated urea as a means of remedying this defect, and has reported good result of its trials. It is desirable to study the costs of making this, as well as other types of coated urea. Such a study is even more significant in view of the present circumstances, namely, that the price per unit nitrogen content is fairly higher for ammonium sulphate and ammonium nitrate than for urea.

(iii) The greater part of Malaysian demand for urea is in West Malaysia. If the cost of transporting urea from Bintulu to the Peninsula can be reduced, it will be possible to lower the domestic cost of urea in Malaysia. In this connection, the urea plant of the ASEAN (Aceh) Fertilizer Project in Indonesia is geographically close to the Malaysian Peninsula. Therefore, if there is a swap of urea produced at the Aceh plant for that produced at Bintulu, it certainly will be possible to reduce the cost of transportation between Bintulu and the Peninsula.

The following measures may be recommended to the Malaysian Government not merely as issues pertinent to this Project but as subjects vital to the promotion of use of proper fertilizing practices in the entire country:

(i) Need exists to obtain and have at all times an accurate grasp of the actual conditions of production, distribution and consumption of fertilizer. There are no official statistics at all in Malaysia concerning fertilizer, making it extremely difficult to gain an accurate understanding of what present conditions and trends are in relation to imports, exports, production, marketing and distribution, and consumption. There has not yet been preparation of a compendium of information on a national basis with regard to fertilizer application practice, and of the effects (i.e., economic effects) of fertilizer use. Such data, however, is indispensable for the reliable formulation of policy regarding fertilizer. At the present time work is proceeding for compilation of agriculture-related data. It is believed by the Evaluation Study Team that compilation of data related to fertilizer and establishment of the foundation for continued collection and tabulation of data is also a subject of extremely high priority.

(ii) The system for transportation of fertilizer is in good condition, but this may not be said with regard to transport of fertilizer from dealers or farmers associations to the individual farmers. This is a reason many farmers refrain from the use of fertilizer. It is necessary to study this problem and make improvements, which can be in such forms as either increasing the number of outlets at village level or providing the suitable transportation facilities at this level.

(iii) Measures for the supply of funds for the purchase of fertilizer have continued to be improved. However, when a smallholder's rubber becomes mature, there seem to be almost no sources of public funds he can use. Improvement of this situation is desirable.

PETRONAS Project Team intends to facilitate and promote establishment of a system for marketing and distribution for the new marketing company on the basis of use of the services of an experienced consultant, and, for this end, to carry out a detailed study on marketing and distribution. Given the present situation as such, further views should be derived from the outcome of the contemplated study. Nevertheless major aspects which the Evaluation Study Team noted, as the result of its present observation, as those to be examined in the course of the above-mentioned marketing and distribution study, are as follows:

(1) Major problems to be given attention in examining organization and systems for domestic marketing and distribution of urea.

(i) Destination points to which the marketing company will have to deliver its urea (to be determined by each region and major consumer).

(ii) Effective manner of organizing existing importers, distributors, retailers and farmers cooperatives with a view to utilizing them as marketing and distribution channels; establishment of commercial arrangements with these enterprises.

(iii) Organizing of extension activities (premarketing, demonstration farms, organizing of extension workers, co-work with related governmental agencies) for use of urea (including urea mixed fertilizer) on farms.

(iv) Establishment of governmental support systems for promoting increased use of urea (including urea mixed fertilizer).

(v) Establishment of a system for providing technical and managerial assistance to mixed fertilizer manufacturers, in order to improve their production technology and the quality of urea mixed fertilizer; study of the possibility of the marketing company's establishing urea mixing plants.

(vi) The method of maritime transport from the Complex's port to major ports of destination (encompassing bulk and bagged shipment; use of ordinary commercial ships, company-owned ships or chartered ships).

(vii) Plans for bagging facilities (location, scale, system used).

(viii) Methods of inland transportation (especially at the level of transportation to end-users).

(ix) The need for company-owned warehouses (at each stage of distribution), and construction and operation plans.

(x) Overall organizational development, manning and training program for operation of marketing and distribution activities.

(2) Major problems to be given attention in examining establishment of organization for export of urea.

(i) Establishment of a system for collection and processing of market information related to export trade.

(ii) Methods of using and choosing export firms (domestic and foreign firms).

(iii) Opening of agencies in major importer countries.

(iv) Setting up a system for bidding and filling orders.

(v) Setting up a system for ship operation control and shipments control.

(3) Major problems to be given attention in examining organization and systems for marketing and distribution of ammonia.

(i) Arranging in advance for sales to users and negotiating long-term supply contracts.

(ii) Study of the means of maritime transport from the Complex's port to major ports of destination (chartered vessels or vessels owned by the company; new ships or used ships), and transport planning.

(iii) Planning for unloading and storage facilities in ports of destination (including the study of the possibility of using existing facilities).

(iv) Study of inland transportation from the ports of arrival to end-users (including use of railroads and tank lorries).

(v) Investigation of arranging for use of ammonia by compound fertilizer factory to be newly established or expanded for the purpose.

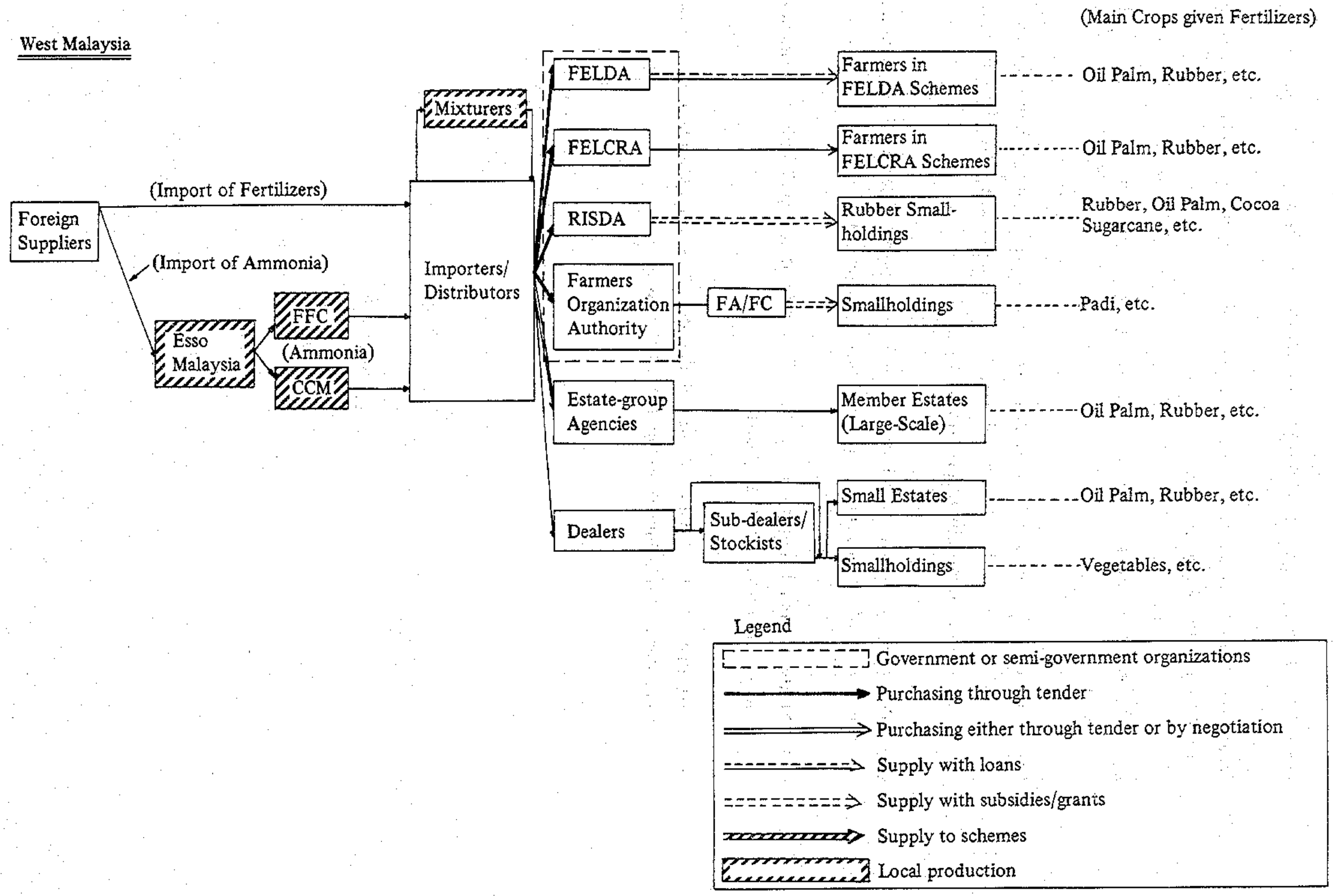
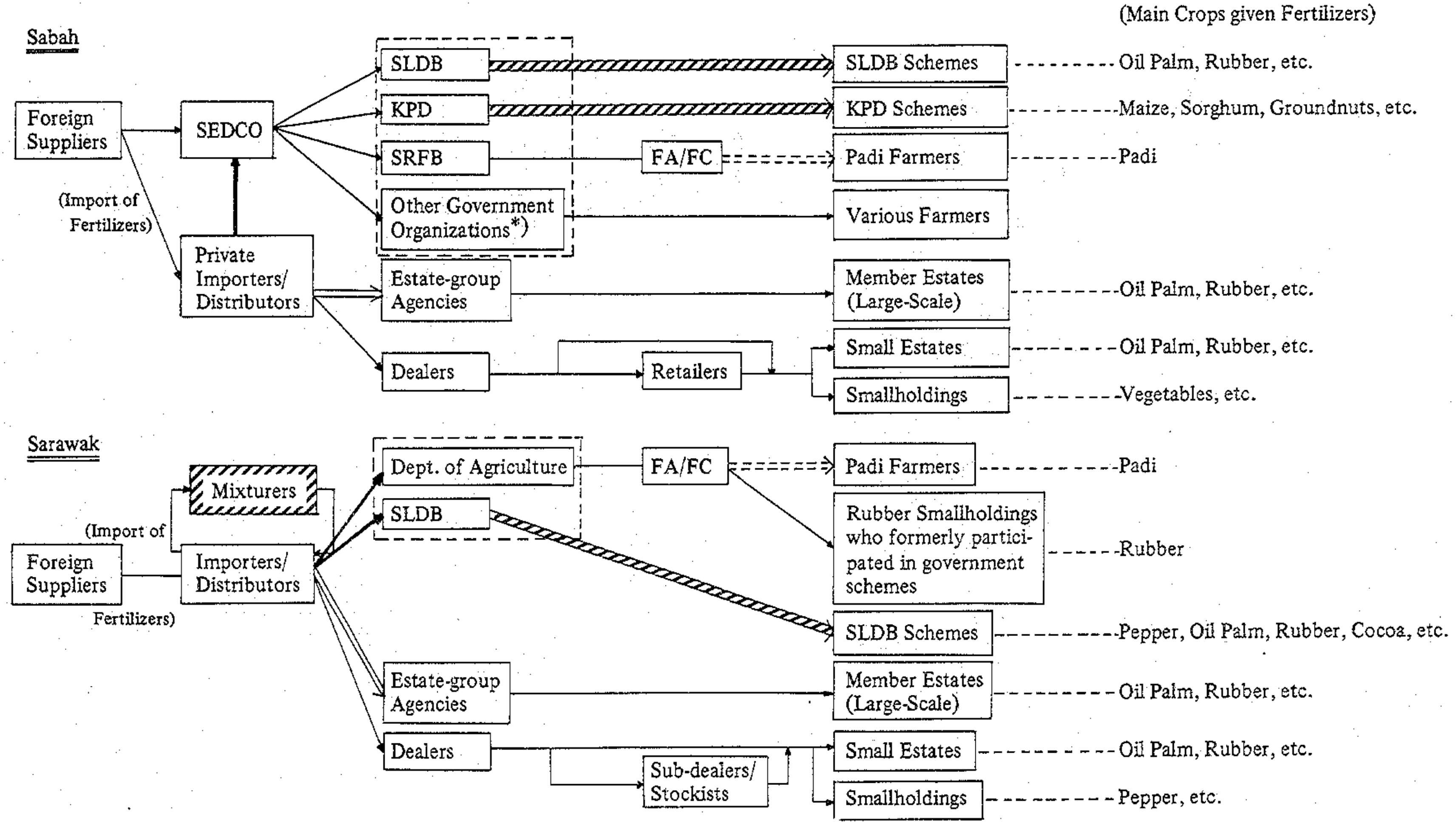



Fig. 1 FERTILIZER DISTRIBUTION FLOW CHART IN MALAYSIA (1)




Note: *) Dept. of Agriculture ........... Various Smallholdings Research Stations
Dept. of Animal Husbandry ...... Pasture
Ministry of Culture and Sports .... Agricultural Training
SAFODA .................. Forest Rehabilitation

Fig. 1 FERTILIZER DISTRIBUTION FLOW CHART IN MALAYSIA (2)

**A T T A C H M E N T**

# ATTACHMENT I STUDY OF THE METHODS OF TRANSPORTING UREA

## I-1 Introduction

(1) Inland and coastal transportation in Malaysia is being performed by use of truck, railroads, river boat, and coastal vessels, and with the exception of some remote parts of Sarawak the various modes of transportation are functioning adequately. Because urea produced by the Complex will have the nature of substituting for imports of urea, it is desirable to use these existing modes for transport of that urea, and to expand their capacity at such times and places as required by future growth of urea shipments in keeping with the expansion of demand.

(2) Therefore, the investigation is made with regard to the method of transporting urea from Bintulu to the ports where imported urea is unloaded.

## I-2 Present Conditions Regarding Unloading of Imported Urea

(1) In West Malaysia most imported urea is landed at Port Kelang and Butterworth. Most of imported urea is in a bulk form, which is transported from alongside to pierside public warehouses by truck. The first three days of storage in these warehouses are free of charge, and during this three-days period the importers bag their urea, using simple bagging equipment which they own by themselves. The bagged urea is then transported to warehouses near the port, for storage. An example of costs of unloading, bagging and transporting urea are given in Table A-1.

(2) While the bulk urea is presently transported by truck, bulk unloading facilities are presently being built at Butterworth and when they have been completed it is expected that the cost of landing bulk urea there will be reduced by about 20% from the present cost.

(3) Public pierside warehouses have been completed or are under construction in Butterworth, Port Kelang, Pasir Gudang and Kuantan, and it is thought that even after the volume of urea handled increases in the future, there will be adequate storage capacity available for use.

(4) Imports for Sabah and Sarawak are unloaded at Kuching and Kota Kinabalu with most of them being shipped via Singapore. Kota Kinabalu has facilities to receive bulk urea, while Kuching is receiving only bagged urea.

## I-3 Study of the Method of Transporting Urea

(1) Two cases have been postulated for the purpose of studying the method of transporting urea, via the following table:

| Case | Within Malaysia | | | To the ASEAN Region | | | Outside the ASEAN region |
|---|---|---|---|---|---|---|---|
| | West Malaysia | Sabah | Sarawak | Philippines | Thailand | Singapore | |
| Case 1 | Shipped in bulk; bagged at port of arrival | Shipped in bulk; bagged at port of arrival | Shipped in bags | 70% shipped in bulk; 30% shipped in bags | Shipped in bags | Shipped in bulk | Shipped in bulk |
| Case 2 | Shipped in bags | Shipped in bags | Shipped in bags | 70% shipped in bulk; 30% shipped in bags | Shipped in bags | Shipped in bulk | Shipped in bulk |

(2) The difference in freight cost per ton, between Case 1 and Case 2, was calculated first. The assumptions and results of the calculation are shown in Table A-2. Because at present there is no cargo movements originated in Bintulu, no information for freight of commercial vessels is available, so an estimation was made of the cost of freight for bulk and bagged urea assuming a newly built ship.

Because the destinations of exports are not specified yet, it is assumed for the sake of these calculations that the destinations are assumed to be as follows:

| | |
|---|---|
| Domestic destinations: | all to West Malaysia |
| ASEAN region destinations: | all to the Philippines |
| Outside the ASEAN region: | all to India |

The annual volumes of urea transported to these destinations are assumed to be as shown in Table A-2.

(3) In comparison of Case 1 and Case 2, a large difference in cost is caused by a difference in freight cost for West Malaysia. Whereas the freight cost for West Malaysia in Case 1 is US$24/ton, it is US$39/ton in Case 2. The weighted average of freight cost for the entire volume of urea transported is US$32.4/ton in Case 1 and US$36.8/ton in Case 2. Therefore, from the viewpoint of freight cost alone, Case 1, in which bulk transport is of provement importance, is the more desirable of the two.

(4) Regarding bag cost, if prices for bags in Bintulu are the same as prices in West Malaysia, there is no difference between the two cases with regard to the cost of bag. However, if it is presumed that the bags are purchased in West Malaysia, Case 1 becomes the more advantageous, to the extent of the cost of shipping the bags from West Malaysia to Bintulu.

(5) Regarding the costs of bagging urea and handling charges at loading/unloading ports for the two cases, compared results are as follows:

(US$/ton)

| | | Case 1 (Bagged in port of arrival) | Case 2 (Bagged in Bintulu) |
|---|---|---|---|
| Bintulu: | Bagging and shipping costs at plant warehouse (Excluding cost of bags) | 1.1 | 2.3 |
| | Handling charges at port | 7.2 | 11.9 |
| | Total | 8.3 | 14.2 |
| West Malaysia: | Bagging charges | 2.1 | - |
| | Handling & transport charges | 15.7 | 17.3 |
| | Total | 17.8 | 17.3 |
| Grand Total | | 26.1 | 31.5 |

Thus, Case 1, in which urea is transported in bulk, is cheaper by US$5.4/ton.

## I-4 Conclusion

(1) As indicated above, as a result of the study of transportation/handling costs for two cases, it is found that Case 1, in which urea is mostly transported in bulk, is the more desirable.

(2) At present, imported urea is received in bulk form in West Malaysia, and if urea from Bintulu will be shipped in bulk, the existing facilities now used for imported urea can be used. Furthermore, when a bulk terminal is constructed as part of an effort to improve public facilities in Butterworth and other Malaysian ports, it will become even more advantageous to use bulk shipments.

(3) Further, in the case of exports, it is assumed above that 30% urea bound for the Philippines is bagged, but the Philippines is likely to continue the present effort to increase the proportion of bulk urea in their imports, and from this viewpoint it is thought that bulk shipment may be desirable.

(4) It is desirable to study the question of what type and scale of carrier is best for transporting bulk urea, at a later time when the destination and quantities to be shipped are specified. For one of examples, it may be mentioned that the pierside draught in Manila port is only 10 feets, so the present operation there is such that bulk urea is transhipped to barges from ocean-going bulk carriers in the port. Thus, this operation limits the extent of efficient utilization of the existing bulk receiving facilities. Because of this, this future study must also take into consideration the possibility of the use of barge type bulk carriers.

(5) According to the agreement made by the ASEAN Economic Ministers, the ASEAN Urea Project (Malaysia), in conjunction with the ASEAN urea project (Indonesia) shall take into consideration the possibility of supplying urea to ASEAN member countries in a manner that would enable the two projects and purchasing ASEAN member countries to benefit from the most-efficient supply and transport arrangements of urea without altering the agreed market sharing arrangements. Therefore, the destinations for shipments of urea from Malaysia to the other ASEAN countries cannot be known yet. And therefore the detailed study of transportation method of urea must be done after the determination of export destination of urea.

**Table A-1 HANDLING CHARGES AT PENANG PORT CIFFO[1] BULK TO FOL[2] BAGGED**
**(All on per ton basis)**

| | Privates Godown | Government Warehouse |
|---|---|---|
| **Customs Charges** | | |
| Customs Duty & Overtime | at Cost | at Cost |
| **PPC[3] Charges** | | |
| 1. Handling Charges | 2.50 | 4.50 |
| 2. Wharfage | 1.50 or | 1.50 or |
| (Whichever is greater) | $\frac{GRT}{100} \times 0.80$ | $\frac{GRT}{100} \times 0.80$ |
| 3. General Charges | 1.20 | 1.20 |
| 4. Weighbridge charges & PPC Clerical charges | 0.85 | 0.85 |
| | M$ 6.05 | M$ 8.05 |
| **Contractors Charges** | | |
| 1. Agency Fees | 2.00 | 2.00 |
| 2. Stevedoring | 6.50 | 6.50 |
| 3. Cargo Handling & Sweeping (Wharf) | 1.50 | 1.50 |
| 4. Tally Clerk (Wharf & Vessel) | 1.00 | 1.00 |
| 5. Hire of Grabs, Trimming (Vessel) | 1.50 | 1.50 |
| 6. Transport (Vessel to Godown) | 2.40 | 2.40 |
| 7. Bagging Charges, Stacking, Supply of stitching machines/ thread & weighing machines | 6.95 | 6.95 |
| 8. Hire of Excavator | 0.60 | 0.60 |
| 9. Outward Delivery (excluding stacking on lorries) | 1.80 | 1.80 |
| 10. Tally at Godown | Nil | 1.20 |
| | 24.25 | 25.45 |
| | M$ 30.30 | M$ 33.50 |

Notes: 1) Cost, insurance, and freight, free out
2) Free on lorry
3) Penang Port Committee

## Table A-2 ESTIMATED FREIGHT RATES FROM BINTULU

| | | Amount to be shipped | | Required numbers of vessels | | Estimated freight rates |
|---|---|---|---|---|---|---|
| Case 1 | Bintulu/Manila | (Bagged) | 108,000 t | | | 42 (US$/t) |
| | | (Bulk) | 140,000 t | Bulk carrier: | 2 | 29 |
| | Bintulu/W. Malaysia | (Bulk) | 160,000 t | Cargo boat: | 2 | 24 |
| | Bintulu/India | (Bulk) | 38,000 t | | | 53 |
| | | Total | 446,000 t | | | Weighted average 32.4 |
| Case 2 | Bintulu/Manila | (Bagged) | 108,000 t | | | 45 |
| | | (Bulk) | 140,000 t | Bulk carrier: | 1 | 25 |
| | Bintulu/W. Malaysia | (Bagged) | 160,000 t | Cargo boat: | 3 | 39 |
| | Bintulu/India | (Bulk) | 38,000 t | | | 46 |
| | | Total | 446,000 t | | | Weighted average 36.7 |

Note: Following are the main specifications of cargo carriers assumed in the above calculations.

| | DWT (LT) | Net carrying capacity (MT) | Service speed (Knots) | Loading/ Discharging Capacity (t/d) | Price of vessel (US$ '000) |
|---|---|---|---|---|---|
| Bulk carrier | 7,500 | 7,000 | 12 | 3,500 | 16,500 |
| Cargo boat | 7,500 | 4,400 | 12 | 950 | 10,800 |

## ATTACHMENT II STUDY ON THE TRANSPORTATION OF AMMONIA

### II-1 Introduction

(1) With the exception of the ammonia consumed at the Complex itself, all ammonia produced by the Project, in principle, is to be sold to domestic West Malaysian users. West Malaysian firms using ammonia (either as liquid ammonia or aqua ammonia), at present purchase it from Esso Malaysia or buy imported ammonia; it is expected that the existing facilities for transportation and storage can be used for ammonia which will be produced in the Complex and landed on the Peninsular. Therefore, this study is concerned only with the method of maritime transportation between Bintulu and West Malaysia.

(2) At present the means available for maritime shipping of ammonia in the Southeast Asian region are quite limited; the following are the methods in use:

(i) Liquid ammonia tankers (in the case of imports from Japan, when special tankers for this particular product are used)

(ii) Liquid ammonia cylinders

(iii) Molasses tankers (for aqua ammonia)

Of these, the cylinders are used for small quantities, and molasses tankers are used only for aqua ammonia. Aqua ammonia contains about 20% ammonia, and the transportation cost per ton of ammonia is higher than in the case of liquid ammonia. From the viewpoint of studying the low-cost transportation of ammonia, the following examinations are limited to the case of transporting liquid ammonia as in (i) above.

(3) At present it is not possible to charter a liquid ammonia tanker in the vicinity of Malaysia. In the future, however, there will be these two possibilities regarding chartering such a tanker.

(i) Long-term charter of an ammonia tanker from Japan.

(ii) In the event that there is significant demand for transportation of ammonia in Indonesia, it is possible that Indonesia will build such a tanker and that it could be made available to Malaysia on a short-term charter basis.

However, in either case it would be necessary to study the possibility of use of a charter ship while paying attention to the development of the situation concerning supply and demand for ammonia in Indonesia and Japan. Nevertheless, in both cases there is too much uncertainty and it is believed that it will be necessary or highly advisable for there to be study of the possibility of owning a tanker for use for this Project.

(4) Below, four cases of transportation of ammonia are compared, in view of the foregoing.

**II-2 Premises and Results of the Study**

(1) The following study uses 1984 prices.

(2) Because the shipment between Bintulu and West Malaysia will be by means of open sea, it is not feasible to use a small vessel.

(3) The four cases which are postulated are as follows:

Case 1: Use of a new ammonia tanker owned for exclusive use. Annual transport volume expected, 11,000 tons. In this case, the rate of utilization of the tanker would be only 32%, so the transportation cost would be high.

Case 2: Use of the new ammonia tanker owned for exclusive use. Annual transport volume expected, 34,500 tons. In this case, full utilization of the tanker would be expected.

Case 3: Use of medium-term charter. (It is hypothetically assumed that a tanker of laden capacity of 800 M/T is used on a 3-months charter basis.) In this case, a tanker is assumed to be chartered from Japan. The number of days needed for bringing the tanker from Japan to Malaysia for operation and bringing it back to Japan, voyage without cargo, and anchoring at ports, must be deducted, and, as a consequence, actually operable days for transporting ammonia would be about 28% and the annual volume of ammonia transported would be 20,800 tons. This low rate of operation would result in high transportation cost.

Case 4: Use of long-term charter (laden capacity, 800 M/T). In this case the tanker is assumed to be chartered for such long period that it would be possible to ignore the days for the voyage from Japan which are included in Case 3. The annual volume which can be transported is 27,600 tons.

(4) The premises and results of the study are summarized in Table A-3.

## II-3 Conclusion

(1) In the event that the annual demand for ammonia transport is as low as 11,000 tons, the transportation cost per ton by the new tanker owned for the Project will be fairly higher than the cost by chartered tanker (comparison of Case 1 and Case 3). Therefore, if it is feasible, it is desirable that the tanker should be chartered.

Because the transportation demand would be low, in the case of chartering a tanker, use would have to be made of medium-term charter. In that case, there will be many days when the ship would be at sea with ballast, as explained above, and the transportation cost per ton will be higher than the case of long-term chartering. Further, since the transportation of ammonia would be concentrated within a relatively short period of time, onshore storage and receiving capacity would have to be increased.

(2) If the transport volume is increased, there is little difference in freight cost between a long-term charter and use of a new tanker owned for the Project (comparison of Case 2 and Case 4). However, there is some doubt as to whether it will be possible to obtain a tanker on a long-term charter. Further, the type of most of tankers now in use in Japan (Case 4), such that which is capable to transport only about 27,000 tons a year and a short or medium-term charter would be needed for any additional volume beyond that.

Therefore, in the event that there is an increase in the volume to be transported, it will be desirable to have a tanker for exclusive use by the Project.

(3) It should be noted that the above study is preliminary in nature, and also because there is likely to be considerable fluctuation in shipbuilding cost as well as charter rates, a more detailed study should be carried out.

## Table A-3 AMMONIA FREIGHT RATE FROM BINTULU TO W. MALAYSIA

| | Specification of the vessels | | | | | | | Days at sea with cargo | Days at sea in ballast | Days at anchor | Shipping capacity per year | Freight rate |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | DWT | Cargo Capacity | Dis-charging Capacity | Service Speed | Number of Crew | Price of Vessel | Con-structed in: | | | | | |
| | M/T | M/T | $m^3$/hr. | Knots | | US$ '000 | | days/year | days/year | days/year | tons/year | US$/ton |
| Case 1 | 1,500 | 1,000 | $200m^3$x2 | 13 | 12 | 4,800 | 1984 | 41 | 41 | 28 | 11,000 | 143 |
| Case 2 | 1,500 | 1,000 | $200m^3$x2 | 13 | 12 | 4,800 | 1984 | 138 | 138 | 69 | 34,500 | 65 |
| Case 3 | 990 | 800 | $160m^3$x2 | 12.7 | 11 | 3,044 | 1979 | 97 | 184 | 64 | 20,800 | 83 |
| Case 4 | 990 | 800 | $160m^3$x2 | 12.7 | 11 | 3,044 | 1979 | 129 | 129 | 87 | 27,600 | 66 |

JICA