PART VII

FINANCIAL EVALUATION

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This Part presents the estimates of costs for producing the products of this Project, i.e., rock salt, soda ash and ammonium chloride; financial projections and analysis as well as the assessment of the Project.

The production cost estimates as well as the financial projections presented and explained in this report are based on the presumption that commercial operation of the rock salt mine and soda ash plant which are the components of the Project is started in July, 1985, and both components have an economic life-span of 15 years after the commencement of commercial operation. [1)]

These estimates and projections are given in terms of 1985 constant price. [2)]

(Notes)

1) The economic life-span of this type of project, in general, is considered to be 12 to 15 years. For this study the Evaluation Study Team has used a 15-year period for the economic life-span.

2) The "1985 constant price" denotes the prices set at a level which is projected as though being prevailing in 1985 and which is deemed to be constant over the project life.

CHAPTER 1 PRODUCTION COSTS

1-1 ANALYSIS OF COSTS FOR ROCK SALT PRODUCED BY THIS PROJECT

1-1-1 Production Cost of Rock Salt

The proposed rock salt mine, as has been stated in Part III, is capable of producing 1.2 million t/y of rock salt by two-shift operation and 1.8 million t/y by three-shift operation. The production cost of rock salt is estimated for two cases, one is the 1.2 million t/y case as the Base Case and the other is the 1.8 million t/y case as an Alternative Case. The results are as summarized in Tables VII-1 and VII-2 below. The costs given here are the ex-mine costs, and do not include the cost of transport. It is noted, however, that the capital costs for the mine which have been used as a basis for the production cost estimates, include the costs for construction of a railway spur for the 5.7 km distance from the mine to the RSR's trunk line.

Table VII-1 PRODUCTION COST OF ROCK SALT (Base Case)

	Production Cost Per Ton (US$/t)		
	6% interest	5% interest	4% interest
Variable cost	6.37	6.37	6.37
Fixed cost	4.14	3.93	3.73
Total ex-min cost	10.51	10.30	10.10

(Notes) 1) Production scale: 1,200,000 t/y
2) Mining level: -140 m below the ground surface

Table VII-2 PRODUCTION COST OF ROCK SALT (Alternative Case)

(1985 price)

	Production Cost Per Ton (US$/t)		
	6% interest	5% interest	4% interest
Variable cost	6.37	6.37	6.37
Fixed cost	2.76	2.62	2.48
Total ex-min cost	9.13	8.99	8.85

(Notes) 1) Production scale: 1,800,000 t/y

2) Mining level: −140 m below the ground surface

The breakdown of the above is shown in Tables VII-3 and VII-4. Included in the variable costs cited above are dynamite, ANFO, blasting caps, fuel and other consumables for rock salt mining, as well as repair and maintenance costs, conveyor expansion costs, direct labor costs and fringe benefits for laborers, and general and administrative costs. Moreover, the equivalent of 4% of the rock salt sales price, on the FOB price, is taken as a royalty to be paid to the GOT. Fixed costs comprise depreciation, tax and insurance, and interest on loans.

The methodology and assumptions used for the cost estimates are stated in the Explanatory Notes to Tables VII-3 and VII-4.

The above estimates indicate that if the production can be increased to 1.8 million t/y or by 50% from the 1.2 million t/y (or by 50% from the 1.2 million t/y) production projected for the Base Case, the production cost will decrease by approximately US$1.30 per ton or by about 12.7%. This correlation is shown in interest on loan, to be calculated by multiplying an interest rate and the outstanding amount of the loan principal after repayment every year, so the amount of interest payable will decrease year by year. For convenience in computation, however, on the assumption that a half of the principal has been repaid, the projected production cost is estimated by the following formula:

$$CR \times 0.7 \times 1/2 \times IR$$

IR : Interest Rates of 6%, 5%, 4% p.a.

CR : Capital Requirements

US$57,294,000 (at 6% p.a. interest)

US$56,660,000 (at 5% p.a. interest)

US$56,039,000 (at 4% p.a. interest)

Table VII-3 PROJECTED PRODUCTION COST (ROCK SALT: 1,200,000 T/Y)

Item	Annual Cost (1980)	Annual Cost (1985)	Cost Per Ton (1985)	%
	(US$ '000)	(US$ '000)	(US$)	
I. VARIABLE COST				
1. Materials & consumables	2,493[1]	3,852[6]	3.21	31.2
2. Electric power	346	442[7]	0.37	3.5
3. Labour	528[2]	850[8]	0.71	6.9
4. Direct overhead	299[3]	482[9]	0.40	3.9
	3,666	5,626	4.69	45.5
II. FIXED COST				
1. Materials & consumables	239[4]	335[10]	0.28	2.7
2. Indirect overhead	299[4]	482[11]	0.40	3.9
	538	817	0.68	6.6
III. DIRECT OPERATING COST	4,204[5]	6,443	5.37	
ROYALTY (@US$1.00/T)		1,200[12]	1.00	9.7
IV. TAX & INSURANCE				
– At 6% p.a. interest		136[13]	0.11	
– At 5% p.a. interest		135[13]	0.11	1.1
– At 4% p.a. interest		133[13]	0.11	
V. DEPRECIATION & AMORTIZATION				
– At 6% p.a. interest		3,637[14]	3.03	
– At 5% p.a. interest		3,594[14]	2.99	29.0
– At 4% p.a. interest		3,553[14]	2.96	
VI. LONG-TERM LOAN INTEREST				
– At 6% p.a. interest		1,203[15]	1.00	
– At 5% p.a. interest		992[15]	0.83	8.1
– At 4% p.a. interest		785[15]	0.66	
PRODUCTION COST				
– At 6% p.a. interest		12,619	10.51	
– At 5% p.a. interest		12,364	10.30	100.0
– At 4% p.a. interest		12,114	10.10	

(EXPLANATORY NOTES)

1) See attached Table (2)
2) See attached Table (3)
3) See attached Table (1) Item I-10 (Fringe benefit)
4) See attached Table (4)
5) See attached Table (1)
6) Estimated with 9% p.a. escalation
7) Estimated with 5% p.a. escalation
8) Estimated with 10% p.a. escalation
9) Estimated with 10% p.a. escalation
10) Estimated with 9% p.a. escalation
11) Estimated with 10% p.a. escalation
12) 4% of sales price, assuming the sales price of US$25.00/t, Royalty is estimated to be US$1.00/t.
13) Estimated in the following formula:

DAV x 1/2 x 0.5%

DAV: Depreciable Assets Value
US$54,550,000 (at 6% p.a. interest)
US$53,916,000 (at 5% p.a. interest)
US$53,295,000 (at 4% p.a. interest)

14) Estimated at 15% of DAV
15) Estimated in the following formula:

CR x 0.7 x 1/2 x IR

IR: Interest Rates of 6%, 5%, 4% p.a.
CR: Capital Requirements
US$56,175,000 (at 6% p.a. interest)
US$55,553,000 (at 5% p.a. interest)
US$54,944,000 (at 4% p.a. interest)

Attachment (1) to

Table VII-3 OPERATING AND MAINTENANCE COSTS

(1980 COST)

(Unit: US$)

ITEM	LABOR	SUPPLIES & CONSUMABLES	POWER	TOTAL
I. DIRECT COST				
1. Mine Face Charge				
Undercutting	20,340	35,406	13,280	
Drilling	20,340	28,636	25,099	
Blasting	20340	669,227	–	
Scaling	15,804	39,920	–	
Bolting	15,804	342,816	–	
2. Loading	22,536	196,260	–	
3. Crushing and Screening	27,072	27,840	143,114	
4. Waste Disposal	20,800	119,876	11,919	
5. Conveying, Storage and Loading	42,876	36,330	71,762	
6. Development for Production	11,268	150,281		
7. Ventilation	–	–	33,864	
8. Maintenance and Repair	216,720	846,256	47,181	
9. Staff Charge	93,624	–	–	
10. Fringe Benefit	299,100	–	–	
Total	826,624	2,492,848	346,219	3,665,691
II. INDIRECT COST				
Mine Overheads	299,100	238,543	–	537,643
	1,125,724	2,731,391	346,219	4,203,334
Grand Total $4,203,334				
Cost per Ton $3.50				

Note: 1. Based on 1.2 million tons of final product.
2. Exclusive royalty, depreciation and interest.
3. Conversion rate: 20.5 Baht/$. 210¥/$.
4. Owner's cost is not included.

Attachment (2) to
Table VII-3 BREAKDOWN OF ANNUAL COSTS FOR SUPPLIES AND CONSUMABLES IN DIRECT COST (SEE TABLE 1)

ITEMS	UNIT	QUANTITY	AMOUNT (US$)
Dynamite	T	30.8	160,270
A N F O	T	268.7	235,401
Blasting caps	piece	160,900	251,158
Roof-bolts	piece	31,230	288,824
Maintenance of equipment			486,556
Repairing of electric driven machines			132,200
Belt-Conveyor expansion	Kl	797	227,500
Fuel	Kl	797	259,180
Others			451,759
Total			2,492,848

Attachment (3) to
Table VIII-3 BASIS FOR ESTIMATION OF DIRECT LABOR COST

QUALIFICATION	WAGES & SALARIES (Baht)
Unskilled labor	80/day
Skilled labor	230/day
Foreman	10,000/month
Engineers	15,000/month
Superintendents	22,500/month

Attachment (4) to
Table VII-3 BREAKDOWN OF ANNUAL COSTS FOR MINE OVERHEAD

	PARTICULARS	AMOUNT (US$)
Supplies & Consumables		
Labor administration	20% of direct labor cost	191,006
Mining concession		1,176
Water		46,361
Total		238,543
Labor cost		
Director class	84 man-months	92,232
Engineer class	120 man-months	87,720
Foreman class	120 man-months	58,560
Skilled labor class	5,400 man-days	60,588
Total		299,100
Grand Total		537,643

Table VII-4 PROJECTED PRODUCTION COST

(ROCK SALT : 1,800,000 T/Y)

		ANNUAL COST (1985)	COST PER TON (1985)	%
I.	DIRECT OPERATING COST [1]	9,665	5.37	59.7
II.	ROYALTY (@US$1.00/T) [2]	1,800	1.00	11.1
III.	TAX & INSURANCE [3]			
	– At 6% p.a. interest	136	0.07	
	– At 5% p.a. interest	135	0.07	0.8
	– At 4% p.a. interest	133	0.07	
IV.	DEPRECIATION & AMORTIZATION [4]			
	– At 6% p.a. interest	3,637	2.02	
	– At 5% p.a. interest	3,594	2.00	22.3
	– At 4% p.a. interest	3,553	1.97	
V.	LONG-TERM LOAN INTEREST [5]			
	– At 6% p.a. interest	1,203	0.67	
	– At 5% p.a. interest	992	0.55	6.1
	– At 4% p.a. interest	785	0.44	
	PRODUCTION COST			
	– At 6% p.a. interest	16,441	9.13	
	– At 5% p.a. interest	16,186	8.99	100.0
	– At 4% p.a. interest	15,936	8.85	

(EXPLANATORY NOTES)

1) Direct operating cost: 1.5 times of the annual cost for Direct Operating Cost (III) given in Table VII-3.

2) Royalty: US$1.00 per ton

3) Tax & insurance: The same amount as given for annual cost in Table VII-3.

4) Depreciation & amortization: The same amount as given for annual cost in Table VII-3.

5) Long-term loan interest: The same amount as given for annual cost in Table VII-3.

Figure VII-1. Sensitivity of the above costs affected by changes in the capital cost is shown in Fig. VII-2.

The above costs are based on the mining level of 140 m below the surface of the ground which, as stated in Part III, has been selected as the result of technical studies.

Here, separate cost estimates are made for a hypothetical case in which it is assumed that the mining is done on a deeper level, e.g. 200m below the surface of the ground, in anticipation that rock salt of higher quality can be produced thereby. In this case, there is no change in the variable cost per ton compared to that shown in Tables VII-1 and VII-2, but an increase in the fixed cost by approximately US$0.28 per ton or by 7.0% against that for the Base Case and by approximately US$0.18 per ton or by 7.0% against that for the Alternative Cases as summarized in Tables VII-5 and VII-6 below.

Table VII-5 PRODUCTION COST OF ROCK SALT (Hypothetical Case-1)

(1985 price)

	Production Cost Per Ton (US$/t)		
	6% interest	5% interest	4% interest
Variable cost	6.37	6.37	6.37
Fixed cost	4.43	4.21	3.99
Total cost	10.80	10.58	10.36

(Notes) 1) Production scale: 1,200,000 t/y

2) Mining level: -200 m below the ground surface

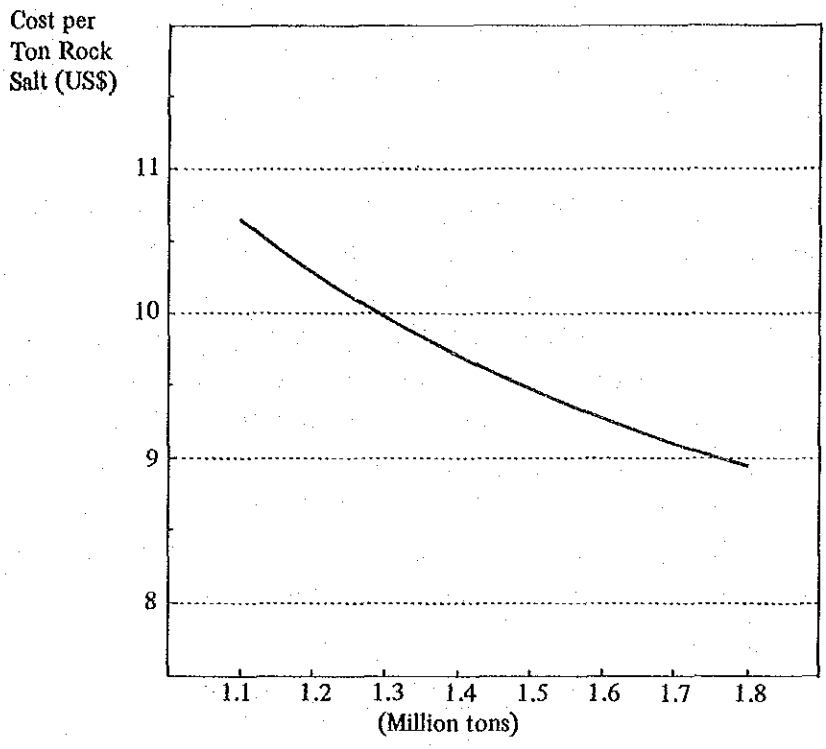

Figure VII-1 CORRELATION BETWEEN COST AND PRODUCTION (ROCK SALT MINE)

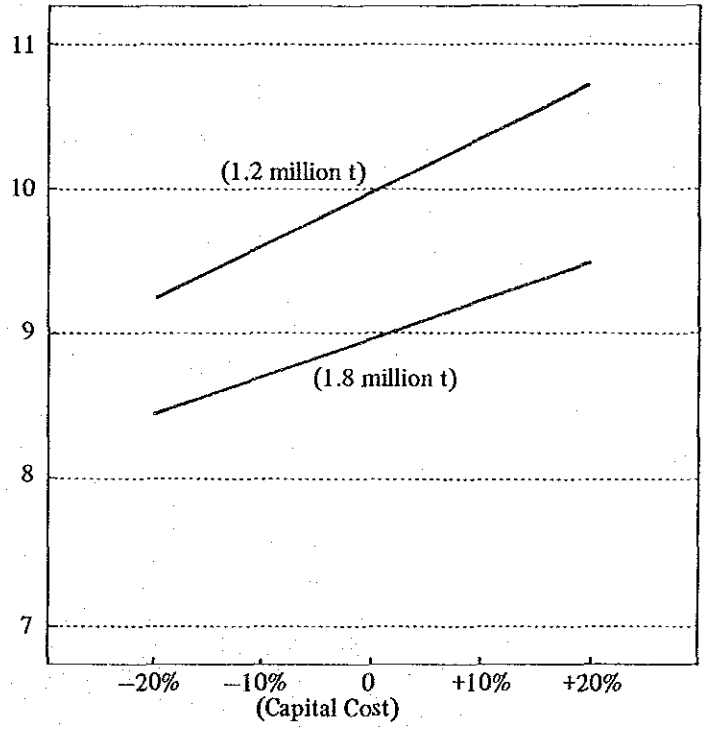

Figure VII-2 SENSITIVITY OF ROCK SALT COST vs. CAPITAL

Table VII-6 PRODUCTION COST OF ROCK SALT
(Hypothetical Case-II)

(1985 price)

	Production Cost Per Ton (US$/t)		
	6% interest	5% interest	4% interest
Variable cost	6.37	6.37	6.37
Fixed cost	2.95	2.80	2.65
Total cost	9.32	9.17	9.02

(Notes) 1) Production scale: 1,800,000 t/y
2) Mining level: -200 m below the ground surface

Such increases in the fixed cost are due to increases in the capital cost. In the case of the Hypothetical Cases, the capital cost is estimated to increase by 7.0% against that used for the Base Case as well as the Alternative Case. This capital cost increase leads to increases in the cost relative to the capital costs (such as tax and insurance, depreciation and loan interest), accounting for a majority of the fixed costs. It can be extrapolated from the graph illustrated in Fig. VII-2.

1-1-2 Cost of Rock Salt Delivered to Laem Chabang

It is planned that the rock salt produced at the mine will be transported by rail to the Laem Chabang area where the soda ash plant is located, and while part will be supplied to the plant, the remainder will be exported through the deep sea port which is to be constructed at Laem Chabang in the near future. This requires assessment of cost competitiveness of the rock salt with the cost level of the rock salt delivered to the Laem Chabang area which can be obtained by adding the rail transport cost to the rock salt production cost at the mine.

Some portion of the rock salt will be sold to Thai domestic users; most of this may be unloaded in Bangkok or its vicinity. Rail transport cost for this portion should be less than that destined to Laem Chabang. In order to compare the cost of rock salt delivered to domestic users with the domestic sales price as shown in section 3-2, however, it is necessary to add the costs for unloading at arrival stations as well as distribution from the stations to users, since that domestic sales price used for financial projections has been set on the basis of delivery to users. It is deemed that such unloading cost and distribution cost as stated above would be equivalent to an increment in rail transport cost which may incur in the event that the rock salt is transported to Laem Chabang instead of the stations near to domestic users.

As has been stated earlier, the costs for the rail spur at the mine have been included in the costs of the mine, and the costs for the rail spur at the soda ash plant as well have been included in the costs of the plant.

In addition to the above facilities, in order to transport the rock salt by rail, it is required that hopper wagons and probably locomotives for marshaling be acquired either by the RSR or the Project. This is yet to be determined. Nevertheless, for purposes of the financial assessment of the Project, it is assumed that these facilities will be acquired by the RSR at its expense, and the Project will pay to the RSR only the freight charges at a unit rate per ton of the rock salt transported from the mine by rail.

The RSR recently quoted a rate of US$8 per ton for the freight charges for transport of rock salt from the mine to Laem Chabang. On this basis, freight charge for the rock salt rail transport in 1985 is estimated to be US$10/t if it is escalated at 5% per annum, and the assessment is made by using this US$10/t rate as the rail transport cost of rock salt from the mine to Laem Chabang.

The cost of the rock salt delivered to Laem Chabang is thus estimated as summarized below.

Table VII-7 COST OF ROCK SALT DELIVERED TO LAEM CHABANG

(1985 price)

	Costs of rock salt delivered to Laem Chabang (US$/T)		
	6% niterest	5% interest	4% interest
I. Base Case	20.51	20.30	20.10
II. Alternative Case	19.13	18.99	18.85
III. Hypothetical Case – I	20.80	10.58	10.36
IV. Hypothetical Case – II	19.32	19.17	19.02

It must be noted that the costs shown above exclude returns on investment. In order to gain 10% return-on-investment (ROI) on an average basis, the following should be added to the above:

		(US$/t)
1.	Base Case	4.72
2.	Alternative Case	3.15
3.	Hypothetical Case-I	5.05
4.	Hypothetical Case-II	3.37

Sensitivity of the costs of rock salt delivered to Laem Chabang which have been affected by changes in freight charges is shown for the Base Case as well as the Alternative Case in Figure VII-3.

The foregoing analysis can be concluded with the following comments:

1. In view of the estimated production cost of rock salt, the ex-mine cost, even including profit margin for returns on investment, is at a reasonable level even in the case of 1.2 million t/y production.

2. However, because rail transport cost from the mine to Laem Chabang is costly, the costs delivered to Laem Chabang increase to a marginal level. Cost competitiveness of the rock salt is greatly dependent upon rail freight charges to be applied to this Project.

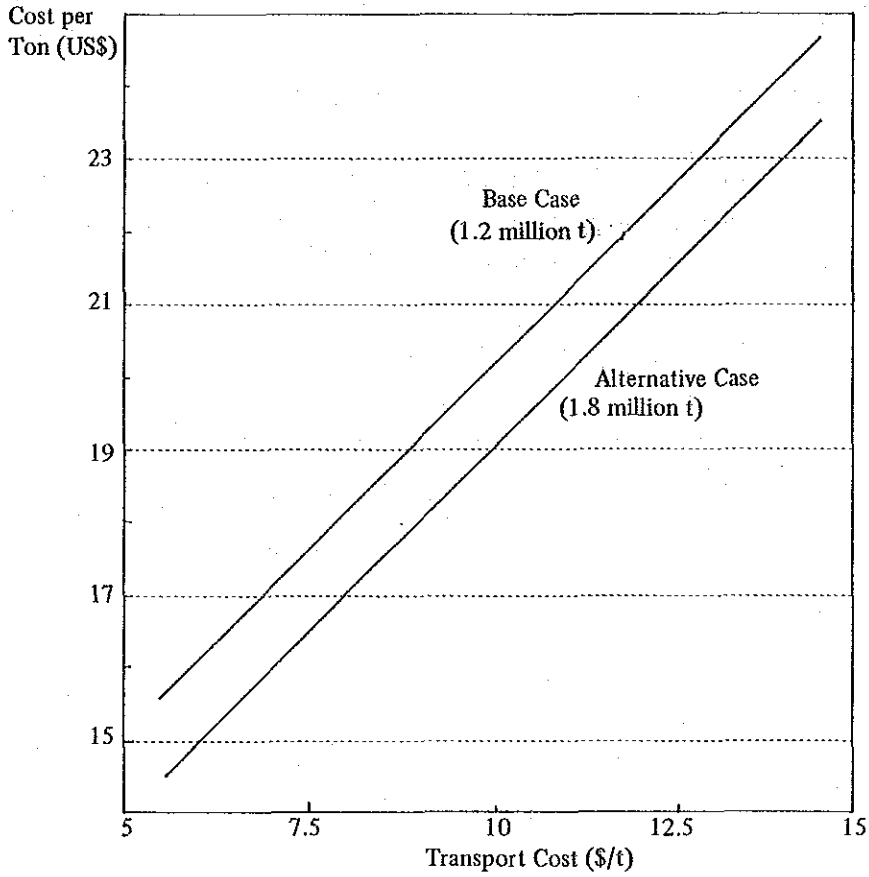

Figure VII-3 SENSITIVITY OF SALT DELIVERED COST vs. RAIL TRANSPORT COST

1-2 ANALYSIS OF COSTS OF SODA ASH AND AMMONIUM CHLORIDE

1-2-1 Major Assumptions for the Estimates of Soda Ash and Ammonium Chloride Manufacturing Costs

The proposed soda ash plant, as stated in Part V, is to adopt a Full AC Process and to produce 400,000 tons each per year of soda ash and byproduct ammonium chloride. The plant is to consume the following materials and utilities for the manufacturing of the products.

Raw materials		Utilities	
1)	Rock salt	1)	Electric power
2)	Ammonia	2)	Water
3)	Carbon dioxide	3)	Fuel (fuel oil)
4)	Quicklime		
5)	Caustic soda (or soda ash)		

Table VII-8 UNIT CONSUMPTION OF RAW MATERIALS AND UTILITIES

		(Per ton of Soda Ash)
1.	Raw Materials	
	Salt	1,413 kg
	Ammonia	320 kg
	Quicklime	46 kg
	Caustic soda	42 kg
	(or soda ash)	(60 kg)
2.	Utilities	
	Electric power	496 KWH
	Water	25.6 m^3
	Fuel oil	0.208 m^3

The requirements of these materials and utilities are as shown in Table VII-8. With regard to the above listed materials and utilities, the major assumptions used for the cost estimates are as summarized below.

	US$/t
Estimated production cost rock salt – Base Case (Table VII-2)	10.30
ROI, 10%	4.72
Rail transport cost from the mine to the plant	10.00
Handling costs	1.00
Total:	26.02 (≒ 26.0)

(1) Rock salt

Rock salt used for the plant is to be supplied from the rock salt mine of this Project. A pricing formula for the rock salt to be supplied to the plant is yet to be determined. Nevertheless, for purposes of cost estimation, it is assumed that rock salt will be supplied to the plant at a price of US$26/t which has been computed in terms of 1985 price as follows:

(2) Ammonia

It is assumed that ammonia requirements will be met by imports. The price of imported ammonia is forecast to be US$235/t, CIF, in 1985.

(3) Carbon dioxide

The supply source of carbon dioxide is to be the PTT's gas processing plant at Rayong where carbon dioxide separated from natural gas is available. The capital costs for installation of necessary facilities to receive the carbon dioxide at the gas processing plant and to transport it to the soda ash plant by a pipeline have been included in the capital requirements for the Project. On the other hand, regarding the price of carbon dioxide itself, it is assumed to be free, since the carbon dioxide has no use and therefore will be purged to the air unless it is utilized at the soda ash plant. In order to operate a compressor for compressing the carbon dioxide for transport to the plant, fuel is required. The requirement of fuel for this purpose has been counted in the fuel requirements for the production of soda ash and ammonium chloride.

(4) Quicklime

It is assumed that quicklime will be procured from local carbide makers. The prevailing price of quicklime, at present, is US$20/t. The 1985 price of this material is projected with an escalation of 7% per annum of the above price shown as the 1980 prevailing price.

(5) Caustic soda (or soda ash)

Caustic soda or soda ash is to be used. Nevertheless, for purposes of financial projections, it is assumed that soda ash be used. Such requirements will be met by a part of the soda ash produced at the plant, and the value of soda ash consumed within the plant can be assessed to be the equivalent of net production cost. In such event, however, a net sales profit will be reduced to the extent that will be consumed within the plant. In view of this fact, the cost estimates use a price of soda ash which is equivalent to the sales price (i.e. US$225/t in 1985) used for financial projections.

(6) Electric power

The Project plans to use electric power supplied by PEA. The PEA's tariff of electricity supply rate is Baht 1.06/kwh which is equivalent to US$0.05/kwh as of late 1980. The 1985 price of electric power used for the cost estimates has been projected with 5% p.a. escalation of the above price up to 1985.

(7) Water

It is assumed that IEAT will supply water required for the plant at a certain price rated according to its tariff. The present tariff sets the price of Baht 1.73/m^3 which is equivalent to US$0.08/$m^3$. For the cost estimation, the price of water as of 1985 is projected with 5% p.a. escalation up to 1985 of the above price in 1980.

(8) Fuel

Fuel required for the soda ash and ammonium chloride production, as stated earlier, is to be supplied from the local petroleum refineries. In Thailand, the present price of fuel oil is Baht 3,650/m^3 which is equivalent to US$177.9/$m^3$. The cost estimates use the fuel oil price of US$227/$m^3$ in terms of 1985 price which has been estimated with 5% p.a. escalation of the above price in 1980.

Regarding the items other than the above, assumptions used for the cost estimates are stated in the Explanatory Notes to Table VII-10.

1-2-2 Production Costs of Soda Ash and Ammonium Chloride

On the basis of the assumptions stated above, the costs of soda ash and ammonium chloride produced at the soda ash plant of this Project, utilizing a Full AC Process and having the capacity of 400,000 t/y each of soda ash and ammonium chloride, are estimated as summarized in Table VII-9, below.

Table VII-9 PRODUCTION COST OF SODA ASH AND AMMONIUM CHLORIDE

(1985 price)

	Production cost per ton (US$/t)			
	Soda Ash	AC	Total	%
Variable Cost	113.15	96.30	209.45	64.20
Fixed Cost	63.10	53.70	116.80	35.80
Total Cost	176.25	150.00	326.25	100.00

(Note) 1) Assuming 5% p.a. interest for purposes of cost estimates.
2) Soda ash cost computed by deducting the ammonium chloride sales price of US$150/T from the total production cost.

The above figures for variable cost include the costs of raw materials and utilities required for producing both soda ash and ammonium chloride. The fixed costs include the costs of plant maintenance and repair, tax and insurance, depreciation, labor, generl and administrative expenses, loan interest, etc. Price of materials and utilities used for the estimation of variable costs are as stated in section 2-2-1 above. The breakdown of the cost estimates is shown in Table VII-10 (see next page).

The above costs exclude any return on investment. If 10% ROI is added, the production costs become as shown in Table VII-11.

Table VII-11 PRODUCTION COST OF SODA ASH AND AMMONIUM CHLORIDE (INCLUDING 10% ROI)

(1985 price: US$/t)

	Soda ash	Ammonium Chloride
Production cost	176.25	150.00
ROI 10%	92.61	33.34
Total	268.86	150.00

Sensitivity of the estimated costs in the variances of major cost factors is shown in Figure VII-4.

Table VII-10 ESTIMATED PRODUCTION COST OF SODA ASH AND AMMONIUM CHLORIDE

(Full AC Process : Soda Ash 400,000 T/Y)
(Full AC Process : AC 400,000 T/Y)

	Annual Costs (US$'000)	Cost per Ton (US$/T)	%
1. Variable Cost			
1.1 Raw materials			
– Salt [1]	14,696	36.74	11.26
– Ammonia [2]	30,080	75.20	23.05
– Quicklime [3]	516	1.29	0.39
– Soda ash [4]	5,400	13.50	4.14
1.2 Utilities			
– Electric power [5]	13,096	32.74	10.04
– Water [6]	1,104	2.76	0.85
– Fuel oil [7]	18,888	47.22	14.47
Total	83,780	209.45	64.20
2. Fixed Cost			
2.1 Tax & Insurance [8]	846	2.11	0.64
2.2 Maintenance [9]	9,249	23.12	7.09
2.3 Labor	2,527	6.32	1.94
2.4 General admin. [10]	5,054	12.63	3.87
2.5 Depreciation [11]	22,563	56.41	17.29
2.6 Interest [12]	6,483	16.21	4.97
Total	46,676	116.80	35.80
3. Production Cost	130,456	326.25	100.00
		(Soda Ash: 76.25)	
		(AC : 150.00)	

(EXPLANATORY NOTES)

1) @$26/t x 1.413 t/t = $36.74/t
2) @$235/t x 0.320 t/t = $75.20/t
3) @$28/t x 0.046 t/t = $1.29/t[
4) @$225/t x 0.06 t/t = $13.50/t
5) @$0.066/KWH x 496 KWH/t = $32.74/t
6) @$0.108/$m^3$ x 25.6 m^3/t = $2.76/t
7) @$227/$m^3$ x 0.208 m^3/t = $47.22/t
8) $338,441,000 x 1/2 x 0.5% = $846,103
9) Constructed facilities x 3%

Constructed facilities

Plant:	US$306,051,000
Rail spur:	US$2,253,000
Total	US$308,304,000

US$308,304,000 x 3% = US$9,249,120

10) 200% of labor cost
11) Depreciable asset value x 1/15

Depreciable asset value

Total capital requirements less

– Land acquisition and site preparation costs

– Initial working capital

US$370,458,000* – (US$6,443,000 + US$25,574,000)

= US$338,441,000

12) Total capital requirements x 0.7 x 1/2 x Interest Rate*

(Note) Assuming 5% p.a. interest rate only for the above estimates.

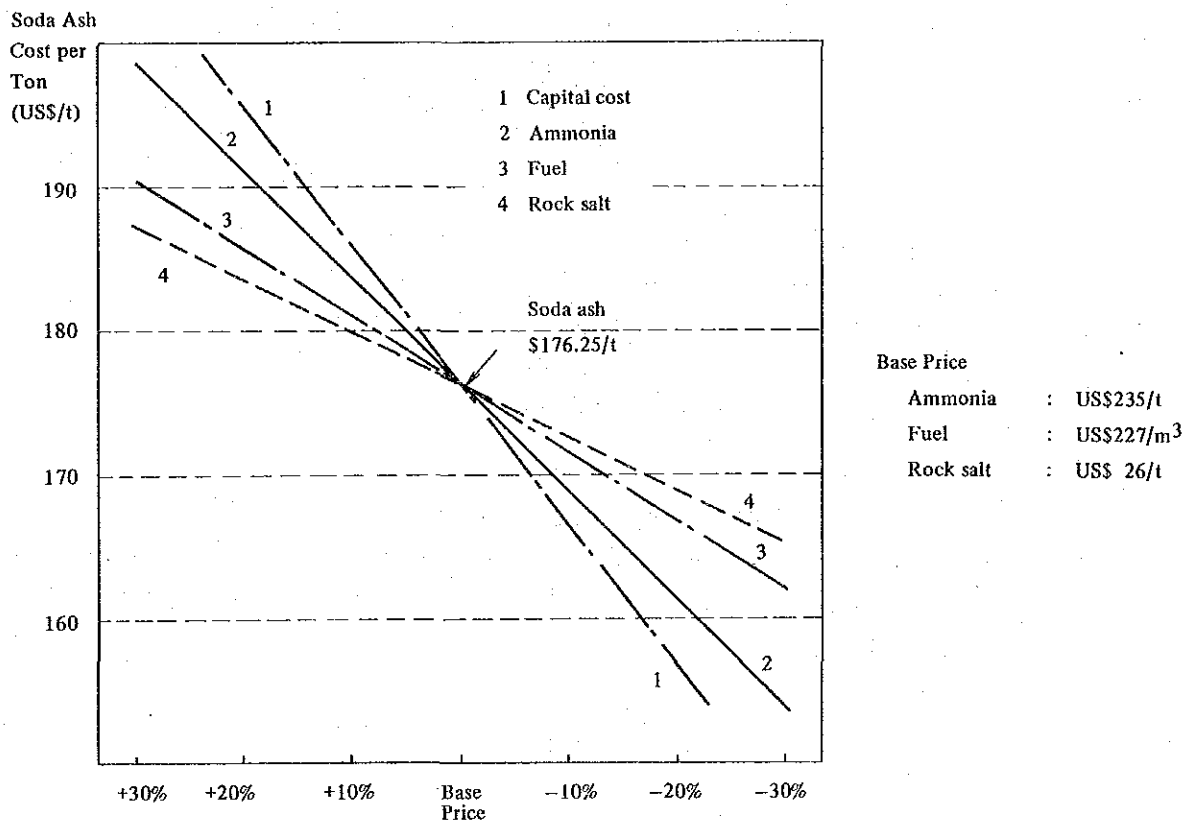

Figure VII-4 (1) SENSITIVITY OF SODA ASH PRODUCTION COST

1-2-3 Analysis of the Soda Ash and Ammonium Chloride Costs; Examination of Necessary Measures to Reduce the Costs

Judging from the above figures, the cost of producing soda ash and ammonium chloride is substantially high. In comparison to the anticipated sales price as given in Chapter 3, it is expected that it will be difficult to obtain an adequate return on investment if production costs are at these levels. As Table VII-9 clearly shows, variable costs occupy a large share – about 6.4% of total costs. In order to reduce the production cost, it is necessary to reduce the cost of raw materials and utilities.

Within the cost of raw materials and utilities, the shares accounted for by ammonia and fuel are high, being 36% and 23% respectively of the variable cost. On the other hand, the cost of rock salt accounts for a comparatively low share in the total variable cost. It is only 18% on the basis of the rock salt cost of US$26/ton. Sensitivity of soda ash cost affected by changes in the main raw material (salt), ammonia and fuel, as shown in Figure VII-4, is summarized below.*

Table VII-12 SENSITIVITY OF SODA ASH COST BY CHANGES IN PRICES OF ROCK SALT, AMMONIA AND FUEL

		Change in product cost
		Soda Ash (US$/t)
Change in salt price	±10%	±3.67
Change in ammonia price	±10%	±7.52
Change in fuel price	±10%	±4.72

(Note) * Assuming the cost of ammonium chloride fixed at US$150/t.

As the levels of ammonia and fuel prices are substantially higher than that of salt price, as is shown in the above table, the cost of soda ash is greatly affected by changes in ammonia and fuel prices rather than salt prices. Hence measures for using ammonia and fuel at lower prices would be essential for reducing the cost of soda ash.

In the estimation of costs, it is assumed that ammonia will be imported, at the cost to the project of US$235/t, and that fuel oil will be used as fuel, at the cost of US$227/$m^3$. (Both of these are 1985 prices.) The price of ammonia is based on the international price of ammonia, whereas estimation of the fuel price is based on the present price of fuel oil in Thailand. As in the above pre-conditions, these costs are considered reasonable as long as imported ammonia and local fuel oil are used for the Project.

In order to reduce these costs, it is required for the GOT to take the following measures. That is, with regard to ammonia, the only possible move is that efforts may be made either to obtain ammonia produced at the natural-gas-based large ammonia plants in the surrounding countries (Indonesia and Malaysia) under a special price arrangement or to use ammonia produced at a fertilizer complex project which is now being planned by the GOT.

It seems that the ammonia plants in Indonesia and Malaysia could produce ammonia at considerably lower costs. If the GOT makes a special price arrangement with the governments of Indonesia and Malaysia for ammonia to be supplied from these countries, this project may be able to use ammonia at a cost lower than the projected level. On the other hand, the Thai domestic production would result in a comparatively higher cost of ammonia compared to Indonesia and Malaysia, it would be possible to reduce ammonia cost by reducing the cost of freight charges for the imported ammonia. It is expected that in such instances the price of ammonia could be reduced to about US175/t.

With regard to fuel, it is recommended that the GOT officials discuss with PTT about measures for natural gas to be supplied to the soda ash plant. Because the price of this natural gas for industrial use has not yet been determined, only tentative observations may be made, but it may be stated that if the natural gas can be obtained at a per calorie cost equal to about 80% of that of fuel oil, it will be possible to make a major reduction in production cost.

If production cost is calculated by using an ammonia price of US$175/t and a fuel price of US$181.60/$m^3$ on the basis of the above possibilities, and comparison is made with the production cost given in Table VII-9, it is found that the following cost reductions are possible, and greatly improve the cost competitiveness:

	Reduction of Soda Ash Cost
Ammonia	US$19.70/ton
Fuel	US$9.44/ton
Total	US$29.14/ton

CHAPTER 2 FINANCIAL ANALYSIS

2-1 MAJOR ASSUMPTIONS TAKEN FOR FINANCIAL PROJECTIONS

Financial projections are made respectively for two profit centers of this Project, (a) rock salt mine and (b) soda ash plant, and another set of projections are made on the (c) the entire project by consolidating (a) and (b).

Major assumptions used in common for these projections are as follows.

1. Taxes

   Corporate tax: In accordance with tax law and industrial policy and related legislation in Thailand, it is assumed that a tax holiday of eight years duration will be granted to the Project, and that after the expiration of that holiday the corporate tax will be imposed at an amount computed as 45% of taxable income.

   Import duty and business tax: To be exempted.

   Depreciation: Straight-line depreciation for 15 years and with no residual value.

2. Financing terms

   The terms for financing, as has been stated in Part VI, are not known at the present stage, because the source of financing for the Project has not been determined. Nevertheless, for purposes of this study, the following terms are used as a hypothesis:

   Repayment schedule: A grace period of three years is to be granted, and the repayment of loans is to be made by 15 annual equal-installments of the principal; such repayment starts in the year immediately subsequent to the expiration of the grace period and ending at the 15th year from and including the first repayment year.

   Loan interest: Three alternative interest rates of 6%, 5% and 4% per annum are assumed. The interest is to be paid on the outstanding loan principal evey year.

2-2 FINANCIAL ANALYSIS OF THE ROCK SALT MINE

Financial projections of the rock salt mine were made on the basis of the production cost estimates shown in section 1-1-1 and the assumptions stated in section 2-1 above. This Section (2-2) gives the thus prepared financial projections as well as a summary of the results of financial analysis on the rock salt mine.

2-2-1 Bases in Financial Projections and Analysis

(1) Production and sales plan

The proposed rock salt mine, as has been stated earlier, is capable of producing rock salt at 1.2 million t/y by two-shift operation and 1.8 million t/y by three-shift operation.

Whether the mine will perform a two shift operation or three shift operation is dependent upon the prospects for sales of the produced rock salt.

The prospects, as have been discussed in Part II, differ depending upon the assurance of competent authorities as to what size of vessels can be used for delivery to non-ASEAN countries such as Taiwan, Korea and Japan.

Since the definite design of the Laem Chabang Deep Sea Port has not been developed yet, the largest size of vessels which can be moored at the port is not known.

According to the master plan previously prepared by NEDECO for the Laem Chabang Deep Sea Port Project, it has been assumed that the maximum size of vessels using the port would be 50,000 DWT, and the transport of rock salt to non-ASEAN countries will be done by 15,000 to 20,000 DWT class vessels. As long as this assumption is taken, it is anticipated that, as stated in Part II, the sales of rock salt would be at a level of approximately 1.1 million t/y up to 1995. The production and sales plan shown in Table VII-13 has been developed on the basis of the above, and this plan is used as the Base Case for financial projections and analysis.

Nevertheless, if 60,000 DWT class vessels can be used for the transport to non-ASEAN countries, there may be possibilities to increase the amount of exports to non-ASEAN countries such as Taiwan, Korea and Japan, because the use of those large vessels would obviously reduce the ocean freight to these countries so that Thai rock salt could compete with other salt exporters to the above in terms of CIF prices. The production and sales plan developed on this basis is shown in Table VII-14, which is the Alternative Case for financial projections and analysis.

According to the foregoing discussions, the financial projections and analysis for the rock salt mine are made on the following two cases:

Base Case:	1.2 million t/y million t/y – two-shift operation (Production and Sales Plan as shown in Table VII-13)
Alternative Case:	1.8 million t/y – three-shift operation (Production and Sales Plan as shown in Table VII-14)

The Base Case for the production and sales plan shown in Table VII-13 has been formulated on the basis of the quantity of rock salt to be supplied to the Soda Ash Plant and that to be sold as projected for the ASEAN markets plus exports to non-ASEAN countries (mainly Taiwan) at an amount of approximately 100,000 tons a year.

The Alternative Case for the production and sales plan shown in Table VII-14 takes the same basis as the Base Case in regard to the supply to the soda ash plant as well as the sales within the ASEAN markets, but it assumes a large amount of exports to non-ASEAN countries such as Taiwan, Korea and Japan.

For the production schedule shown in the above plans, it is assumed that the rock salt mine will have an inventory of the rock salt produced at an amount equivalent to two months production including the inventory carried over from the preceding year.[1)]

(2) Sales price

(a) Base Case

The Base Case uses the following sales prices as a basis for financial projections.

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1) The years which are shown in all the production and sales plans for the rock salt start at the beginning of July, 1985 through the end of June, 1986 as the first year, with each year starting and ending similarly thereafter so as to meet the production schedule in which it has been assumed to start commercial operation at the beginning of July, 1985. It applies to the production and sales plans for other products of the Project (i.e., soda ash and ammonium chloride).

Table VII-13 PROJECTED SALES OF ROCK SALT
(Rated Capacity: 1,200,000 t/y)

(Unit: tons)

(Year)	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th	15th
Capacity Utilization (%)	(68)	(70)	(79.4)	(85.5)	(86.7)	(88.5)	(89.8)	(91.3)	(92.7)	(94.1)	(95.5)	(97)	(98.4)	(99.8)	(100.0)
Production	816,000	840,000	952,800	1,026,000	1,040,400	1,062,000	1,077,600	1,095,600	1,112,400	1,129,200	1,146,000	1,164,000	1,180,800	1,197,600	1,200,000
Inventory Increase	136,000	4,000	18,800	12,200	2,400	3,600	2,600	3,000	2,800	2,800	2,800	3,000	2,800	2,800	400
Sales Volume	680,000	836,000	934,000	1,013,800	1,038,000	1,058,400	1,075,000	1,092,600	1,109,600	1,126,400	1,43,200	1,161,000	1,178,000	1,194,800	1,199,600
Supply to Soda Ash Plant	395,640	452,160	508,680	565,200	565,200	565,200	565,200	565,200	565,200	565,200	565,200	565,200	565,200	565,200	565,200
Thai Domestic Sales	87,400	116,450	145,700	158,500	171,300	184,400	197,800	211,200	224,600	238,000	251,400	264,800	278,200	291,600	305,000
Export to Malaysia	152,000	162,000	172,250	182,800	193,550	200,710	204,330	207,950	211,570	215,190	218,810	222,430	226,050	229,670	233,290
Export to Singapore	7,750	7,850	7,950	8,050	8,150	8,250	8,350	8,450	8,550	8,650	8,750	8,850	8,950	9,050	9,150
Export to Other Countries	37,210	97,540	99,420	99,250	99,800	99,840	99,320	99,800	99,680	99,360	99,040	99,720	99,600	99,280	86,960

Table VII-14 PROJECTED SALES OF ROCK SALT
(Rated Capacity: 1,800,000 t/y)

(Unit: tons)

(Year)	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th	15th
Capacity Utilization (%)	(70)	(80)	(90)	(100)	(100)	(100)	(100)	(100)	(100)	(100)	(100)	(100)	(100)	(100)	(100)
Production	1,260,000	1,440,000	1,620,000	1,800,000	1,800,000	1,800,000	1,800,000	1,800,000	1,800,000	1,800,000	1,800,000	1,800,000	1,800,000	1,800,000	1,800,000
Inventory Increase	210,000	30,000	30,000	30,000	0	0	0	0	0	0	0	0	0	0	0
Sales Volume	1,050,000	1,410,000	1,590,000	1,770,000	1,800,000	1,800,000	1,800,000	1,800,000	1,800,000	1,800,000	1,800,000	1,800,000	1,800,000	1,800,000	1,800,000
Supply to Soda Ash Plant	395,640	452,160	508,680	565,200	565,200	565,200	565,200	565,200	565,200	565,200	565,200	565,200	565,200	565,200	565,200
Thai Domestic Sales	87,400	116,450	145,700	158,500	171,300	184,400	197,800	211,200	224,600	238,000	251,400	264,800	278,200	291,600	305,000
Export to Malaysia	152,000	162,000	172,250	182,800	193,550	200,710	204,330	207,950	211,570	215,190	218,810	222,430	226,050	229,670	233,290
Export to Singapore	7,750	7,850	7,950	8,050	8,150	8,250	8,350	8,450	8,550	8,650	8,750	8,850	8,950	9,050	9,150
Export to Taiwan	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000
Export to other non-ASEAN countries	307,210	571,540	655,420	755,450	761,800	741,320	707,200	690,080	672,960	672,960	655,840	638,720	621,600	604,480	587,360

	Price	(1985 prices) Terms of Trade
Supply to soda ash plant	US$26/t	At soda ash plant gate
Sale within Thailand	US$30/t	Delivered to user
Export		FOB Laem Chabang
– Malaysia	US$29/t	
– Singapore	US$24/t	
– Other (non-ASEAN)*	US$17/t	

(Note) * Assuming Taiwan as the main destination.

The price for supply to the Soda Ash Plant has been set on the basis of the production cost including 10% ROI on average plus rail transport cost which is estimated as follows.

Production cost	
– Base Case	10.30 (US$/t)
ROI 10%	4.72
Transport cost	10.00
Handling cost	1.00
Total:	26.02 (US$26/t)

For the sales prices for the Thai domestic market as well as exports, the financial projections use the prices as projected in the market study (Part II).

(b) Alternative Case

The Alternative Case is to produce rock salt at the rate of 1.8 million t/y, so in this case the production cost of rock salt would be lower than the Base Case. Nevertheless, regarding the sales price for the supply to the soda ash plant, the same figure as the Base Case is used in order to compare the differences in returns between Base Case and Alternative Case which may be derived from an increase in the production as well as an increase in the exports to non-ASEAN countries.

In the Alternative Case, it is assumed that 60,000 DWT class vessels will be used for transport to non-ASEAN countries such as Korea and Japan, so that freight cost for these destinations can be reduced to some extent compared to the Base Case. Assuming the use of 60,000 DWT class vessels, the FOB price for the above destinations is estimated to be US$16/t in 1985 (see 3-3 of Part II). Hence the Alternative Case uses the above price for the exports to non-ASEAN countries other than Taiwan, while the sales price for the Thai domestic sale as well as the exports to Malaysia, Singapore and Taiwan are the same as the Base Case.

(c) Hypothetical Case

In the case of Base Case and Alternative Case, it is assumed that the quality of the produced rock salt is inferior to Australian salt and other industrial salt so that the sales price is discounted by about US$1/t. However, there is an anticipation that a higher quality of rock salt can be produced by mining a deeper level of deposits, although so far there is no sufficient data to assure such possibilities. The Hypothetical Case takes a hypothesis that the rock salt produced by the above method can be sold at a level comparable to the international salt prices. On the above assumptions, the Hypothetical Case uses the following sales prices for financial projections.

	Price	(1985 price) Terms of Trade
Supply to soda ash plant	US$26/t	At soda ash plant gate
Sale within Thailand	US$31/t	Delivered to user
Export		FOB Laem Chabang
– Malaysia	US$30/t	
– Singapore	US$25/t	
– Non-ASEAN (Taiwan)	US$18/t	
– Non-ASEAN (others)	US$17/t	

2-2-2 Profitability of Rock Salt Mine

The financial rate of return on investment for the rock salt mine was assessed in terms of the internal rate of return (IRR) computed by using the Discounted Cash Flow (DCF) method. The assumptions taken for this computation are as stated in Chapter 1, section 1-1 of Chapter 1, and sections 2-1 and 2-2-1 of this Chapter 2. The IRRs computed for the Base Case and the Alternative Case are as follows.

	IRR before tax	IRR after tax
Base Case	13.53%	12.03%
Alternative Case	14.19%	12.70%

The financial statements are attached as Annex VII. Sensitivity of the IRR cited above was also analyzed by the variances of capital requirements, rail transport cost and sales prices. The results are shown in Table VII-15 and Figure VII-4.

Another analysis was made of a Hypothetical Case in which a deeper level of the deposits (hypothetically set at a level of −200 m from the surface of the ground) is mined so that a higher quality of rock salt can be produced. The results of this analysis are as follows.

	IRR after tax
Hypothetical Case – I	12.1%
Hypothetical Case – II	13.2%

As the results of the foregoing analyses, the profitability of the rock salt mine can be summarized with the following comments:

1. Since the sales price to the soda ash plant is set at a relatively high level, it is anticipated that the mine will gain comparatively high returns despite a high transport cost.

2. As is apparent from the sensitivity analysis, the factors greatly affectiving the returns are sales prices and rail transport cost. The price for supply to the soda ash plant should be determined in view of returns of the soda ash plant part. Therefore the most importance is how much charges will be applied to the transport of rock salt.

Table VII-15 SENSITIVITY OF IRR VS. VARIANCES OF CAPITAL REQUIREMENTS, RAIL TRANSPORT COST AND SALES PRICE (ROCK SALT MINE)

Affecting Factors		Base Case		Alternative Case	
Items	Variances	IRR before Tax	IRR after Tax	IRR before Tax	IRR after Tax
a) Rail Transport Cost (US$10/t)	+20 (%)	10.21 (%)	8.82 (%)	8.39 (%)	7.03 (%)
	+10	11.94	10.48	11.53	10.08
	Base Cost	13.53	12.03	14.19	12.70
	−10	15.03	13.51	16.58	15.08
	−20	16.44	14.91	18.80	17.31
	−30	17.79	16.26	20.86	19.40
b) Sales Price	+10	17.18	15.64	19.10	17.61
	Base Cost	13.53	12.03	14.19	12.70
	−10	9.22	7.89	7.93	6.62
c) Capital Requirements	+10	12.11	10.66	12.73	11.27
	Base Cost	13.53	12.03	14.19	12.70
	−10	15.17	13.64	15.87	14.35

Figure VII-4 (2) SENSITIVITY OF IRR (AFTER TAX)
(Rock Salt Mine — Base Case)

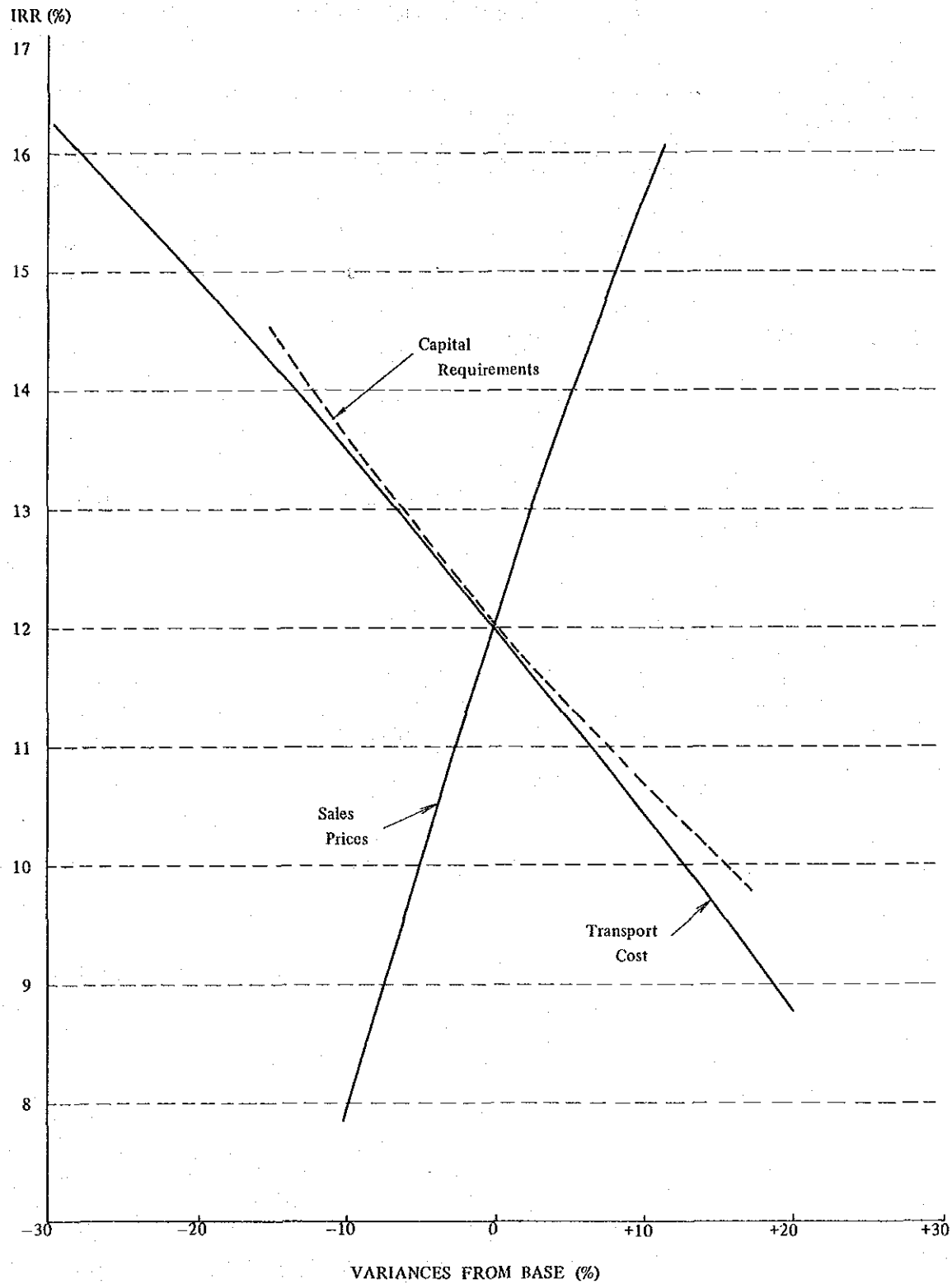
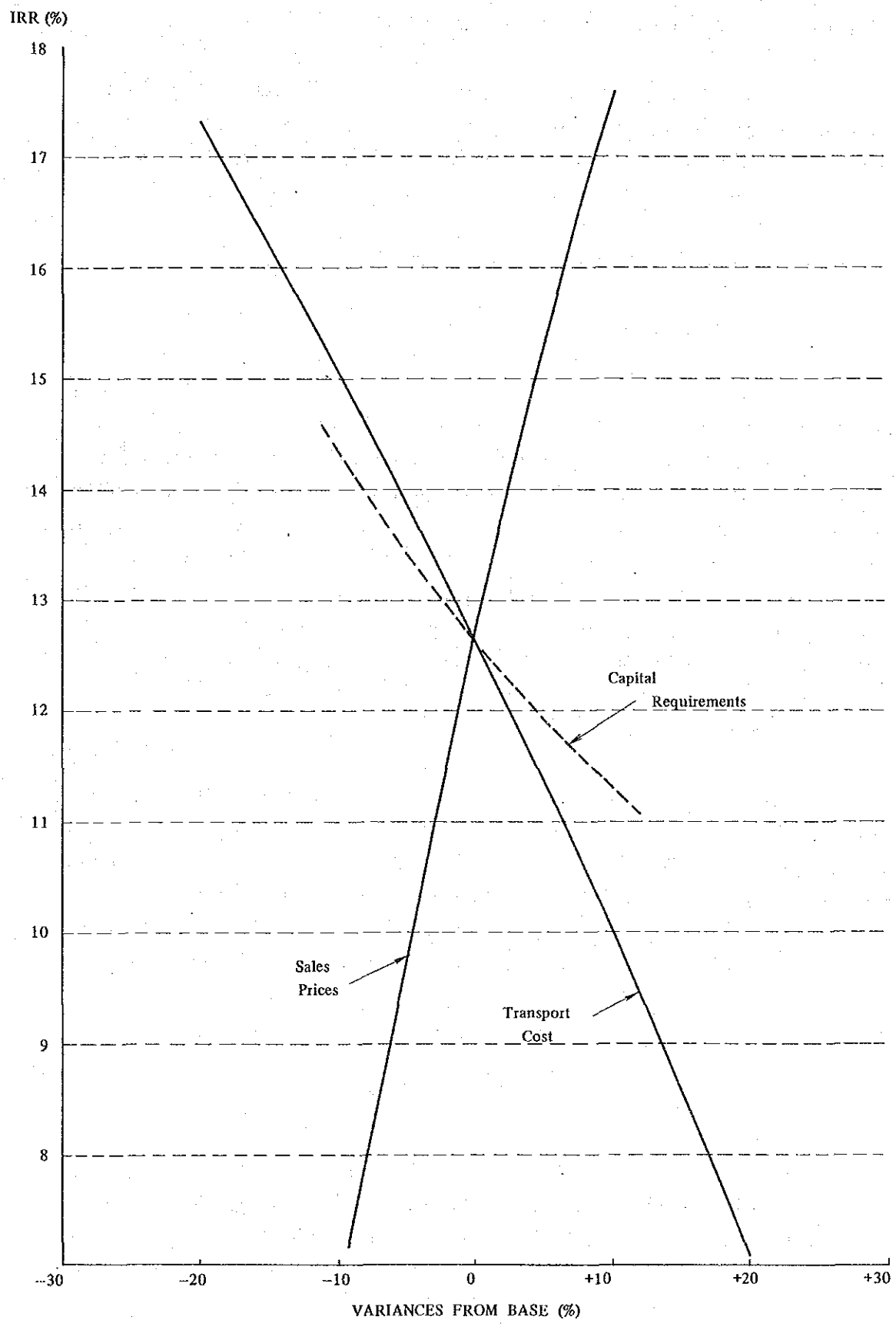


Figure VII-4 (3) SENSITIVITY OF IRR (AFTER TAX)
(Rock Salt Mine — Alternative Case)



2-3 FINANCIAL ANALYSIS OF SODA ASH PLANT

Financial projections of the Soda Ash Plant were made on the basis of the production cost estimates shown in section 1-2 and the assumptions stated in section 2-1. This section (2-3) gives the thus prepared financial projections as well as a summary of the results of financial analysis on the soda ash plant.

2-3-1 Bases for Financial Projections and Analysis

(1) Production and sales plan

The proposed soda ash plant, as has been stated earlier, is to adopt a Full AC Process and to have the capacity of 400,000 t/y each of soda ash and ammonium chloride. The production and sales plan used for financial projections is shown in Table VII-16.[1)] For the production schedule shown in the above plan, it is assumed that the Soda Ash Plant will have an inventory of the soda ash and ammonium chloride produced at an amount equivalent to one month of production including the inventory carried over from the preceding year. The annual production has been set on the basis of capacity utilization rates being 70% in the initial year, 80% in the second year, 90% in the third year, and 100% in the fourth year onward.

(2) Sales price of soda ash

The ASEAN Economic Ministers have agreed that the sales price of the soda ash from this Project will be set at prices comparable to international prices in terms of CIF in each destined country. On this basis, the CIF price of soda ash in each ASEAN country, including Thailand, has been projected (see section 2-3 of Chapter 2), and the shipment price has been projected by deducting ocean freights from the thus projected CIF price. The financial projections use the thus projected shipment prices, which are as summarized below.

(Note)

1) The years which are shown in the production and sales plan for the soda ash and ammonium chloride start at the beginning of July, 1985 through the end of June, 1986 as the first year, with each year starting and ending similarly thereafter, so as to meet the production schedule in which it has been assumed commercial operation starts at the beginning of July, 1985.

Table VII-16 (1) PROJECTED SALES OF SODA ASH
(Soda Ash: 400,000 t/y)

(Unit: tons)

	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th	15th
Capacity Utilization (%)	(70)	(80)	(90)	(100)	(100)	(100)	(100)	(100)	(100)	(100)	(100)	(100)	(100)	(100)	(100)
Production	280,000	320,000	360,000	400,000	400,000	400,000	400,000	400,000	400,000	400,000	400,000	400,000	400,000	400,000	400,000
Inventory Increase	23,333	3,344	3,333	3,333	–	–	–	–	–	–	–	–	–	–	–
Sales Volume	256,667	316,666	356,667	396,667	400,000	400,000	400,000	400,000	400,000	400,000	400,000	400,000	400,000	400,000	400,000
Thailand	124,600	135,200	146,350	157,650	169,350	180,100	189,700	199,300	208,900	218,500	228,100	237,700	247,300	256,900	266,500
Singapore	15,950	16,000	16,100	16,200	17,300	18,650	19,200	19,750	20,300	20,850	21,400	21,950	22,500	23,050	23,600
Malaysia	44,300	47,400	50,650	53,750	57,300	61,500	65,650	69,800	73,950	78,100	82,250	86,400	90,550	94,700	98,850
Indonesia	71,817	103,200	109,900	116,850	124,000	131,600	125,450	111,150	96,850	82,550	68,250	53,950	39,650	25,350	11,050
Philippine	–	14,866	33,667	52,217	32,050	8,150	–	–	–	–	–	–	–	–	–

Table VII-16 (2) PROJECTED SALES OF AMMONIUM CHLORIDE
(Ammonium Chloride: 400,000 t/y)

(Unit: tons)

	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th	15th
Capacity Utilization (%)	(70)	(80)	(90)	(100)	(100)	(100)	(100)	(100)	(100)	(100)	(100)	(100)	(100)	(100)	(100)
Production	280,000	320,000	360,000	400,000	400,000	400,000	400,000	400,000	400,000	400,000	400,000	400,000	400,000	400,000	400,000
Inventory Increase	23,333	3,334	3,333	3,333	–	–	–	–	–	–	–	–	–	–	–
Sales Volume	256,667	316,666	356,667	396,667	400,000	400,000	400,000	400,000	400,000	400,000	400,000	400,000	400,000	400,000	400,000
Thai Domestic Sales	256,667	316,666	334,700	350,950	366,100	179,200	379,200	400,000	400,000	400,000	400,000	400,000	400,000	400,000	400,000
Exports to Non-ASEAN	–	–	21,967	45,717	33,990	33,900	8,800	–	–	–	–	–	–	–	–

(US$/t in 1985 prices)

	CIF Price	Freight	Shipment Price
Thailand	225	—	225
Singapore	229	15	214
Malaysia	230	17	213
Indonesia	229	19	210
Philippine	225	23	202

(3) Sales price of ammonium chloride

It is assumed that the overwhelming majority of the ammonium chloride produced by this Project will be marketed mainly to the Thai domestic market, and that any remainder is exported to non-ASEAN markets.

On the above assumption, the sales price of ammonium chloride for this Project has been projected (see section 4-4 of Part II). The financial projections use the thus projected prices of ammonium chloride, as summarized below.

	(1985 price) Price (US$/t)
Domestic sales in Thailand	150
Exports (FOB)	120

(4) Prices of raw materials and utilities

The financial projections use the prices of raw materials and utilities as stated in section 2-2-1.

2-3-2 Profitability of Soda Ash Plant

The financial rate of return on investment for the soda ash plant was assessed in terms of IRR by taking the assumptions as stated in the opening paragraphs of this Part; section 1-2 of Chapter 1, and sections 2-1 and 2-3-1 of this Chapter 2. The IRR computed for the proposed soda ash plant is as follows.

	IRR (%)
IRR before tax	7.45
IRR after tax	6.46

The financial statements are attached as Annex VII.

The sensitivity of the IRR by affects of changes in major factors are shown in Table VII-17 and Figure VII-5.

The above calculation was made on the basis of the assumption that as has been stated earlier, the soda ash produced at the plant is made from rock salt purchased from the mine. Ammonia requirements are to be satisfied by use of imported ammonia, and fuel oil is to be the fuel used. Consequently, the costs of these raw materials and utilities, as given in 1-2-1, are: rock salt, US$26/t; ammonia, US$235/t; fuel oil, US$227/$m^3$. It is assumed that carbon dioxide will be obtained by recovering the gas which is separated from natural gas and is purged at the PTT's natural gas processing plant, as mentioned above, at no charge to the Project. The cost of carbon dioxide recovery facilities and the pipeline to the soda ash plant, however, is included as one of the costs of the soda ash plant and therefore is included in the capital requirement of the plant. Also included in the tabulation of required capital are: receiving facilities for imported ammonia; rock salt storage facilities as well as a belt conveyor system for transport of rock salt to the plant; export shipment facilities for rock salt and soda ash (a belt conveyor system to the pier and bulk loading facilities on the pier). The cost of laying railroad spurs is also included. As is evident from the above figures, as long as the assumptions used and specified here exist in reality, the return on investment for this Project does not exceed the minimum level agreed upon for ASEAN industrial project (8%). The low level of profitability of this profit center is ascribable to high costs relative to the expected sales price. Referring to the results of sensitivity analysis, recommendations on measures to be taken by the GOT for improving profitability of the soda ash plant are summarized below. (see Table VII-17 and Figure VII-5). The IRRs referred to in the following discussions denote IRR after tax unless otherwise specified.

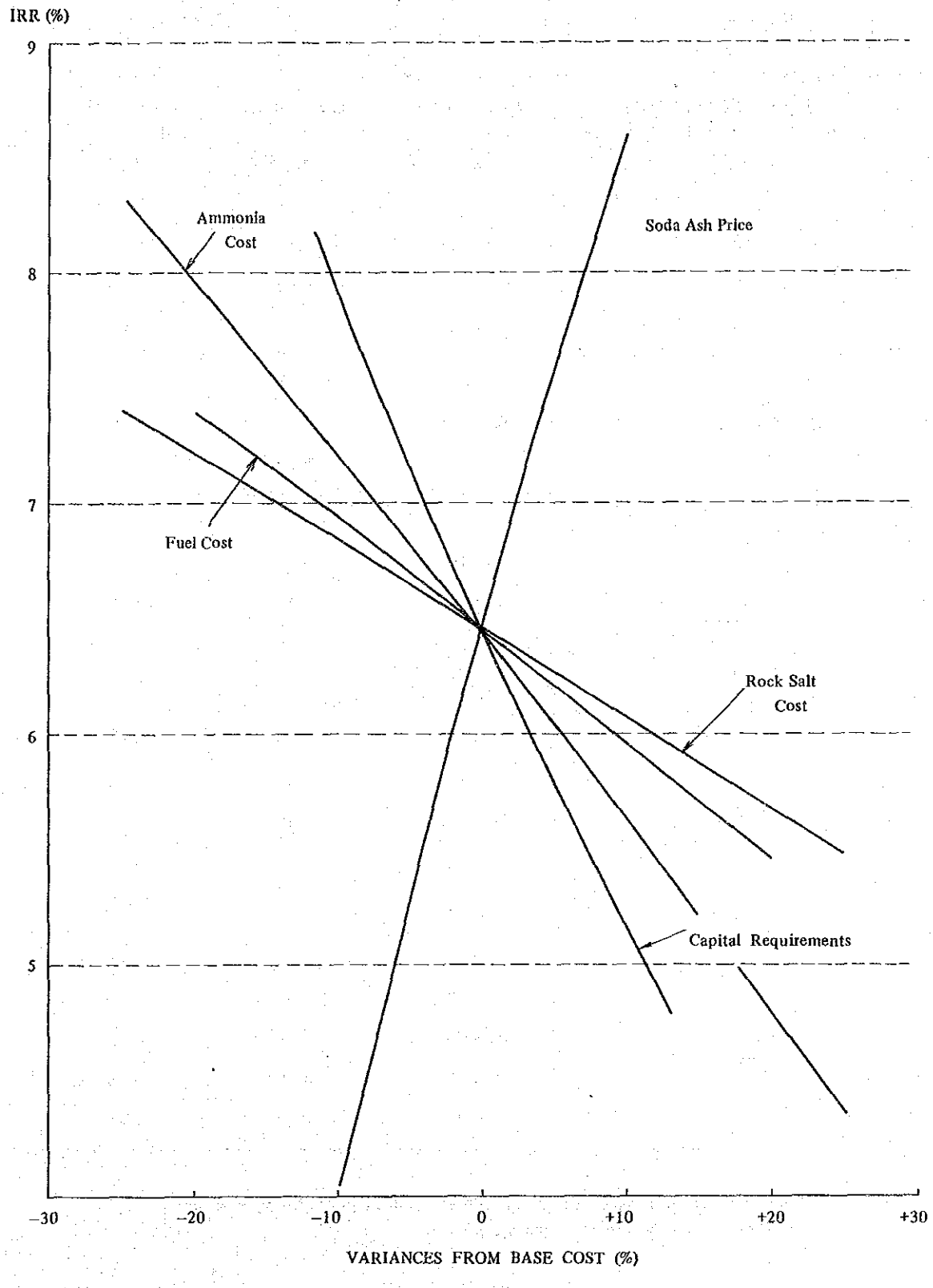
(1) The major cause of the cost of soda ash being high, as has been discussed earlier, is the high cost of ammonia. It is essential to find appropriate ways to obtain a lower cost of ammonia. If the ammonia cost is lowered by 10%, the IRR would increase by 0.76% up to 7.22%. The IRR could be improved by 1.86% and become 8.32% in the event that ammonia can be obtained at the cost of US$176/t which is about 25% lower than the projected cost.

Table VII-17 SENSITIVY OF IRR (SODA ASH PLANT)

AFFECTING FACTORS	VARIANCES	IRR before Tax	IRR after Tax
a) Soda Ash Prices *	+ 10 (%)	9.78 (%)	8.60 (%)
	+ 5	8.74	7.58
	Base Cost	7.45	6.46
	− 5	6.16	5.30
	−10	4.73	4.03
b) Capital Requirements	+ 10	5.98	5.15
	Base Cost	7.45	6.46
	−10	9.10	7.97
c) Ammonia Cost (US$235/t)	+ 25	5.11	4.36
	+ 10	6.57	5.66
	Base Cost	7.45	6.46
	−10	8.28	7.22
	−25	9.47	8.32
d) Rock Salt Cost (US$26/t)	+ 25	6.36	5.48
	+ 10	7.03	6.08
	Base Cost	7.45	6.46
	−10	7.86	6.84
	−25	8.46	7.39
e) Fuel Cost (US$227/$m^3$)	+ 20	6.34	5.46
	+ 10	6.91	5.97
	Base Cost	7.45	6.46
	−10	7.98	6.95
	−20	8.49	7.41

(Note) * The sales prices are changed only on soda ash, and the prices for ammonium chloride are fixed at the projected prices.

Figure VII-5 SENSITIVITY OF IRR (AFTER TAX)
(Soda Ash Plant)



It is recommended, as has been discussed in 1-2-3, that the GOT's authority take steps for obtaining lower cost ammonia either by means of importing ammonia produced at large-scale ammonia plants operating in the surrounding countries (Indonesia and Malaysia) under special price arrangements or by means of promoting the natural-gas-based fertilizer complex project in Thailand which is now being planned by the GOT so that the ammonia produced at the complex can be used. It is thought to be impossible to precisely determine, at this point, what the price of ammonia would be in such a case, but in view of general considerations of the cost of ammonia produced in large ammonia plants based on natural gas, it is expected that a price on the order of US$175/t (1985 price) would be negotiable.

(2) With regard to fuel, as is recommended in 1-2-3, if natural gas can be obtained at a per calorie cost lower than that of fuel oil, it will greatly contribute to improvement of the profitability. As is evident from the sensitivity analysis, the IRR will increase by 0.49% from the base IEE of 6.46% to 6.95% by 10% lowering of fuel cost and will increase by 0.95% to 7.41% by 20% lowering of fuel cost.

(3) If the rail freight charges can be lowered 25 to 30% from the projected US$10/t, the cost of rock salt supplied to the soda ash plant could be reduced to that extent, i.e., a 10% lowering of the projected rock salt cost of US$26/t. In this event the IRR would be improved by 0.38% to increase to 6.95%.

(4) Summing up the above discussions, when it is assumed that ammonia, fuel and rock salt can be obtained at the following costs, that is, US$176.25/t of ammonia (25% reduction), US$181.60/t of fuel (20% reduction), and US$23.4/t of rock salt (10% reduction), the IRR of 9.87% before tax and 8.67% after tax can be anticipated. This rate of returns is within a range of justifying the investment, although it does not necessarily indicate a high profitability. It is observed that the above measures would be the primary importance for improving the profitability.

(5) Increases in sales prices would also greatly contribute to improvement of the profitability. For instance if any measures are taken so as to increase the soda ash sales prices by 5%, the IRR would rise by 1.12% up to 7.58%, and by increasing the sales prices by 10% the IRR would be improved by 2.14% and become 8.6%.

(6) Another factor affecting the profitability is the capital costs. It is difficult, at present, to find any measures for reducing the projected capital cost. Nevertheless, for the instance, if the fertilizer complex is located adjacent to the soda ash plant site and excess carbon dioxide produced from an ammonia plant of the complex is supplied to the soda ash plant, the supply of carbon dioxide from the PTT's gas processing plant can be substituted, so that the capital cost is reduced by approximately US$ 20 million or about 5% due to deletion of long distance pipeline as well as other related facilities. It will improve the IRR by about 0.6%.

2-4 FINANCIAL ANALYSIS OF THE ENTIRE PROJECT

2-4-1 Profitability of the Entire Project

The overall return on investment of this Project was assessed by consolidating the two profie centers, i.e., the rock salt mine and soda ash plant, discussed in the previous sections. The calculated IRR are as follows:

	Internal Rate of Return	
	IRR before tax	IRR after tax
Base Case	7.84%	6.71%
Alternative Case	8.01%	6.93%

For the Base Case it is assumed that the Project comprises

(A) Rock salt mine of 1.2 million t/y production and

(B) Soda Ash Plant having the capacity of 400,000 t/y each of soda ash and ammonium chloride.

All the assumptions used here are the same as those used for the Base Case in the foregoing IRR computation shown in 2-2-2 and 2-2-1. However, the projected sales revenue for rock salt exclude that for the rock salt supplied to the soda ash plant, and simultaneously no cost is accounted with regard to the rock salt consumed for soda ash production at the plant. For the Alternative Case the production scale of rock salt mine is assumed as 1.8 million t/y, whereas the capacity of soda ash plant is the same as the Base Case. The financial statements are attached as Annex VII. Sensitivity of the IRRs affected by changes in the prices of major factors is shown in Table VII-18 and Figure VII-6.

Table VII-18 SENSITIVITY OF IRR (ENTIRE PROJECT)

Affecting Factors		Base Case		Alternative Case	
Items	Variances	IRR before Tax	IRR after Tax	IRR before Tax	IRR after Tax
a) Rail Transportaion Cost(US$10/t)	+20	7.30	6.28	7.12	6.12
	+10	7.57	6.53	7.53	6.53
	Base Cost	7.84	6.71	8.01	6.93
	−10	8.10	7.01	8.44	7.33
	−20	8.36	7.25	8.85	7.71
	−30	8.61	7.48	9.25	8.08
b) Ammonia Cost (US$235/t)	+25	5.90	5.01	6.08	5.18
	+10	7.09	6.09	7.27	6.25
	Base Cost	7.84	6.71	8.01	6.93
	−10	8.54	7.42	8.71	7.58
	−25	9.55	8.36	9.72	8.52
c) Fuel Cost (US$227/$m^3$)	+20	6.90	5.92	7.08	6.08
	+10	7.38	6.35	7.55	6.51
	Base Cost	7.84	6.71	8.01	6.93
	−10	8.28	7.18	8.46	7.34
	−20	8.72	7.58	8.89	7.75
d) Soda Ash Sales Prices *	+10	9.82	8.61	9.98	8.76
	+ 5	8.76	7.62	8.95	7.80
	Base Cost	7.84	6.71	8.01	6.93
	− 5	6.75	5.78	6.93	5.95
	−10	5.58	4.73	5.77	4.90
e) Capital Requirements	+10	6.37	5.45	6.53	5.60
	Base Cost	7.84	6.71	8.01	6.93
	−10	9.48	8.29	9.67	8.46

(Note) * The sales prices are changed only on soda ash and the prices for rock salt and ammonium chloride are fixed at the projected prices.

Figure VII-6(1) SENSITIVITY OF IRR (AFTER TAX)
(Entire Project — Base Case)

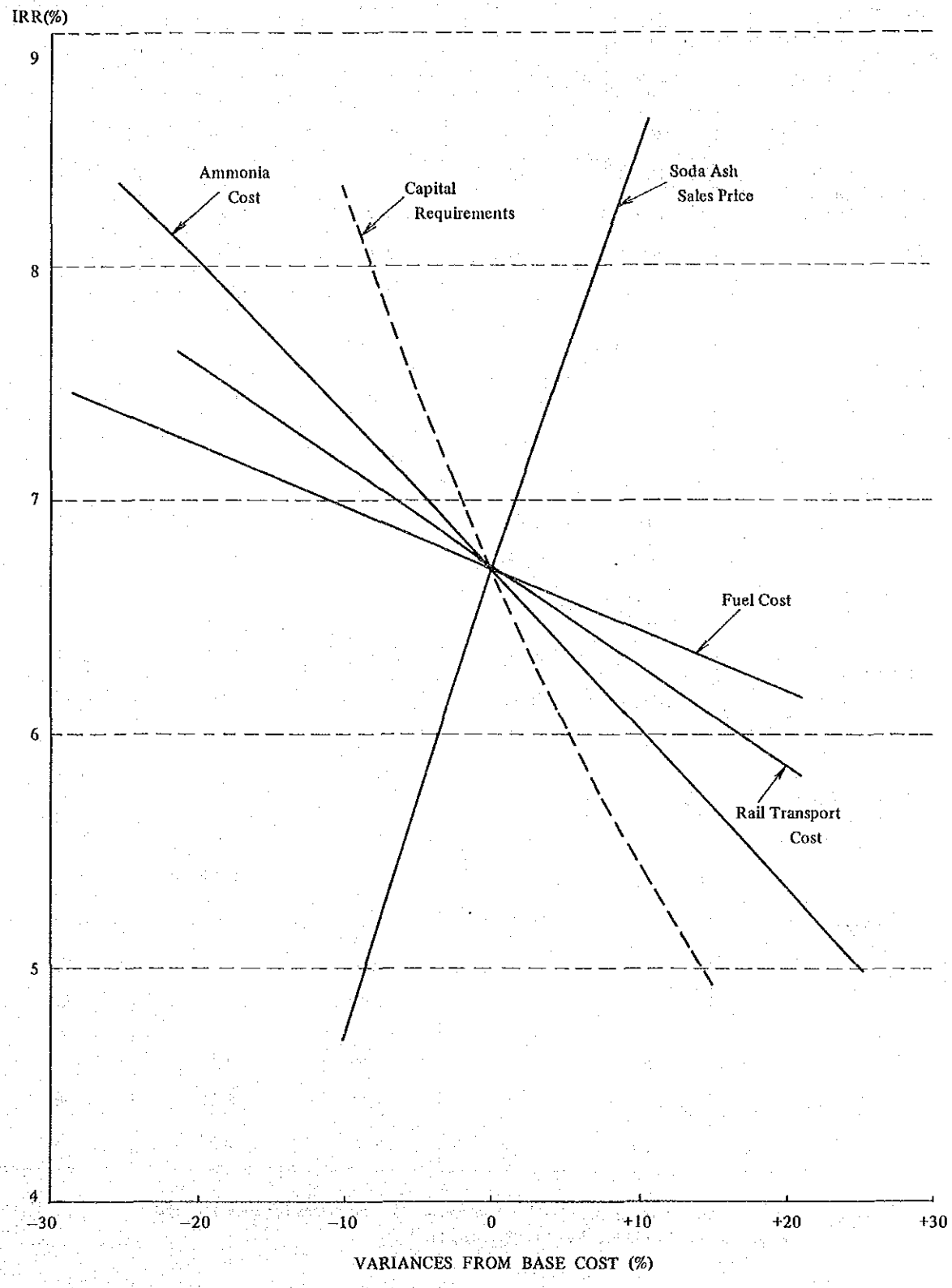
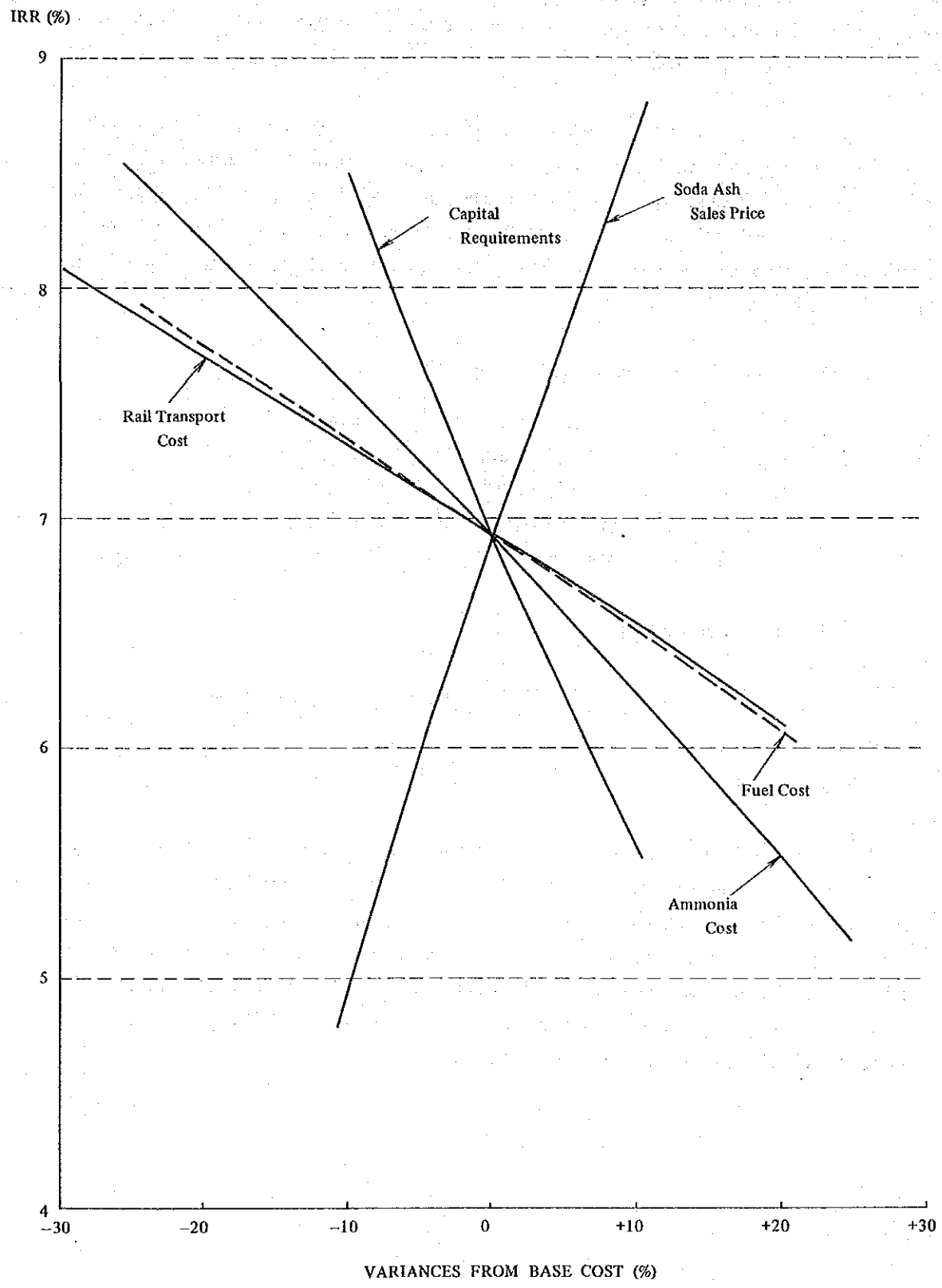


Figure VII-6 (2) SENSITIVITY OF IRR (AFTER TAX)
(Entire Project — Alternative Case)



As the above figures evidently show, as long as the assumed conditions prevail, it is likely that this Project (both Base Case and Alternative Case) has a low profitability. A low profitability of the soda ash plant, as has been discussed in 2-2 and 2-3, would cause low returns for the entire Project.

If appropriate measures on such steps as stated in 3-3-2 are taken by the GOT with regard to the improvement of profitability of the soda ash plant, the profitability of the entire Project would obviously be improved. The following shows the IRR computed on the basis of assumptions that, as results of the GOT's measures, ammonia and fuel can be obtained at such costs as indicated in 2-3-2 and rail freight charges as well have been lowered as suggested in 2-2-2.

1) Cost of key factors used for IRR computation

- Ammonia US$176.25/t (25% less than Base Cost)
- Fuel US$181.60/m^3 (20% less than Base cost)
- Rail freight charges US$7.40/t (26% less than Base Case)
  (The 26% reduction of rail freight charges result in 10% reduction of the cost for rock salt supplied to the soda ash plant.)

2) IRRs of the entire Project

	IRR before tax	IRR after tax
Base Case	10.97%	9.69%
Alternative Case	11.05%	10.21%

It is obvious that when the above assumptions are ensured in actuality the Project would have reasonable financial returns. Moreover, if any measures are taken so as to assume higher sales prices particularly with regard to soda ash, the profitability would be further improved. Assuming that the above costs listed for the three key elements (ammonia, fuel and rail freight) have been attained in actuality, sensitivity of the IRR affected by changes in soda ash sales prices as well as capital requirements for the Project was analyzed. The results of this analysis are summarized below:

Affecting Factors	Variances	Base Case		Alternative Case	
		IRR before tax (%)	IRR after tax (%)	IRR before tax (%)	IRR after tax (%)
Capital Requirements	+10%	9.43	8.25	9.94	8.74
	Base Cost	10.97	9.69	11.05	10.21
	-10%	12.73	11.37	13.28	11.92
Soda Ash Sales Prices	+10%	12.73	11.38	13.23	11.87
	+ 5%	11.28	10.00	11.83	10.54
	Base Cost	10.97	9.69	11.05	10.21
	- 5%	10.04	8.82	10.59	9.35
	-10%	9.09	7.92	9.66	8.46

The above analyses can be concluded with the following comments.

1) In order that this Project has reasonable profitability, it is essential for the GOT to conceive measures to obtain lower cost ammonia and fuel and also to reduce rail transport cost as recommended in 2-2-2 and 2-2-1. Such measure are prerequisite for the Project to be financially viable.

2) Moreoer, it is also important for the GOT to conceive measures which can secure the sale of soda ash at prices higher than the projected prices.

3) This Project has possibilities to gain reasonable returns as the results of these measures taken by the GOT.

2-4-2 Financial Structure of the Project

If the prices of the rail transport, ammonia and fuel in actuality are substantially higher than those assumed in 2-4-1, there is no question but that the financial structure of the project will be weakened along with less profitability. Therefore, it is the precondition for the Project being financially viable that the above conditions are satisfied. Nevertheless, on the assumption that these conditions will be as anticipated, the financial structure of the Project is as summarized in Table VII-19. The financial statements are attached as Annex VII.

Table VII-19 (1) FINANCIAL INDEXES (POSSIBLE IMPROVEMENT)

	Base Case			Alternative Case		
	6% p.a. interest	5% p.a. interest	4% p.a. interest	6% p.a. interest	5% p.a. interest	4% p.a. interest
1. Net Profit against Sales Revenue (Average for 15 years) * (%)	13.3	14.4	15.6	13.6	14.7	15.7
2. Debt Service Coverage Ratio (DSR)						
1st year (1985)	1.02	1.12	1.24	1.05	1.15	1.27
2nd year	1.28	1.41	1.55	1.34	1.46	1.61
3rd year	1.58	1.69	1.85	1.61	1.76	1.93
(Average for 15 years*)	1.90	2.02	2.15	1.96	2.09	2.23
3. Current Ratio (Average for 15 years) * (%)	7.06	7.61	8.15	7.35	7.88	8.40
4. Quick Ratio (Average for 15 years) * (%)	6.51	7.06	7.60	6.79	7.33	7.84
5. IRR on Equity (%)	13.48	14.98	16.46	14.69	16.18	17.65

(Note) * Weighted average for 15 years.

Table VII-19 (2) FINANCIAL INDEXES (BASE PROJECTION)

	Base Case	Alternative Case
1. Net Profit against Sales Revenue (Average for 15 years) (%)	7.6	7.4
2. Debt Services Coverage Ratio (DSR)		
1st year (1985)	0.86	0.86
2nd year	1.08	1.09
3rd year	1.30	1.31
4th year	1.56	1.61
(Average for 15 years)	1.64	1.66
3. Current Ratio (Average for 15 years) (%)	5.03	5.04
4. Quick Ratio (Average for 15 years) (%)	4.37	4.37

As is shown by the indices figured in the table, even after the above conditions are satisfied, until the third or fourth year, the financial structure does not warrant an optimistic view. Nevertheless, it is judged that the Project is financially self-liquidating.

Taking all of the above into consideration, it is judged that if the price level projected above in 2-4-1 for the ghree key factors (rail transport charges, ammonia cost and fuel cost) could be obtained so as to secure reasonable returns, that the project becomes financially viable.

PART VIII

ECONOMIC EVALUATION

PART VIII ECONOMIC EVALUATION

The economic importance of this Project can be defined from two different angles; one is for Thailand, the host country for the Project, and the other is for the other four ASEAN countries. For Thailand, the importance will be the contribution to her national economy in the following terms;

1. The value added to indigenous natural resources which could be attained by means of mining rock salt deposits and producing soda ash, efficiently utilizing the produced rock salt and labor resources available in the country, and

2. Foreign exchange savings or earnings which could be gained through the supply of the produced rock salt and soda ash to the domestic Thailand markets as well as the exportation of the products to other ASEAN markets.

On the other hand, for the other ASEAN countries, it should be the expansion of investment opportunities as well as the expansion of inter-regional trade which could contribute to further development of their economy. Furthermore, the implementation of this Project may serve as a foothold for evolving an ASEAN common market and other joint developments.

From the above viewpoint, the Evaluation Study Team has made quantitative analysis on the economic benefits of this Project to Thailand while qualitatively evaluating the economic effects of this Project to the other ASEAN member countries.

CHAPTER 1 ASSESSMENT OF THE ECONOMIC INTERNAL RATE OF RETURN OF THIS PROJECT

First an assessment of economic benefits and costs of this Project had been made. Then the economic internal rate of return was computed for the Project on the basis of the thus-assessed economic benefits and costs. These analyses were made from the standpoint of Thailand.

1-1 ECONOMIC BENEFITS OF THIS PROJECT

The economic benefits are evaluated separately as direct benefits and indirect benefits.

1-1-1 Direct Benefits

The direct benefits can be assessed as the economic value of the produced rock salt, soda ash and ammonium chloride (for sale) which will be gained through the contemplated investment.

The economic benefit for Thailand will be primarily the revenue of the Project entity earned by supplying the above products to the domestic market and also by exporting to ASEAN countries and outside the ASEAN region in part at internationally competitive prices.

1-1-2 Indirect Benefits

Indirect benefits of this Project can be generally defined as follows:

1. Increase in employment opportunities

   One of the indirect benefits of this Project will be an increase in employment opportunities in Thailand with the employment of labor for the construction and operation of the rock salt mine and the soda ash plant of this Project.

2. Ripple effects to related industries

   Ripple effects of this Project to related industries include the increase in demand for construction materials such as steel materials and cement, and stimulation for the development of engineering and construction

industries. Also the increase of demands for various materials which will be used for the operation of the mine and the plant and the packing and shipment of the products will be beneficial.

3. Contribution to the development of regional economy

   This Project will contribute directly or indirectly to the development of the regional economy through an increase in demands of transport and service sectors which will arise due to the construction and operation of the mine and the plant in the Project.

The implementation of this Project will, as is stated above, bring various indirect benefits to Thailand where the Project is located. Quantitative assessment in strict terms of these benefits is rather difficult. If such benefits are assessed, they should tend to be subjective. From such a viewpoint, the indirect benefits were not accounted in the computation of the economic internal rate of return of the Project.

1-2 ECONOMIC COSTS

Economic costs of this Project may be as follows:

1. Initial cost incurred in the implementation of this Project (capital cost)
2. Cost of the materials and utilities consumed for the production of rock salt, soda ash and ammonium chloride
3. Cost of labor resources consumed
4. Other costs required for the production

1-2-1 Initial Cost

Initial costs incurred in the implementation of this Project include the capital cost for the Project, pre-operation expenses and initial working capital. The amount of such initial costs was estimated by deducting the cost of paid-tax in Thailand from the capital cost used for the computation of the financial internal rate of return, that is, the capital requirement of the Project less the interest during construction.

1-2-2 Costs of Production

Costs of production include the costs for materials and utilities consumed for the production, costs of maintenance and repair of the plants and facilities, and cost of laborers engaged in production.

In assessing the above economic costs shadow prices of those items were estimated by using the standard conversion factors which had been established for application to economic assessment of various projects in Thailand,* and the thus estimated economic costs are used as the basis for computation of the economic internal rate of return. The taxes to be imposed under the Thai tax laws were excluded from the cost items, since these are regarded as transferrable costs from the point of view of the Thai nation.

1-3 ECONOMIC INTERNAL RATE OF RETURN

On the basis of the above-mentioned economic benefits and costs of this Project, the economic internal rate of return was computed for an economic life of 12 years. The thus-computed return rate is 15! (details are shown in Table VIII-1). It must be noted that this computation was made on the assumption that ammonia production using natural gas will be started as contemplated by the GOT and ammonia requirements at this Project will be met by the thus-produced ammonia. In view of the above figure, as far as such assumptions are realized, it is assessed that this Project would gain reasonable economic returns to the nation.

(Note): * World Bank Staff Working Paper No. 239 Social Cost-Benefit Analysis: A Guide for Country and Project Economists to the Derivation and Application of Economic and Social Accounting Prices.

The established standard conversion factors are as follows:

Standard conversion factor:	£ = 0.791
Conversion factor for producer goods:	B_k = 0.82
Conversion factor for consumer goods:	B_c = 0.963
Conversion factor for electricity:	B_p = 1.276
Conversion factor for transportation:	B_t = 0.759
Conversion factor for labor:	B_l = 0.963

CHAPTER 2 OTHER ECONOMIC BENEFITS AND OVERALL EVALUATION

In addition to the economic return, this Project will greatly contribute to foreign exchange earnings or savings particularly for Thailand. Furthermore, this Project will serve as a foothold for the ASEAN countries to develop a common market and expand joint investment opportunities, thereby promoting industrialization and economic development in the whole of the ASEAN region.

Table VIII-1 (1) COST/BENEFIT (EIRR) (Rock Salt: 1,200,000 t/y, Soda ash: 400,000 t/y)

(B '000'000)

Year	Cost	Benefit	Dis. Rate 10%	Discounted Cost	Discounted Benefit	Dis. Rate 15%	Discounted Cost	Discounted Benefit
82	2,742.98		1	2,742.98		1	2,742.98	
83	3,657.30		0.9091	3,324.85		0.8696	3,180.39	
84	2,742.98		0.8265	2,267.07		0.7561	2,073.97	
85		1,263.50	0.7513		949.27	0.6575		830.75
86		1,566.39	0.6830		1,069.84	0.5718		895.66
87		1,740.74	0.6209		1,080.83	0.4972		865.50
88		1,918.92	0.5645		1,083.23	0.4323		829.55
89		1,988.79	0.5132		1,020.64	0.3759		747.59
90		2,021.16	0.4665		942.87	0.3269		660.72
91		2,046.97	0.4241		868.12	0.2843		581.95
92		2,067.22	0.3855		796.91	0.2472		511.02
93		2,080.71	0.3505		729.29	0.2149		447.14
94		2,094.12	0.3186		667.19	0.1869		391.39
95		2,107.50	0.2897		610.54	0.1625		342.47
96		2,120.98	0.2633		558.45	0.1413		299.69
97		2,134.48	0.2394		510.99	0.1229		262.33
98		2,147.86	0.2176		467.37	0.1069		229.61
99		2,159.47	0.1978		427.14	0.0929		200.61
				8,344.90	11,782.75		7,997.34	8,095.98
				+3,447.85			+98.64	

$$(15-10) \times \frac{98.64}{3{,}447.85 - 98.64} = 0.03$$

EIRR = 15 + 0.03 = 15.03%

Table VIII-1 (2) ECONOMIC CAPITAL COST

	Items	Capital Cost (in Financial Prices) (US$'000)	Conversion Factors	Capital Cost (in Shadow Prices) (B'000'000)
1.	Foreign exchange cost	270,324	x 1.26 x 20.56	7,003.32
2.	Local currency cost	131,750	x 0.79 x 20.56	2,139.94
		402,074		9,143.26

(Note) Excluding land acquisition cost and interest during construction.

Table VIII-1(3) PROJECTED ECONOMIC NET BENEFIT
(Rock Salt: 1,200,000 t/y, Soda Ash: 400,000 t/y)

(B '000'000)

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1. DIRECT ECONOMIC BENEFIT (See Att. 1)	2,604.83	3,220.59	3,602.15	3,983.37	4,074.17	4,111.21	4,140.83	4,165.11	4,182.50	4,199.75	4,216.98	4,234.54	4,251.93	4,269.16	4,281.87
2. ECONOMIC COST															
A. Rock Salt															
– Direct op. cost (See Att. 2)	51.63	63.48	70.92	76.98	78.81	80.36	81.62	82.96	84.25	85.53	86.80	88.15	89.44	90.72	91.08
– Fixed cost (See Att. 3)	25.84	31.77	35.49	38.52	39.44	40.22	40.85	41.52	42.17	42.80	43.44	44.12	44.76	45.40	45.59
– Transportation cost (See Att. 4)	78.30	96.26	107.54	116.73	119.52	121.86	123.78	125.80	127.76	129.69	131.63	133.68	135.64	137.57	138.12
Total	155.77	191.51	213.95	232.23	237.77	242.44	246.25	250.28	254.18	258.02	261.87	265.95	269.84	273.69	274.79
B. Soda ash plant															
– Raw materials & utilities (See Att. 5)	929.66	1,146.97	1,291.86	1,436.74	1,448.81	1,448.81	1,448.81	1,448.81	1,448.81	1,448.81	1,448.81	1,448.81	1,448.81	1,448.81	1,448.81
– Fixed cost (Sec Att. 6)	255.90	315.72	355.60	395.48	398.80	398.81	398.81	398.81	398.81	398.81	398.81	398.81	398.81	398.81	398.81
Total	1,185.56	1,462.69	1,647.46	1,832.22	1,847.61	1,847.61	1,847.61	1,847.61	1,847.61	1,847.61	1,847.61	1,847.61	1,847.61	1,847.61	1,847.61
ECONOMIC COST-TOTAL	1,341.33	1,654.20	1,861.41	2,064.45	2,085.38	2,090.05	2,093.86	2,097.89	2,101.79	2,105.63	2,109.48	2,113.56	2,117.45	2,121.30	2,122.40
3. NET BENEFIT (1-2)	1,263.50	1,566.39	1,740.74	1,918.92	1,988.79	2,021.16	2,046.97	2,067.22	2,080.71	2,094.12	2,107.50	2,120.98	2,134.48	2,147.86	2,159.47

Attachment 1 DIRECT ECONOMIC BENEFIT

Year	Benefit (in Financial Prices) (US$'000)	Conversion Factors	Benefit (in Shadow Prices) (B'000,000)
1985	100,845	(x 1.26 x B20.5)	2,604,826
1986	124,684		3,220,588
1987	139,456		3,602,148
1988	154,215		3,983,373
1989	157,730		4,074,166
1990	159,164		4,111,206
1991	160,311		4,140,833
1992	161,251		4,165,113
1993	161,924		4,182,497
1994	162,592		4,199,751
1995	163,259		4,216,980
1996	163,939		4,234,544
1997	164,612		4,251,928
1998	165,279		4,269,157
1999	165,771		4,281,865

(Note) * Sales revenue of rock salt, soda ash and ammonium chloride.

Attachment 2 ECONOMIC COST
DIRECT OPERATING COST
(Rock Salt Mine)

Year	Annual Direct Operating Cost for 1.2 million tons (B'000) *	Sales Volume ** (tons)	Annual Direct Operating Cost (in Shadow Prices) (B'000)
1985	(91,113.07)	x 680,000/1,200,000	51,631
1986		836,000/1,200,000	63,475
1987		934,000/1,200,000	70,916
1988		1,013,800/1,200,000	76,975
1989		1,038,000/1,200,000	78,813
1990		1,058,400/1,200,000	80,362
1991		1,075,000/1,200,000	81,622
1992		1,092,600/1,200,000	82,958
1993		1,109,600/1,200,000	84,249
1994		1,126,400/1,200,000	85,525
1995		1,143,200/1,200,000	86,800
1996		1,161,000/1,200,000	88,152
1997		1,178,000/1,200,000	89,443
1998		1,194,800/1,200,000	90,718
1999		1,199,600/1,200,000	91,083

(Note)

* Composed in the following manner.

* (A) Annual Cost for 1.2 million tons (Accounted in Financial Prices) (US$'000)	(B) Conversion Factor	(C) Annual Cost Accounted in Shadow Prices (B'000) (A) x (B)
5,626	0.79 x 20.5	91,113.07

** Including the supply to soda ash plant.

Attachment 3 ECONOMIC COST
FIXED COST (Rock Salt Mine)

Year	Annual Cost (in Shadow Prices) (B'000)	Sales Volume (tons)	Annual Cost (in Shadow Prices) (B'000)
1985	(38)	x 680,000	25,840
1986		836,000	31,768
1987		934,000	35,492
1988		1,013,800	38,524
1989		1,038,000	39,444
1990		1,058,400	40,219
1991		1,075,000	40,850
1992		1,092,600	41,519
1993		1,109,600	42,165
1994		1,126,400	42,803
1995		1,143,200	43,442
1996		1,161,000	44,118
1997		1,178,000	44,764
1998		1,194,800	45,402
1999		1,199,600	45,585

(Note)

* Computed in the following manner.

Items	Annual Cost (in Shadow Prices) (US$'000)	Conversion Factors	Annual Cost (in Shadow Prices) (B'000)
Labour	482	0.963 x 20.5	9,515
Materials	335	0.82 x 20.5	5,549
		Total:	15,064 ÷ 400 = 38

Attachment 4 ECONOMIC COST RAIL TRANSPORTATION (Rock Salt)

Year	Transportation Cost per ton (in Shadow Prices) * (B/t)	Sales Volume (tons)	Annual Transportation Cost (in Shadow Prices) (B'000)
1985	(115.14)	x 680,000	78,295
1986		836,000	96,257
1987		934,000	107,541
1988		1,013,800	116,729
1989		1,038,000	119,515
1990		1,058,400	121,864
1991		1,075,000	123,776
1992		1,092,600	125,802
1993		1,109,600	127,759
1994		1,126,400	129,694
1995		1,143,200	131,628
1996		1,161,000	133,678
1997		1,178,000	135,635
1998		1,194,800	137,569
1999		1,199,600	138,122

(Note)

* Computed in the following manner.

(A) Financial Prices (US$/t)	(B) Conversion Factors	(C) Transportation Cost Accounted in Shadow Prices (B/t) (A) x (B)
7.40	0.759 x 20.5	115.14

Attachment 5 ECONOMIC COST, RAW MATERIALS AND UTILITIES (Soda Ash Plant)

Year	Per-ton Cost (in Shadow Prices) (B/t) *	Sales Volume (tons)	Annual Cost (in Shadow Prices) (B'000)
1985	(3,622.03)	x 256,667	929,656
1986		316,666	1,146,974
1987		356,667	1,291,859
1988		396,667	1,436,740
1989		400,000	1,448,812
1990		400,000	1,448,812
1991		400,000	1,448,812
1992		400,000	1,448,812
1993		400,000	1,448,812
1994		400,000	1,448,812
1995		400,000	1,448,812
1996		400,000	1,448,812
1997		400,000	1,448,812
1998		400,000	1,448,812
1999		400,000	1,448,812

(Note) * Computed in the following manner.

Items	(A) Financial Prices (US$)	(B) Consumption per ton of soda ash	(C) Financial Cost per ton of soda ash (US$/t) (A) x (B)	(D) Conversion Factors	Per-ton Cost accounted in Shadow Prices (B/t) (C) x (D)
Ammonia	176.25/t	320 Kg	56.40	1.26 x 20.5	1,456.81
Quicklime	28.00/t	46 Kg	1.29	0.82 x 20.5	21.68
Soda ash	225.00/t	60 Kgs	13.50	0.82 x 20.5	226.94
Electricity	0.066/KWH	496 KWH	32.74	1.276 x 20.5	856.41
Water	0.108/m^3	25.6 m^3	2.76	1.276 x 20.5	72.20
Fuel	181.60/m^3	0.208 m^3	37.77	1.276 x 20.5	987.99
				Total:	3,622.03

1) No value is accounted for rock salt used for soda ash production.

2) Assuming that imported ammonia is used.

Attachment 6 ECONOMIST COST
FIXED COST (Soda Ash Plant)

Year	Per-ton Cost (in Shadow Prices) (US$'000)	Sales Volume (tons)	Annual Cost (in Shadow Prices) (B'000)
1985	(997)	x 256,667	255,897
1986		316,666	315,716
1987		356,667	355,597
1988		396,667	395,477
1989		400,000	398,800
1990		400,000	398,800
1991		400,000	398,800
1992		400,000	398,800
1993		400,000	398,800
1994		400,000	398,800
1995		400,000	398,800
1996		400,000	398,800
1997		400,000	398,800
1998		400,000	398,800
1999		400,000	398,800

(Note) * Computed in the following manner.

Items	Annual Cost (in Shadow Prices) (US$'000)	Conversion Factors	Annual Cost (in Shadow Prices) (B'000)
Labour	2,527	0.963 x 20.5	49,887
Overhead	5,054	0.963 x 20.5	99,774
Maintenance			
Foreign portion:	7,544	1.26 x 20.5	194,862
Local portion:	3,233	0.82 x 20.5	54,347
		Total:	398,870 ÷ 400,000
			= 997

ANNEX I

ANNEX I-1

MINUTES OF DISCUSSION

ON

WORK PROGRAM FOR EVALUATION STUDY OF

ASEAN ROCK SALT–SODA ASH PROJECT IN THAILAND

AGREED

BETWEEN

THAI COUNTERPART TEAM

AND

JAPANESE EVALUATION TEAM

DATED : SEPTEMBER 12TH, 1980.

/s/

MR. CHANA NILKUHA
DEPUTY DIRECTOR–GENERAL
DEPARTMENT OF MINERAL RESOURCES
MINISTRY OF INDUSTRY
TEAM LEADER
THAI COUNTERPART TEAM

/s/

MR. AKIHIRO MITARAI
HEAD OF INDUSTRY DIVISION
MINING & INDUSTRIAL PLANNING
AND SURVEY DEPARTMENT
JAPAN INTERNATIONAL
COOPERATION AGENCY

/s/

MR. MASAYASU SAKANASHI
TEAM LEADER
JAPANESE EVALUATION STUDY TEAM

In accordance with the scope of work previously discussed during March 20 to 30, 1979, both parties discussed about work program of the evaluation study, and as a subsequence confirmed that the evaluation study shall be proceeded with by referring to the attached paper.

WORK PROGRAMME FOR EVALUATION STUDY OF ASEAN ROCK SALT – SODA ASH PROJECT IN THAILAND

I. Background and Objectives of the Study

1.1 Rock salt is one of the mineral resources of which Thailand has possible deposits for commercial exploitation. Extensive work performed for the exploration of these resources has found the existence of rock salt deposits in the area of Khorat Plateau, Northeast Region of Thailand.

1.2 The ASEAN Economic Ministers, at their meeting of March, 1976, decided that one of the ASEAN Industrial projects shall be allocated a project (called the "ASEAN Rock Salt – Soda Ash Project") in Thailand which envisages the mining of the foregoing rock salt as well as the manufacturing of soda ash from the produced rock salt, provided that each ASEAN member state is satisfied with the viability of the project.

1.3 Following this decision of ASEAN Economic Ministers, the Government of Thailand (GOT), as the host country, carried out a feasibility study of the project under the technical assistance provided by the Asian Development Bank. The result of this study*[1)] was submitted to the ASEAN Economic Ministers Meeting convened in December, 1978, with the GOT's proposal that the ASEAN Rock Salt – Soda Ash Project shall be based on the production capacity of 2 million tons a year of rock salt and 400,000 tons a year of soda ash, and the ASEAN Economic Ministers agreed that the GOT takes necessary steps to finalize the proposed plan for their final decision.

1.4 Hence, in December, 1978, the GOT requested the Japanese Government to provide technical assistance for the evaluation study of the project with a view to providing financial assistance required for implementation of the project. The Japanese Government agreed to provide such technical assistance and entrusted the Japan International Cooperation Agency (JICA), the execution agency with the undertaking of the evaluation study.

1.5 In compliance with this GOT's request, a preliminary study team organized by JICA visited Thailand in March, 1979, for the purpose of identifying major problem areas for the evaluation study. As a result, the preliminary study team recommended that the following steps, among others, be taken by the GOT prior to the evaluation study:

(1) Conduct additional four test borings in the contemplated rock salt mining area in order to produce and collect basic data and information necessary for precise investigations on the rock salt mining.

(2) Select the site location for the soda ash plant.

(3) Organize the counterpart team.

1.6 Taking the above recommendation, the GOT and the Japanese Government mutually agreed that the evaluation study shall be carried out after the completion of such steps. Under this agreement, the GOT proceeded with the test borings and, for this end, the JICA provided the GOT with technical assistance in the selection of boring points, preparation of boring samples as well as the analysis of collected samples. These work have recently been completed and the results of boring tests have been compiled in the JICA report*2) submitted to the GOT. In the meantime, the GOT has completed the site selection with their decision that the soda ash plant be located in Laem Chabang, and also GOT has organized the counterpart team.

1.7 With the satisfactory completion of the agreed steps, GOT in June, 1980 requested the Japanese Government to proceed with the evaluation study by JICA. Under the foregoing background, this evaluation study is carried out by the JICA's Evaluation Study Team.

1.8 The "ASEAN Rock Salt – Soda Ash Project" proposed by the GOT broadly comprises the following three components:

(A) Rock Salt Mining:
Mining of rock salt from deposits scattered in the areas of Khorat Plateau, Northeast Region of Thailand, which is to produce rock salt at a rate of approximately 2 million tons per annum.

(B) Limestone Quarry:
Quarrying of Limestone from Khao Pang Sok Site, Saraburi area, which is designed to produce Limestone as required for the project.

(C) Soda Ash Plant:
Setting up of a soda ash plant in Laem Chabang, which is capable of producing soda ash at a rate of approximately 400,000 tons per annum.

And the produced rock salt and soda ash will be supplied primarily to the Thai domestic markets as well as other ASEAN markets.

1.9 The objectives of the evaluation study are to review, update and revise as necessary the feasibility study report*1) prepared by the GOT and to evaluate the technical and economic feasibility and financial viability of the project.

Note:

*1) Report on The Feasibility of a Rock Salt – Soda Ash Project in Thailand, prepared by SNC

*2) Technical Report of The First-Stage Evaluation for ASEAN Rock Salt – Soda Ash Project at Bamnet Narong Rock Salt Deposit, JICA:

II. Premises of the Study

2.1 Soda Ash manufacturing processes to be studied

Typical representatives of the alternative processes for manufacturing soda ash are the Solvey Process the Soda Ash/Ammonium Chloride Dual Process and the AC partial co-production process. The Evaluation Study Team will make comparative studies of alternative project schemes based on these three processes and recommend an optimum project scheme bases on either process.

2.2 Supply of ammonia

Ammonia required for the manufacturing of soda ash shall be met either by imports or domestic production. The Evaluation Study Team will discuss with the GOT about the supply of ammonia and, based on this discussion, will evaluate the availability of ammonia.

2.3 Supply of utilities and infrastructure

Laem Chabang area is situated in a grass-roots condition at present. However, the GOT would develop the supply of utilities (electric power, fuel gas and water) as well as infrastructure such as port, railway and road for public use. The Evaluation Study Team will evaluate the feasibility of the soda ash plant on the presumption that the GOT will be responsible for the supply of necessary utilities and infrastructure in time.

2.4 Improvement of railway

The mined rock salt will be transported by railway to the soda ash plant as well as the loading port for exports. The Evaluation Study Team will investigate the conditions of the existing railway on route and will recommend on any necessary improvement, but it is presumed that the GOT shall be responsible for implementation of such recommended improvement.

III. Programme of the Study

3.1 The study will be made on the basis of premises as set forth in Paragraphs 2.1 to 2.4 above. The study broadly consists of the following activities:

(A) Market study
(B) Technical study on the Rock Salt Mining and Limestone Quarry
(C) Transportation study
(D) Technical study on the Soda Ash Plant
(E) Management, financial and economic studies on the Project
(F) Overall evaluation of the Project

The programme of the study on each of the above-listed activities is defined in the following paragraphs.

A) Market study

3.2 Forecast the future demands up to 1995 for salt, soda ash and ammonium chloride in Thailand, and assess likely sales on the Thai domestic markets of rock salt, soda ash and ammonium chloride produced at the Project. In particular the assessment of sales for rock salt will be made in due consideration of the quality of mined rock salt.

3.3 Based on the necessary data and information provided by the GOT and/or arrangements by the GOT, forecast the future demands, domestic supplies and possible imports up to 1995 for salt, soda ash and ammonium chloride in other ASEAN markets; study on governmental policies in these countries regarding importation of these products as well as their prevailing practice and channels for imports; and assess likely sales of rock salt, soda ash and ammonium chloride for exportation to these markets from the Project.

3.4 Study the possibilities to export these products to non-ASEAN countries.

3.5 Study the future price trend of these products in international markets, and assess likely sales prices of these products for the Project.

3.6 Based on the above studies, formulate the projected sales for the Project and also recommend on marketing and distribution of these products to the domestic markets as well as exports.

B) Technical study on the Rock Salt Mining and Limestone Quarry

3.7 Based on available data, locate the optimum mining site and examine accessibility for the mining; delineate physical features and geologic conditions of the mining site; estimate the volume of deposits and mining life; and analyze and assess the quality of mined rock salt and limestone.

3.8 Based on the above studies, examine the optimum mining method and define necessary equipment and facilities; and develop plot plan for the facilities.

3.9 Examine organizational structure and man-power requirements, and formulate implementation programmes.

3.10 Estimate capital requirements for the rock salt mining and shipment and also production cost of the rock salt and limestone.

3.11 Regarding the quarrying of limestone, the evaluation shall be based on available data and information provided by GOT.

C) Transportation study

3.12 Study the existing conditions of railway on route to be used for transportation of mined rock salt, limestone and also any GOT's plan for expansion and/or improvement.

3.13 Study the availability of wagons to be used and also any GOT's plans for the future.

3.14 Examine the possibility of using the railway for transportation of the mined rock salt, limestone and recommend on any necessary improvement.

D) Technical study on the Soda Ash Plant

3.15 Study the site conditions of the selected site and examine the suitability of the site.

3.16 Study on the availability and/or proximity of utilities and infrastructure, and recommend on any steps to be taken by the GOT for the supply of utilities and infrastructure.

3.17 Based on the above studies and also discussion with the authorities, define technical requirements and project scope for the Soda Ash Plant.

3.18 Study on the optimum process scheme for the plant in the manner and procedure as set forth in Paragraph 2.1, and recommend on the process to be adopted.

3.19 Based on the above studies, define the optimum scale and concept for the manufacturing facilities, utilities and auxiliary facilities as well as offsite facilities. In this study special regards will be paid to pollution control systems and effluent disposal systems in line with NEB guideline.

3.20 Prepare a plot plan for the Soda Ash Plant.

3.21 Examine organizational structure and man-power requirements for the Plant and also examine implementation programmes.

3.22 Estimate capital requirements and production cost for the Soda Ash Plant.

E) Management, financial and economic studies on the Project

3.23 Study on management and financial conditions in Thailand which are related to the assessment of the Project.

3.24 Prepare financial plans and financial projections for the Project, and analyze the IRR and other financial indicators, including sensitivity analysis of these factors.

3.25 Financial analysis of Rock Salt Mine, Limestone Quarry and Soda Ash Plant as three independent profit centers.

3.26 Assess the Economic Internal Rate of Returns and other economic benefits of the Project.

F) Overall evaluation of the Project

3.27 Based on the foregoing studies, evaluate the technical and economic feasibility and financial viability of the Project.

IV. Work Schedule

4.1 The Evaluation Study will be completed by the end of January, 1981, and a draft final report will be presented to the GOT by the middle of February, 1981.

4.2 Following the presentation of the draft final report, a review meeting will be held in Bangkok between the representatives of the GOT and the Evaluation Study Team.

4.3 Given that all the content of the draft final report be finalized at the review meeting, the final report will be presented to the GOT by the middle of April, 1981.

V. Facilities and Services to be Provided by the GOT

During the field work in Thailand by the Evaluation Study Team, the GOT shall pro-provide the Evaluation Study Team with the following facilities and services:

(1) Provide available data and information which are required for the evaluation study.

(2) Arrange the Evaluation Study Team's visits to relevant ministries, agencies, institutes, firms, plants and/or places as well as their appointments with officials, officers and/or persons concerned in Thailand.

(3) Arrange the Evaluation Study team's trips outside Bangkok in Thailand, and provide land transportation required for these trips.

(4) Arrange the Market Expert's visit to other ASEAN countries for his market surveys in those countries.

(5) Provide office accommodation and facilities in Bangkok.

ANNEX I-2 MEMBERS OF JAPANESE EVALUATION STUDY TEAM

Mr. MASAYASU SAKANASHI
Team Leader
Techno-Economist

Mr. YOSHIO SATO
Assistant Team Leader
Project Engineer

Mr. SHOHEI MAENO
Project Engineer

Mr. TETSUO INOOKA
Economist,
Market Analyst

Mr. KOHKI KIKUCHI
Process Engineer

Mr. MASANORI MIURA
Process Engineer

Dr. YATARO SHIMOMURA
Mining Engineer

Mr. YUTAKA SUZUKI
Mining Engineer

Mr. ATSUSHI MIYAZU
Civil Engineer

Mr. KOJI ASANO
Civil Engineer

Mr. MASANAO KOYAMA
Transport Engineer

Mr. MASAHIRO KUMAGAI
Ministry of International
Trade and Industry

Mr. AKIHIRO MITARAI
Japan International
Cooperation Agency

Mr. YUKIO NAKAJIMA
Japan International
Cooperation Agency

Mr. KENJI KAWABI
The Overseas Economic
Cooperation Fund

ANNEX I-3 MEMBERS OF THAI EVALUATION STUDY TEAM

1.	Mr. Chana Nilkuha Deputy Director-General Department of Mineral Resources	Team Leader
2.	Mr. Prachuap Phawandon Director Mining Technology Division	Assistant Team Leader
3.	Mr. Thawat Japakasetr Geologist	Member
4.	Mr. Burachote Upalakalin Mining Engineer	Member
5.	Miss Supornsri Tumkosit Mining Engineer	Member
6.	Miss Pimpan Boonyakachorn Chemist, Process	Member
7.	Mr. Somchok Kongpitak Industrial Engineer	Member
8.	Mr. Pitak Amasuwan Mechanical Engineer	Member
9.	Mr. Wanchai Banpakan Mechanical Engineer	Member
10.	Mr. Vinit Hansamuth Mining Engineer	Member
11.	Mr. Somchai Duangkhae Mining Engineer	Member
12.	Dr. Anant Suwanapal Mining Engineer	Member and Secretary

ANNEX I-4 LIST OF ORGANIZATIONS VISITED

Sept. 10	Arrival at Bangkok
Sept. 11	Dept. of Technical & Economic Cooperation (NESOB)
	Japanese Embassy & JICA
	Dept. of Mineral Resources (MOI)
Sept. 12	- ditto -
Sept. 13	Thai Plastic & Chemical Co., Ltd.
Sept. 15	Dept. of Mineral Resources
	Thai Asahi Glass
	Thai Glass Industries
	Bangkok Glass
	Glass Organization
	Thai Asahi Caustic Soda Co., Ltd.
	Thai Central Chemical Co., Ltd.
	City Hall of Bamnet Narong
	Bamnet Narong Railway Station
	Proposed Mine Site & Village
Sept. 16	National Environmental Board
	Ministry of Industry (MOI)
	New Tiem Heng Humber
	The Siam Cement Co., Ltd.
	Substation of Electric Power at Bamnet Narong
	Department of Custom
	Department of Agriculture
	Bank of Tokyo
	Thai Asahi Caustic Co., Ltd.
Sept. 17	Bang Pakong Power Generation, Plant Construction Site
	Bang Phra Water Reservoir
	Proposed Plant Site Area (Laem Chabang)
	Sakol Patana Co., Ltd.
	Proposed Limestone Bury Site (Sara Buri)
	Department of Mineral Resources
	Department of Communication
	Japan Embassy
Sept. 18	ESSO Refinery
	TORC Refinery

	Rayong Area for Natural Gas Pipeline
	Dokkrai Water Reservoir
	The Punichi Company Ltd. (at Chiengmai)
	Universal Mining Ltd. (〃)
Sept. 19	Tapioca Jetty
	Proposed Plant Site Area (Laem Chabang)
Sept. 22	Electric Generating Authority of Thailand (EGAT)
	Petroleum Authority of Thailand (PTT)
	Department of Mineral Resources
	Ajinomoto (Thailand) Co., Ltd.
Sept. 23	Royal Irrigation Department
	Industrial Estate Authority of Thailand (IEAT)
	Department of Mineral Resources
	Bank of Tokyo
	Sumitomo Construction Co., Ltd.
	Tokai Thailand Co., Ltd.
Sept. 24	Port Authority of Thailand (PAT)
	Ministry of Communication (MOC)
	NYK Transport Service (Thailand) Co., Ltd.
	Thai Asahi Caustic Soda Co., Ltd.
	Express Transport Organization (E. T. O.)
	International Heavy Equipment Co., Ltd.
	Bangkok Motor Works Co., Ltd.
Sept. 25	Provincial Electric Authority
	Department of Town & Country Planning
	Metro Company Ltd.
	The Concrete Product & Aggregate Co., Ltd.
	The Siam Cement Co., Ltd.
	Construction Division of Royal State Railway
	Marketing Department of Royal State Railway
Sept. 25	Ministry of Industry
	The Overseas Economic Cooperation Fund
	Japan Trade Centre
	Department of Mineral Resources
Sept. 28	Proposed Rock Salt Mining Area
Sept. 29	Thai Asahi Caustic Soda Co., Ltd. (plant)
	Thai Asahi Glass Co., Ltd. (plant)

	Central Chemical Co., Ltd. (plant)
	Japanese Embassy
Sept. 30	Department of Mineral Resources

ANNEX II

ANNEX II-1 METHOD OF PROJECTING DEMAND FOR SODA ASH, SALT AND AMMONIUM CHLORIDE

In order to project the demand for the three products (soda ash, salt and ammonium chloride) the method adopted was to project demand at each of the following steps, for each product.

1. Projection of demand for the final product. (Here, "final product" is taken as meaning the form in which each of soda ash, salt and ammonium chloride is finally consumed.)

2. Study of the domestic production potential for each final product.

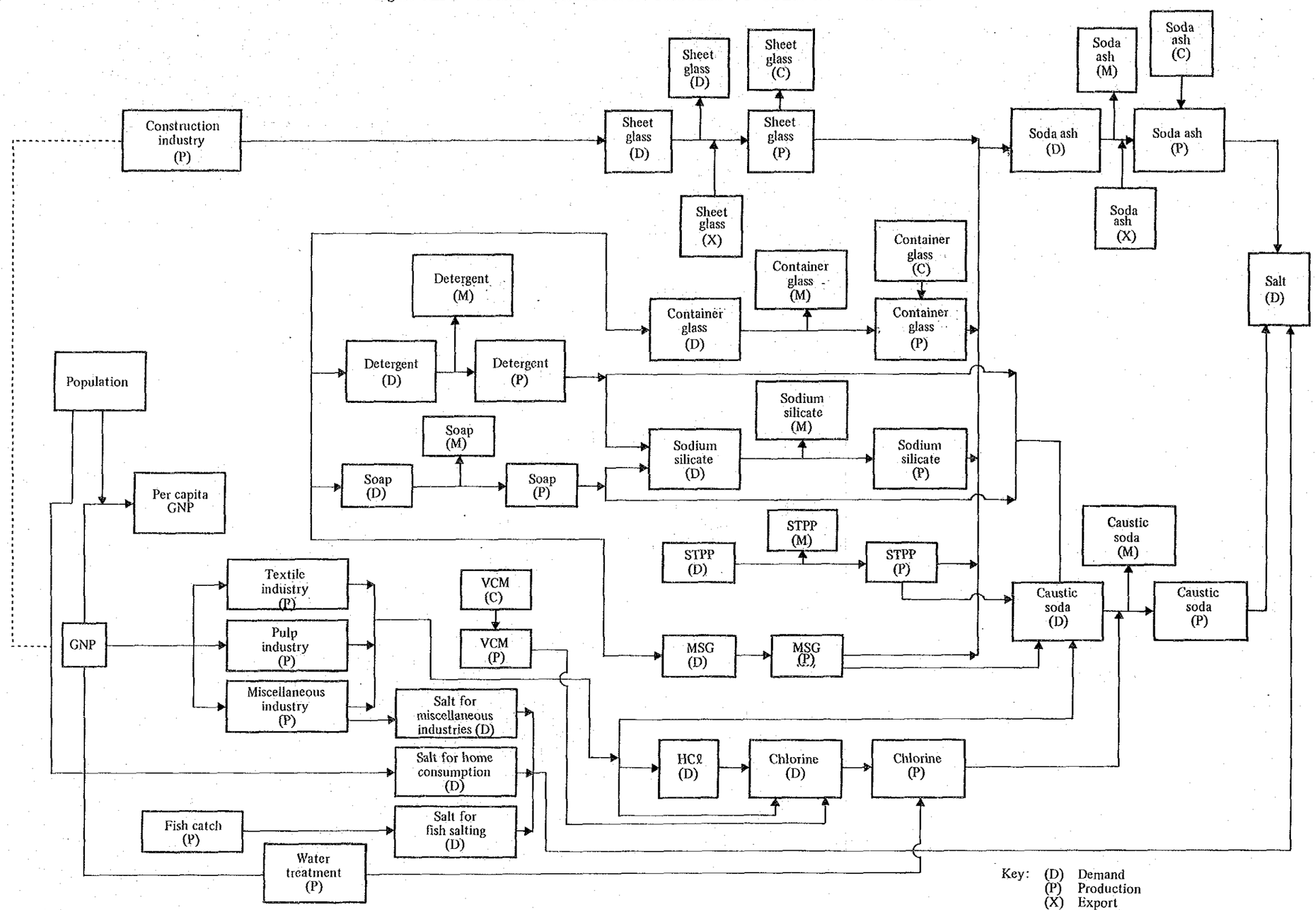
3. On the basis of the results of 2, projection of the demand for intermediate products (products used to make the final products).

4. Study of the domestic production potential for each intermediate product.

5. On the basis of the results of 3, projection of the demand for each product (soda ash, salt and ammonium chloride).

The varieties of intermediate and final products as well as the process of making the demand projections are shown in Figure AII-1.

Figure AII-1 DEMAND PROJECTION PROCESS OF SODA ASH AND SALT



Key: (D) Demand
(P) Production
(X) Export
(M) Import
(C) Production capacity

Demand projections, except in the case of ammonium chloride fertilizer, were made by the method given below.

1. Regarding the demand for such final products which are consumed by individuals as bottle glass, synthetic detergent, soap, monosodium glutamate, etc.:

   Per capita consumption was forecast by use of the coefficient of correlation with the per capita GNP.

   Results of the above were multiplied by the number of the population and gross demand quantity was obtained.

   In forecasting per capita consumption, consideration was given to the past and present per capita consumption levels in other countries, in order to insure that the projected levels do not exceed what is likely to occur.

2. For products such as sheet glass demand which bears a close relation to the country's construction industry, future values were projected on the basis of the correlation with the volume of construction.

Regarding population projections, where a country had announced future projections, use was made of these figures, and where no such announcement had been made, past growth rates were employed. Regarding GNP projections, fundamentally each country's target growth rates were used and when target rates were very different from past actual rates, correction of the former was done in view of actual trends.

Projected values for demand for intermediate products were sought by calculating the quantity of domestic production expected for each final product on the basis of domestic demand for each final product, and calculating the quantity of intermediate product required to produce these amounts of final products. In the study of expected quantity of domestic production of the final products, the following two factors were taken into consideration.

1. Percentage of supply of the final product through means of imports.

2. Possibility for expanding domestic production capacity to match domestic demand.

Further, because there are inter-country differences in quantities of consumption of intermediate products (unit consumption values) used to produce final products, the unit consumption values were modified to conform to conditions in each country.

Demand for each product (soda ash, salt and ammonium chloride) was sought by calculating the quantity which would be needed to produce the corresponding intermediate products. The process of calculation used was the same as described in the preceding paragraph.

Ammonium chloride fertilizer presents a different situation with regard to the consumption behavior of consumers of products based on soda ash and salt. That is, in the case of fertilizer, the final product can also be thought of as being an industrial good. In such a case, it is necessary to project demand in view of trends of agricultural production, the economic effects of the use of fertilizer, and so on. Therefore, demand projections for ammonium chloride were made by means of the following method, which differs from that used for the other products.

1. The area of land devoted to each crop was firstly projected in view of trends of agricultural production.

2. The potential demand for fertilizer was ascertained by taking up the case for application of fertilizer in such quantity as to obtain optimum economic effects for each crop on the cultivated area projected in 1 above.

3. With consideration given to the extent of diffusion of knowledge regarding the economic effects of fertilizer use, the realizable demand for fertilizer was projected on the basis of the potential demand.

4. The demand for ammonium chloride was projected among the above total fertilizer demand by examining the crops and areas on which ammonium chloride can be applied in view of characteristics of the fertilizer.

ANNEX II-2 DEMAND AND USER INDUSTRIES FOR SODA ASH, SALT AND AMMONIUM CHLORIDE IN THE ASEAN COUNTRIES

2-1 THAILAND

The quantities consumed and outlook for demand for soda ash and salt in user industries in Thailand are given in Tables AII-1 and AII-2.

General economic indicators used for preparation of demand projections are as shown in Table AII-3.

2-1-1 Soda Ash

The quantities of consumption of soda ash in Thailand, by user industry, are as follows (1979):

Sheet glass	27%
Bottle glass	60%
Sodium silicate	11%
Others	2%
Total	100%

Sheet glass is being produced by one company which is steadily expanding capacity in keeping with growth of demand. Imports are at an extremely low level. Present conditions and the outlook for demand for sheet glass are shown in Table AII-4.

There are three major makers of bottle glass. Domestic production capacity is expanding in keeping with growth of domestic demand. The composition of demand for bottle glass is: 40% for beer and soft drink bottling, and 30% for whisky bottling, with the remainder used for foods and cosmetics. Present conditions and outlook for bottle glass are shown in Table AII-4.

The majority (98% in 1979) of domestic demand for sodium silicate is satisfied by domestic production. More than 40% of the production is used by detergent makers, and the remainder is used in manufacturing soap.

Present and expected future demand is as shown in Table AII-4.

Table AII-1 ESTIMATED AND PROJECTED SODA ASH SUPPLY/DEMAND, THAILAND

(000 ton)

	1970	1973	1976	1979	Projected						
					1985	1986	1987	1988	1989	1990	1995
Import [1]	27.5	37.6	48.1	66.9							
Demand by User Industry											
Sheet Glass	7.2	10.8	11.8	17.8	28.3	30.7	33.1	35.8	38.7	41.7	60.5
Container Glass		22.5	30.1	40.2	75.7	81.8	88.2	94.8	101.7	108.8	148.6
Sodium Silicate	1.1	3.5	5.1	7.4	13.3	14.7	16.1	17.8	19.4	21.1	29.4
Caustic Soda	0.7	1.1	1.3	1.5	2.3	2.4	3.4	3.5	3.6	3.7	4.3
Total		37.9	48.3	66.9	119.6	129.6	140.8	151.9	163.4	175.3	242.8

Source: 1) Department of Customs, "Foreign Trade Statistics of Thailand".

Table AII-2 ESTIMATED PROJECTED SALT SUPPLY/DEMAND, THAILAND

(000 ton)

	1970	1973	1976	1978	Projected						
					1985	1986	1987	1988	1989	1990	1995
Production											
Solar Salt [1]	323.7	323.7	450.0	751.9	350.0	350.0	350.0	350.0	350.0	350.0	350.0
Rock Salt [2]			5.5	11.8	11.8	12.0	12.0	12.0	12.0	12.0	12.0
Total (A)			455.5	763.7	362.0	362.0	362.0	362.0	362.0	362.0	362.0
Export (B) [3]	96.3	104.5	83.3	87.9	96.0	96.0	96.0	96.0	96.0	96.0	96.0
Demand by User Industry											
Home Consumption	103.2	119.9	129.6	136.1	161.6	165.3	169.0	172.9	176.9	180.9	200.9
Caustic Soda	26.1	37.6	48.5	49.7	80.3	84.3	121.6	125.3	129.0	132.5	151.2
Fish Salting	53.4	61.5	62.1	76.6	105.3	110.0	114.7	119.9	125.0	130.3	158.6
Total (C)	182.7	219.0	240.2	262.4	347.2	359.6	405.3	418.1	430.9	443.7	510.7
Available Market for Rock Salt [4] (B) + (C) − (A)					81.2	93.6	139.3	152.1	164.9	177.7	244.7

(Notes) 2) Existing mines only.
4) ASEAN project only.

Sources: 1) 1976, 1978: Ministry of Agriculture and Cooperatives, "Solar Salt Situation".
1970: Applied Scientific Research Corporation of Thailand, "A Description of the Industrial Section in Thailand".
1973: SNC Report
2) 1970–78: Department of Mineral Resources, "Mineral Statistics of Thailand".
3) 1970–78: Department of Customs, "Foreign Trade Statistics of Thailand".

Table AII-3 POPULATION AND GDP IN THAILAND

	Actual			Projected			
	1970	1975	1977	1980	1985	1990	1995
Population [1] (000 persons)	34,397	42,391	44,273	47,686	53,851	60,310	66,951
GDP at 1972 Prices [2] (million Bahts)	149,541	204,056	236,500	294,385	412,890	579,099	812,217
Per Capita GDP (Bahts per person)	4,348	4,814	5,342	6,173	7,667	9,602	12,132
Domestic Product [2] by Construction Industry (million Bahts)	8,384	8,514	11,947	14,329	16,611	19,256	22,323

(Note) 2) Projected: Calculated on the basis of the target annual growth rates in the Fourth National Economic and Social Development Plan.

Sources: 1) Actual: National Statistical Office, "Statistical Handbook of Thailand".
Projected: National Statistical Office, "Quarterly Bulletin of Statistics".

2) Actual: Bank of Thailand, "Annual Economic Report".

Table AII-4 SUPPLY/DEMAND SITUATION AND PROJECTION OF USER INDUSTRIES OF SODA ASH, THAILAND

(000 ton)

	Sheet Glass	Container/Bottle Glass	Sodium Silicate					
	Consumption[1]	Consumption[2]	Import[3]	Production[4]	Consumption by User Industry			
					Total	Of Which:		
						Detergent	Soap	Miscellaneous Industries
Actual/Estimated								
1970	31.0		1.9	2.5	4.4	2.7		1.7
1973	46.2	160.4	0.4	7.8	8.2	4.7		3.5
1976	49.4	215.3	0.3	8.3	8.6	5.5	0.7	2.4
1979	79.6	289.7	0.4	16.5	16.9	7.2	1.5	8.2
Projected								
1985	122.6	540.7	0.8	29.5	30.3	14.9	3.0	12.4
1986	132.7	584.5	0.9	32.6	33.5	16.7	3.4	13.4
1987	143.5	630.0	1.0	35.8	36.8	18.6	3.8	14.4
1988	155.1	677.2	1.1	39.6	40.6	20.8	4.2	15.6
1989	167.5	726.4	1.2	43.2	44.4	23.0	4.6	16.8
1990	180.7	777.4	1.3	46.9	48.2	25.3	4.8	18.1
1995	262.1	1,061.2	1.8	65.3	67.1	37.2	3.7	26.2

(Notes) 2) Total of import and domestic production.

Sources: 1) Information from industry sources.
3) Department of Customs, "Foreign Trade Statistics of Thailand".
4) Industrial Econimics & Planning Division, MOI, "Industrial Statistics".

2-1-2 Salt

Present demand and the future outlook with regard to salt in Thailand are given in Table AII-2.

Solar salt production is greater than the level of domestic demand and thus there is exportation. Output is greatly influenced by weather conditions. In 1978 and 1979 when weather conditions were favorable, record increases in production were attained. However, the area devoted to salt fields is decreasing, as shown by the figures below.

Solar salt production in Thailand

	1978/79	1979/80
Production (Quen)	501,264	555,966
Farm area (Rai)	82,391	77,107
Production per rai (Quen)	6.5	7.1

Source: Dept. of Business Economics

Note: 1 Quen = 1,500 kg
1 Rai = 0.16 ha.

Consumption is presumed to be as follows, in 1979.

Household use	52%
Fish salting	29%
Caustic soda production	19%
Total	100%

For salt used to make caustic soda, rock salt and solar salt both of which are produced domestically are being used. Caustic soda demand at present and as anticipated for the future is as shown in Table AII-5. It is estimated that the use of caustic soda, by industry, was as follows in 1979.

Textile industry	28%
MSG production	28%
Detergent & soap	16%
Others	28%
Total	100%

Table AII-5 SUPPLY/DEMAND SITUATION AND PROJECTION OF USER INDUSTRIES OF SALT, THAILAND

(000 ton)

	Caustic Soda							Chlorine				Hydrochloric Acid		
	Import [1]	Domestic Sale [2]	Consumption by User Industry					Production [3]	Consumption by User Industry			Production [4]	Consumption by User Industry	
			Total	Of which:					Total	Of which:		Total	Of which:	
				Textile	MSG	Detergent	Soap			HCl	VCM			MSG
Actual/ Estimated														
1970	2.3	15.4	17.7		4.9	2.7		13.6	13.6	11.4	–	31.6	31.6	14.6
1973	1.5	24.3	25.8		7.2	4.7		21.5	21.5	16.5	–	45.7	45.7	21.6
1976	4.1	30.3	34.4	5.7	7.0	5.5	1.3	26.8	26.8	21.2	–	58.8	58.8	20.9
1979	17.6	33.0	50.6	14.2	13.7	8.1		29.2	29.2	27.4	–	76.2	76.2	28.1
Projected														
1985	23.8	50.2	74.0	25.8	12.4	14.9	5.5	44.5	44.5	40.5	–	112.6	112.6	37.2
1986	27.0	52.7	79.7	28.2	12.9	16.7	6.3	46.7	46.7	42.7	–	118.5	118.5	38.7
1987	9.6	76.0	85.6	30.8	13.4	18.6	7.0	67.3	67.3	44.7	18.6	124.2	124.2	40.1
1988	13.3	78.3	91.6	33.4	13.8	20.8	7.8	69.4	69.4	46.8	18.6	129.9	129.9	41.4
1989	17.1	80.6	97.7	36.1	14.3	23.0	8.4	71.4	71.4	48.8	18.6	135.6	135.6	42.8
1990	21.1	82.8	103.9	39.0	14.7	25.3	8.9	73.4	73.4	50.8	18.6	141.2	141.2	44.1
1995	38.1	94.5	132.6	55.0	16.7	37.2	6.8	83.7	83.7	61.1	18.6	169.7	169.7	50.0

(Notes) 2) From domestic production only.

3) Estimated using the following formula: (The amount of caustic soda produced) x 0.886.

Sources: 1) Department of Customs, "Foreign Trade Statistics of Thailand".

2) & 4) Industrial Economics & Planning Division, MOI, "Industrial Statistics".

3) UNICO estimate.

Demand for chlorine and hydrochloric acid at present and in the future are as shown in Table AII-5.

2-1-3 Ammonium Chloride

Fertilizer consumption by crop in Thailand at the present time, and its outlook for the future, are shown in Tables AII-6, 7 and 8. Paddy rice is the crop for which most fertilizer is consumed; it is followed in importance by sugarcane. Regarding the form of fertilizer used, compound fertilizer of N and P (or N, P and K) is most common. Ammonium chloride is now being used as straight fertilizer for paddy rice and as the nitrogen source in NP fertilizer, for paddy rice, and almost no ammonium chloride is used for other crops.

In regard to the use of ammonium chloride as a fertilizer, various problems are encountered due to a build-up of chlorine ions in the soil, and the decision on whether or not to use it must be made in light of specific soil and water conditions. Tests by the Ministry of Agriculture and Cooperatives, GOT, indicate that ammonium chloride may be used without reservation for paddy rice. However, with regard to other crops, tests are either underway or have just been begun, so it is necessary to wait for the results of those tests before reaching any conclusions regarding the use of ammonium chloride for crops other than paddy. Therefore in the following consideration the use of ammonium chloride as a fertilizer is considered to be for paddy rice only.

The majority of ammonium chloride are used in the form of in the case of Thailand compound fertilizer. There is one existing plant which is producing compound fertilizer based on imported ammonium chloride and/or other form of imported nitrogen fertilizer. However, as their production cannot cover all requirements, the requirement which is not covered by them are met by imports. In view of such situations, it is assumed as follows;

1. In keeping with expansion of domestic demand for compound fertilizer, facilities for production of compound fertilizer will be expanded in Thailand.

2. Ammonium chloride will be sold at a lower price (per percent composition of nitrogen nutrient contained) comparable to nitrogen sources (ammonium sulfate, urea, etc.) in order to make it desirable as the nitrogen source.

On the basis of the foregoing assumptions the outlook for demand for ammonium chloride is as shown in Table AII-9.

Table AII-6 FERTILIZER SUPPLY/DEMAND SITUATION IN THAILAND

(000 ton)

Year	Opening Inventory (A)	Imports (B)	Raw Materials Used for Mixed Fertilizer (C)	Local Production		Consumption			Inventory (I)
				Urea/Ammonium Sulphate[1](D)	Mixed Fertilizer[1](E)	Industrial Use(F)[1]	Fertilizer Use: Final Consumption(G)	Fertilizer Use: Distribution Loss[5](H)	
1973	81.3[6]	398.9[2]	4.5[3]	22.7	7.7	10.3	407.9[1]	10.5	77.4[6]
1974	77.4[6]	342.9[2]	20.2[3]	29.0	10.9	12.1	373.1[1]	9.6	45.2[6]
1975	45.2[6]	466.0[2]	119.6[3]	18.4	99.0	12.3	478.0[1]	12.3	6.4[6]
1976	6.4[6]	679.5[2]	132.6[3]	28.6	132.6[7]	10.7	618.0[1]	15.8	70.0[1]
1977	70.0[1]	952.5[2]	100.2[1]	35.7	126.5	11.4	783.0[6]	20.1	270.0[1]
1978	270.0[1]	846.4[2]	264.3[1]	26.0	301.6	12.5	855.3[6]	21.9	290.0[1]
1979	290.0[1]	617.0[4]	239.2[1]	0 [8]	323.0[8]	13.0	787.6[6]	20.2	170.0[1]

Sources: 1) OAE, MOAC.
2) IFDC/World Bank, "Thailand, Strategy for Fertilizer Development" (1979).
3) J. Kitoh (Central Glass Co., Ltd.), "Chemical Fertilizer Situation of Thailand" (1977).

(Notes) 4) Primary information.
5) Distribution loss was assumed 12.5% of the amount distributed to fertilizer use.
6) Estimated using the following formula: (A) + (B) − (C) + (D) + (E) = (F) + (G) + (H) + (I).
7) TCCC started production in 1976.
8) Mae Moh plant and BBMF were shut down in 1974.
9) Locally supplied rock phosphate was excluded.

Table AII-7 PROJECTED DEMAND FOR FERTILIZER BY CROP, THAILAND

(000 ton)

	Actual or Estimated*1)							Projected			
	1973	1974	1975	1976	1977	1978	1979	1980	1985	1990	1995
Rice North	4.5	4.1	6.9	7.0	12.0	15.8	13.8	15.8	23.3	30.6	37.8
Northeast	66.2	53.6	86.8	102.6	136.2	169.0	160.4	173.3	241.3	306.9	371.1
Central	149.9	126.0	137.0	169.1	227.8	278.7	243.7	282.3	399.4	517.4	637.8
Total	232.2	193.7	242.9	293.2	397.2	482.9	432.3	489.3	685.2	879.2	1,074.0
Sugarcane	43.2	48.6	70.8	162.1	170.0	138.2	127.2	159.2	191.1	213.2	234.0
Tobacco	19.5	26.0	26.0	20.0	24.5	24.6	22.3	23.7	24.7	25.8	26.8
Other Upland Crops	23.7	14.0	22.0	23.6	41.2	51.8	51.0	59.6	92.5	127.6	163.5
Rubber	39.3	35.0	40.0	37.1	47.9	47.8	50.5	57.9	113.9	130.6	138.9
Fruits	22.2	21.4	40.3	41.1	57.1	62.9	58.6	65.8	82.2	93.9	102.9
Vegetables	27.8	34.4	36.0	40.9	45.1	47.1	45.7	55.8	61.8	70.5	77.8
Total	407.9	373.1	478.0	618.0	783.0	855.3	787.6	911.3	1,251.4	1,540.8	1,817.9

(Note) *1) Estimated based on the information from Office of Agricultural Economics, Ministry of Agriculture and Cooperatives.

Table AII-8 PROJECTED FERTILIZER DEMAND BY FERTILIZER FORMULA AND N.P.K. NUTRIENT, THAILAND

(000 ton)

	1985				1990				1995			
	Product	N	P	K	Product	N	P	K	Product	N	P	K
Ammonium Chloride	44.5	11.1			57.1	14.3			69.8	17.5		
Ammonium Sulfate	105.1	22.1			117.3	24.6			128.7	27.0		
Urea	52.5	24.2			59.9	27.6			65.9	30.3		
Other Fertilizer	19.3	0	3.3	6.2	21.1	0	3.6	6.8	22.3	0	3.8	7.1
Sub-total	221.4	57.4	3.3	6.2	255.4	66.5	3.6	6.8	286.7	74.8	3.8	7.1
NP Group	670.1	107.2	134.0		858.8	137.4	171.8		1,048.2	167.7	209.6	
13–13–21 Group	117.4	15.3	15.3	24.7	146.9	19.1	19.1	30.8	176.5	22.9	22.9	37.1
20–11–11 Group	23.5	4.7	2.6	2.6	29.8	6.0	3.3	3.3	36.2	7.2	4.0	4.0
11–18–4+3 Group	70.6	7.8	12.7	2.8	81.0	8.9	14.6	3.2	86.1	9.5	15.5	3.4
18–11–5 Group	43.3	7.8	4.8	2.2	49.6	8.9	5.5	2.5	52.8	9.5	5.8	2.6
6–18–24+4 Group	12.4	0.7	2.2	3.0	12.9	0.8	2.3	3.1	13.4	0.8	2.4	3.2
12–12–17+2 Group	20.6	2.5	2.5	3.5	23.5	2.8	2.8	4.0	25.7	3.1	3.1	4.4
15–15–15 Group	72.1	10.8	10.8	10.8	82.9	12.4	12.4	12.4	92.3	13.8	13.8	13.8
Sub-total	1,030.0	156.8	184.9	49.6	1,285.4	196.3	231.8	59.3	1,531.2	234.5	277.1	68.5
Total	1,251.4	214.2	188.2	55.8	1,540.8	262.8	235.4	66.1	1,817.9	309.3	280.9	75.6

Table AII-9 PROJECTED DEMAND FOR AMMONIUM CHLORIDE, THAILAND

(000 ton)

	1985	1986	1987	1988	1989	1990	1995
Direct Application (A)	45.6	48.2	50.8	53.4	56.0	58.6	71.6
Raw Material for Compound Fertilizer							
Potential Demand	308.4	326.7	344.6	361.9	378.8	395.3	470.6
Projected Demand (B)	237.5	261.4	275.7	289.5	303.0	314.6	361.6
Total Projected Demand (A) + (B)	283.1	309.6	326.5	342.9	359.0	373.2	433.2

2-2 INDONESIA

The present situation and outlook for demand for soda ash in Indonesia is as shown in Table AII-10.

General economic indicators used for projections of demand are shown in Table AII-11.

2-2-1 Soda Ash

Consumption of soda ash, by user industry, is as follows.

Sheet glass	18%
Bottle glass	74%
Sodium silicate	6%
Others	2%
Total	100%

Domestic production of sheet glass commenced in 1973 and since then the share of imports in total demand has steadily decreased. At the present time, however, all types of sheet glass which are capable of being produced in Indonesia are being produced there, and import of sheet glass is limited to other kinds of sheet glass than are domestically produced, with the share of imports among the total consumption of sheet glass being around 50%. It is thought that this import ratio will not greatly change in the future (see Table AII-12).

Almost the entire domestic demand for bottle glass is met through domestic production. Moreover, domestic production capacity is growing in keeping with growth of demand (see Table AII-12).

Sodium silicate demand in Indonesia is satisfied by domestic production to the extent of 80% of the demand, and the remaining 20% is imported. Consumption of sodium silicate is primarily in the detergent and soap industries (see Table AII-12).

2-2-2 Salt

Indonesian production and importation of salt are as shown in Table AII-13. Fundamentally, Indonesia is self-sufficient with regard to her supply of salt, but sometimes importation has been done because of a supply shortage caused by fluctuations in production of solar salt due to weather conditions.

Table AII-10 ESTIMATED AND PROJECTED SODA ASH SUPPLY/DEMAND, INDONESIA

(000 ton)

	1970	1973	1976	1979	Projected						
					1985	1986	1987	1988	1989	1990	1995
Import [1]	13.8	29.4	39.3	65.1							
Demand by User Industry											
Sheet Glass		4.0	7.8	12.7	21.6	22.7	23.7	24.8	25.8	26.8	32.0
Bottle/Container Glass	2.6	17.8	50.3	47.2	93.0	99.9	107.1	114.5	122.2	130.1	174.1
Sodium Silicate				4.0	7.7	8.3	8.9	9.5	10.2	10.9	14.9
Caustic Soda				1.2	2.3	2.3	2.3	2.3	2.3	2.3	2.3
Total				65.1	124.6	133.2	142.0	151.1	160.5	170.1	223.3

Source: 1) Central Bureau of Statistics, "Foreign Trade Statistics".

Table AII-11 POPULATION AND GNP IN INDONESIA

	Actual			Projected			
	1970	1975	1978	1980	1985	1990	1995
Population [1] (000 persons)	116,717	124,671	131,205	136,522	150,779	166,524	183,914
GNP at 1973 Prices [2] (billion Rp.)	5,142	7,271	8,906	10,101	13,840	18,961	25,979
Per Capita GNP (Rp. per persons)	44,056	58,317	67,877	73,990	91,787	113,865	141,254
Domestic Product by Construction Industry [2] (billion Rp.)	144	365	494	586	902	1,388	2,136

(Note) GNP in future was calculated using the target of annual growth rates in the Third Five-Year Economic Development Plan with the year 1978 being the base year for the projection.

Sources: 1) Central Bureau of Statistics, "Monthly Statistical Bulletin, INDIKATOR EKONOMI".

2) Central Bureau of Statistics, "Statistical Pocketbook of Indonesia".

Table AII-12 SUPPLY/DEMAND SITUATION AND PROJECTION OF USER INDUSTRIES OF SODA ASH, INDONESIA

(000 ton)

	Sheet Glass			Bottle/Container Glass			Sodium Silicate				
	Import[1]	Production[2]	Consumption	Import[1]	Production[2]	Consumption	Import[1]	Production[2]	Consumption by User-Industry		
									Total	Of which:	
										Detergent	Soap
Actual/Estimated											
1970	18.2	–	18.2	10.2	14.3	24.5					
1973	37.6	16.1	53.7	8.0	99.4	107.4	9.8		4.8	0.7	4.1
1976	50.7	31.4	82.1	4.1	281.1	285.2	3.9		9.0	3.4	5.6
1978	51.8	51.4	103.2	3.1	279.5	282.6	2.7	8.8	11.5	4.4	7.1
Projected											
1985	58.1	87.1	145.2	–	514.3	514.3	4.3	17.0	21.3	9.6	11.7
1986	60.9	91.4	152.3	–	558.2	558.2	4.6	18.4	23.0	10.6	12.4
1987	63.7	95.6	159.3	–	598.2	598.2	4.9	19.7	24.6	11.6	13.0
1988	66.5	99.8	166.3	–	639.7	639.7	5.3	21.1	26.4	12.7	13.7
1989	69.5	104.2	173.7	–	682.7	682.7	5.7	22.6	28.3	13.9	14.4
1990	72.1	108.2	180.3	–	727.0	727.0	6.0	24.2	30.2	15.1	15.1
1995	86.2	129.2	215.4	–	972.5	972.5	8.3	33.1	41.4	22.8	18.6

Sources: 1) Central Bureau of Statistics, "Foreign Trade Statistics".
2) Directorate General of Basic Chemical Industry.

As for the industrial salt in Indonesia, solar salt has been used in the past, but Indonesia is now studying the possibility of producing industrial salt (high-grade salt) domestically. The demand outlook for salt (according to the Department of Chemical Industries, Government of Indonesia) is as given in Table AII-14.

2-3 MALAYSIA

The present conditions and outlook for soda ash and salt demand in Malaysia are as indicated in Tables AII-15 and AII-16.

General economic indicators used for projection of demand are given in Table AII-17.

Table AII-13 IMPORT AND PRODUCTION OF SALT, INDONESIA

(000 ton)

	Import[1]	Production[2]
1970	19.3	217.1
1971	6.4	156.3
1972	26.6	690.8
1973	4.9	141.4
1974	12.2	265.2
1975	181.2	205.2
1976	319.7	562.7
1977	2.4	786.7
1978	2.7	234.9
1979	1.3	470.0

Sources: 1) Central Bureau of Statistics, "Foreign Trade Statistics".
2) Directorate General of Allied Industry.

Table AII-14 PROJECTED DEMAND FOR SALT, INDONESIA

(000 ton)

	Home Consumption	Fish Salting	Industrial Use	Total
1980	436	104	65	605
1981	446	106	72	624
1982	458	108	79	645
1983	469	110	90	669
1984	480	112	280	872
1985	492	114	290	896
1986	505	116	300	921
1987	517	118	310	945
1988	513	120	320	953

Source: Directorate General of Allied Industry.

Table AII-15 ESTIMATED AND PROJECTED SODA ASH SUPPLY/DEMAND, MALAYSIA

(000 ton)

	1970	1973	1976	1978	Projected						
					1985	1986	1987	1988	1989	1990	1995
Import [1]	9.9	18.2	21.3	29.5							
Demand by User Industry											
Sheet Glass	–	5.9	5.9	5.9	15.1	16.5	18.0	19.7	21.4	23.2	34.3
Bottle/Container Glass	–	–	–	14.2	27.0	29.0	31.2	33.4	35.0	38.1	51.6
MSG	–	–	–	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8
Sodium Silicate	–	–	–	4.6	6.6	6.9	7.2	7.5	7.8	8.1	9.6
Total	–	–	–	29.5	53.5	57.2	61.2	65.4	69.0	74.2	100.3

Source: 1) Department of Statistics, "Annual Statistics of External Trade".

Table AII-16 ESTIMATED AND PROJECTED SALT SUPPLY/DEMAND, MALAYSIA

(000 ton)

	1975	1976	1977	1978	Projected						
					1985	1986	1987	1988	1989	1990	1995
Import [1]	96.9	98.0	117.7	125.1							
Demand by User Industry											
Home Consumption		30.7	31.5	32.3	38.4	39.3	40.3	41.3	42.4	43.4	49.1
Food Industry, etc.		15.7	25.0	24.9	55.4	59.0	62.6	66.2	69.8	73.4	73.4
Fish Salting		32.9	39.8	45.2	74.6	79.9	85.5	91.2	97.3	103.4	138.5
Caustic Soda		18.7	21.4	22.7	22.7	22.7	22.7	22.7	22.7	22.7	22.7
Total		98.0	117.7	125.1	191.1	200.9	221.1	221.4	232.2	242.9	283.7

Source: 1) Department of Statistics, "Annual Statistics of External Trade".

Table AII-17 POPULATION AND GDP IN MALAYSIA

	Actual			Projected			
	1973	1976	1978	1980	1985	1990	1995
Population [1] (000 persons)	9,502	10,242	10,762	11,306	12,792	14,473	16,375
GDP at 1970 Prices [2] (million Ringgits)	15,904	19,288	22,195	25,364	35,408	49,430	69,004
Per Capita GDP (Ringgits per person)	1,674	1,883	2,062	2,243	2,768	3,415	4,214
Domestic Product by Construction Industry [2] (million Ringgits)	651	713	891	1,011	1,385	1,897	2,599

(Notes) 1) Population in the future was projected using the 2.5% of annual growth rate.
2) Annual growth rate of GDP was assumed to be the same as that of 1973 through 1978.

Sources: 1) Department of Statistics, "Monthly Statistical Bulletin".
2) The Treasury, Malaysia, "Economic Report".

2-3-1 Soda Ash

Consumption of soda ash, by industry, is as follows.

Sheet glass	20%
Bottle glass	48%
Sodium silicate	16%
MSG	16%
Total	100%

There is only one producer of sheet glass in the country. Production was begun in 1973, with an annual production capacity of 30,000 tons. Thereafter, an additional 20,000 t/y of capacity was added, and in 1982 it is planned to add an additional 30,000 tons of capacity. It is planned, moreover, to add 20,000 to 30,000 t/y within about five years of the upcoming expansion, so the outlook is for continued expansion of capacity in keeping with expansion of domestic demand.

Bottle glass is produced by three companies. At the present time, after there has been phased expansion of capacity in keeping with the growth of demand, total capacity of the industry comes to 89,000 t/y. Within the forthcoming five years, 162,000 t/y will be added to this. The main uses of bottle glass are for beer bottles (40%), followed by soft drinks (30%); the remainder being used for foods and cosmetics.

Sodium silicate production capacity is 13,000 t/y and actual output is 12,000 t/y. The applications for this product are primarily in the detergent and soap industries.

Malaysia, different from the other ASEAN countries, uses soda ash as the major raw material for production of MSG. In these other countries, MSG producers own their own caustic soda plants, but this is not the case in Malaysia, where the company purchases either caustic soda or soda ash, whichever is lower in price. The amount of soda ash required for the production of one ton of MSG is estimated to be 265 kg, with the assumption that 50% of Na_2O requirement is derived from soda ash.

2-3-2 Salt

There is no domestic production of salt in Malaysia; the country is entirely dependent on imports. Domestic production of salt was considered at one time but the idea was abandoned for lack of a suitable site for solar salt production.

The consumption of salt, by industry or application, is estimated to be as follows.

Household use	26%
Food industry	20%
Salting of fish	36%
Caustic soda industry	18%
Total	100%

Consumption of caustic soda, by user industry, is estimated as shown in Table AII-18.

Table AII-18 ESTIMATED DEMAND FOR CAUSTIC SODA, MALAYSIA

(000 ton)

	1976	1977	1978
Demand for Caustic Soda	11.7	13.4	14.2
Of which:			
MSG	3.2	3.6	4.8
Textile and Others	3.7	3.7	3.8
Soap/Detergent	4.8	6.1	5.6

Malaysia's production level of caustic soda is limited by the demand for chlorine, because the demand for chlorine is low. Chlorine is used for water treatment and hydrochloric acid which is mainly used in production of MSG.

2-4 SINGAPORE

The present condition and outlook for soda ash and salt demand in Singapore are as shown in Tables AII-19 and AII-20.

2-4-1 Soda Ash

Consumption of soda ash by user industry is as follows.

Glass	80%
Sodium silicate	16%
Detergent & soap	4%
Total	100%

Table AII-19 ESTIMATED AND PROJECTED SODA ASH SUPPLY/DEMAND, SINGAPORE

(000 ton)

	1975	1976	1977	1978	Projected						
					1985	1986	1987	1988	1989	1990	1995
Import [1]	7.2	14.2	11.9	13.3							
Demand by User Industry											
Glass	–	10.0	10.0	10.1	19.0	19.0	19.0	19.0	19.0	22.0	25.0
Sodium Silicate	1.7	2.5	2.2	2.0	2.7	2.8	2.9	3.0	3.1	3.2	3.8
Soap & Detergent	0.9	0.5	1.1	0.5	1.0	1.0	1.0	1.1	1.1	1.1	1.3
Total		13.0	13.3	12.6	22.7	22.8	22.9	23.1	23.2	26.3	30.1

Source: 1) Department of Statistics, "Singapore External Trade Statistics".

Table AII-20 ESTIMATED AND PROJECTED SALT SUPPLY/DEMAND, SINGAPORE

(000 ton)

	1975	1976	1977	1978	Projected						
					1985	1986	1987	1988	1989	1990	1995
Import [1]	27.6	34.9	33.9	34.0							
Demand by User Industry											
Caustic Soda	2.7	5.0	5.3	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8
Home Consuption	6.7	6.8	6.9	7.0	7.6	7.7	7.8	7.9	8.0	8.1	8.6
Others	18.2	23.1	21.7	22.2	21.3	21.3	21.3	21.3	21.3	21.3	21.3
Total	27.6	34.9	33.9	34.0	33.7	33.8	33.9	34.0	34.1	34.2	34.7

Source: 1) Department of Statistics, "Singapore External Trade Statistics".

Because most of Singapore's industry is export-oriented, increased production in user industries does not necessarily correspond to an increase in domestic demand. Therefore it is assumed that the scale of production in user industries will expand at the same rate as in the recent past, 3.5% p.a.

In the case of the glass industry there is one factory in existence, and in 1981 it is planned to increase its capacity by 15,000 t/y. In addition, another company is expected to begin production in the near future.

2-4-2 Salt

Singapore does not produce any salt and imports all of the salt required by the country. The composition of salt consumption, by area of use, as estimated to be as follows.

Caustic soda production	14%
Household use	21%
Other uses	65%
Total	100%

The quantity of caustic soda production was not available, but consumption of caustic soda for detergent and soap production is as shown in Table AII-21.

2-5 PHILIPPINES

Present conditions and outlook for soda ash demand in the Philippines are as shown in Table AII-22.

General economic indicators used for projections are as shown in Table AII-23.

2-5-1 Soda Ash

Consumption of soda ash, by user industry, is as follows.

Sheet glass	10%
Bottle glass	65%
Sodium silicate	6%
STPP	19%
Total	100%

Table AII-21 PRODUCTION OF DETERGENT AND SOAP, AND CAUSTIC SODA USED, SINGAPORE

(000 ton)

	Production[1]				Caustic Soda used for Production of Detergent and Soap
	Detergent	Soap			
		Washing Soap	Toilet Soap	Total	
1975	12.7	4.9	0.9	5.8	1.7
1976	21.5	4.3	1.2	5.5	3.1
1977	18.8	3.9	1.3	5.2	3.3
1978	16.7	3.5	1.4	4.9	3.0

Source: 1) Department of Statistics, "Report on the Census of Industrial Production".

Table AII-22 ESTIMATED AND PROJECTED SODA ASH SUPPLY/DEMAND, THE PHILIPPINES

(000 ton)

	1970	1973	1976	1979	Projected						
					1985	1986	1987	1988	1989	1990	1995
Import [1]	47.9	75.8	67.7	81.6							
Demand by User Industry											
Sheet Glass	5.4	8.3	6.7	8.0	10.2	10.5	10.8	11.2	11.7	12.1	15.1
Bottle/Container Glass	38.8	39.3	38.8	53.5	67.8	71.4	75.3	79.3	83.3	87.7	111.4
Sodium Silicate			4.9	4.5	8.1	8.8	9.5	10.4	11.2	12.2	17.3
STPP			7.6	15.6	23.0	25.1	27.3	27.3	32.1	34.7	49.5
Total			58.0	81.6	109.1	115.8	122.9	128.2	138.3	146.7	193.3

Source: 1) National Economic Development Authority, "Foreign Trade Statistics of the Philippines".

Table AII-23 POPULATION AND GNP IN THE PHILIPPINES

	Actual			Projected			
	1965	1970	1975	1980	1985	1990	1995
Population (000 persons)	31,770	36,851	42,517	49,137	56,742	65,041	73,867
GNP at 1972 Prices 1) (million Pesos)	39,520	50,035	68,561	95,356	130,953	179,838	246,973
Per Capita GNP (Pesos per person)	1,244	1,358	1,613	1,941	2,308	2,765	3,344
Domestic Product by Construction Industry 2) (million Pesos)	1,807	1,543	3,076	6,306	9,482	14,258	21,439

(Notes) 1), 2) Annual growth rate in the future was projected using the following figures:

GNP 6.55%

Domestic product by construction industry 8.50%

Sources:
1. National Economic Development Authority (NEDA), "Philippine Statistical Yearbook".
2. NEDA, "Five-Year Philippine Development Plan, 1978–82".
3. NEDA, "Long-Term Philippine Development Plan Up To the Year 2000".

Sheet glass is being produced by one company, and 17–18% of domestic demand is satisfied by imports. At the same time, somewhat more than 20% of production is exported. Expansion of production capacity is planned to be undertaken during 1981 and it is thought that such expansion will be adequate to cover the expected domestic demand expansion in the future period in question.

There are a large number of bottle glass makers. Almost all of domestic demand is satisfied by their production. The strongest area of demand is for use in making beer, whisky and soft drink bottles, and in addition bottle glass is used for food and cosmetics containers.

Sodium silicate production is being carried out by two companies. The major use is in the production of detergent but there is also some use in metalcasting, textiles and welding applications.

STPP is a raw material for production of detergent, and is being produced by one company. Most part of Na_2O requirement in STPP production is fulfilled by soda ash, but about 10% of that is being made with use of caustic soda.

2-5-2 Salt

With the exception of industrial salt, the Philippines' demand for salt is met by solar salt, domestically produced. With the exception of a portion of the industrial salt, all domestic requirement of industrial salt are imported. The country's production of solar salt, and importation of salt, are shown in Table AII-24.

In the past all of the country's production of industrial salt was done by two companies. The domestic industry was protected by a 50% tariff on imported salt. However, there is little meaning to a 50% tax on the salt which is levied on the FOB price, and at the same time the cost of domestic production of industrial salt has risen to the point at which the domestic product cannot compete with imports. One of the two companies has abandoned production for this reason. However, at the present time plans exist in the Philippines for production of industrial salt through the use of geothermal energy, and both of the companies are in the process of developing new plans. If this salt production project is realized, not only will the Philippines be able to satisfy all of the domestic demand for industrial salt but the country also will be able to export salt.

Table AII-24 IMPORT AND PRODUCTION OF SALT, THE PHILIPPINES

(000 ton)

	Import[1)]	Production[2)]
1970	2.0	210.3
1971	27.2	235.0
1972	104.7	219.5
1973	21.1	220.0
1974	45.4	213.6
1975	46.5	202.1
1976	55.1	203.4
1977	61.6	200.0
1978	45.2	N.A.[3)]
1979	64.0	N.A.

(Notes) 2) According to the opinion in the Philippines this data has always been understated, perhaps as much as 50%.

3) Not available.

Sources: 1) NEDA, "Foreign Trade Statistics of the Philippines".

2) NEDA, "Philippine Statistical Yearbook".

ANNEX II-3 DATA USED FOR PROJECTION SODA ASH PRICE

3-1 PROJECTION OF OCEAN FREIGHT RATES

See Table AII-25.

3-2 PROJECTED PRODUCTION COST OF SODA ASH IN KENYA AND THE UNITED SATES

See Table AII-26.

3-3 PROJECTION OF CAUSTIC SODA PRICE IN THE UNITED STATES

See Table AII-27.

Table AII-25 PROJECTED MARITIME FREIGHT RATES

From: / To:	Australia Japan	Mexico Japan	Australia Port Kelang	Australia Singapore	Kenya Singapore	US West Coast Singapore
Assumptions:						
Cargo Capacity (tons)	60,000	60,000	7,000	7,000	15,000	7,000
Distance of Transport (miles)	3,353	6,260	2,097	1,891	4,617	8,123
Days at Sea with Cargo (days)	10.0	18.6	7.3	6.6	14.8	28.2
Anchor for Loading (days)	3.0	1.5	1.0	1.0	12.5	4.0
Anchor for Unloading (days)	2.0	2.0	6.0	6.0	12.5	6.0
Estimated/Projected Freight Rates:						
1978 (US$/ton)	8.5	8.5	17.1	12.1	32.5	20.6
1985 (US$/ton)	18.2	20.9	34.2	24.6	60.5	44.5

(Note) Freight rates are projected on the basis of the following assumptions:

1. Bunker–C oil price: US$303/ton in 1985.
2. Diesel oil price: US$506/ton in 1985.

Table AII-25 PROJECTED MARITIME FREIGHT RATES (CONT'D)

From: / To:	Bangkok Port Kelang	Bangkok Singapore	Bangkok Manila	Bangkok Jakarta	Bangkok Japan	Bangkok Japan	Bangkok Taiwan
Assumptions:							
Cargo Capacity (tons)	7,000	7,000	7,000	7,000	15,000	60,000	15,000
Distance of Transport (miles)	1,050	844	1,455	1,294	3,102	3,102	1,700
Days at Sea with Cargo (days)	3.7	2.9	5.1	4.5	10.0	9.3	6.0
Anchor for Loading (days)	6.0	6.0	6.0	6.0	0.5	3.0	6.0
Anchor for Unloading (days)	6.0	6.0	6.0	6.0	12.5	2.0	12.5
Estimated/Projected Freight Rates:							
1978 (US$/ton)	8.0	7.0	12.0	11.0	9.5	8.3	7.8
1985 (US$/ton)	16.5	14.5	22.5	18.8	18.8	17.1	15.2

(Note) Freight rates are projected on the basis of the following assumptions:

1. Bunker–C oil price: US$303/ton in 1985.
2. Diesel oil price: US$506/ton in 1985.

Table AII-26 PROJECTED FOB PRICE OF SODA ASH PRODUCED BY THE USA AND KENYA — 1985

(000 ton)

	U.S.A.	Kenya
Fixed Costs		
Depreciation (15–year, Straight Line)	8.1	5.8
Interest on Working Capital (12% per annum)	1.4	1.5
Maintenance and Insurance	11.2	4.1
Sales and Administration	4.3	2.6
Operating Labor and Supervision	5.1	4.8
Sub-total	30.2	18.9
Variable Costs		
Raw Materials	—	—
Royalties	4.7	1.6
Utilities, Fuels and Operating Supplies	12.5	43.8
Labor	19.1	10.8
Sub-total	36.2	56.1
Production Cost per ton	66.5	75.0
Loading Cost plus Marketing Cost	46.3	59.7[1)]
Ex-factory Price (Bulk)	112.8	
Inland Transportation Cost	32.6	
FOB Export Port Price (Bulk)	145.4	134.6

(Note) 1) "Loading Cost plus Marketing Cost" and "Inland Transportation Cost".

Table AII-27 ESTIMATED/PROJECTED PRODUCTION COSTS OF CAUSTIC SODA IN THE U. S. A.

			1985
– Production Capacity			
Caustic Soda (tons/year)			360,000
Chlorine (tons/year)			320,400
– Capacity Utilization Rate			80%
– Total Investment (million US$)			85.9
Variable Costs			
Salt	(1.62 tons)	(US$42/ton)	6.8
Electricity	(2,500 KWH)	(US¢4.08/KWH)	120.0
Other Variable Costs			24.3
Utilities	(Electricity 150 KWH, Steam 4.0 tons, Cooling Water 137 tons)		82.0
Fixed Costs			
Operating Labor and Supervision	(40 persons/day)	(US$26,500 per person-year)	3.7
Overhead			45.8
Interest on Working Capital and Sales Cost			19.2
ROI (20% of Total Investment)			59.7
Production Cost per pair ton			343.5
Production Cost:	Caustic Soda (A)		(194.0)
	Chlorine		(168.8)
– Inland Transportation Cost plus Marketing Cost (B)			72.8
– CIF Price (C) = (A) + (B)			266.8
– Equivalent Soda Ash Price (C) ÷ 1.3 ÷ 1.2			167.2

ANNEX II-4 SALT IMPORTS IN ASIAN COUNTRIES OUTSIDE THE ASEAN REGION

4-1 SALT IMPORTS IN ASIAN COUNTRIES OUTSIDE OF THE ASEAN REGION

The major source of Asian salt imports is Australia. Salt imports from Australia during a recent three-year period are as shown in Table AII-28. The major Asian salt importers outside of the ASEAN region are Japan, Korea and Taiwan. In the case of Japan, as noted in the Evaluation Report proper, because large vessels — 60,000 DWT class — are used though transport distances are long the delivered cost of the salt is low, and in order for there to be exports from Thailand the FOB Thailand price would have to be reduced considerably and exports are therefore not to be expected.

4-2 KOREAN IMPORTATION OF SALT

The quantity of salt imports by South Korea during 1978 was about 385,000 tons, all of which was imported from Australia. The import price is US$16.73/MT which is about the same level as the import price for Japan. Therefore in the case wherein small vessels transported salt from Thailand, the same as is true with regard to exports to Japan, it would be necessary to greatly reduce the FOB price in order to export to Korea.

Table AII-29 shows the present situation of demand for industrial salt in Korea.

4-3 TAIWANESE IMPORTATION OF SALT

The quantity of salt imports by Taiwan during 1978 was about 495,000 tons, all of which was imported from Australia. The import price, at US$16.44/MT, is close to the level of the import price for Japan. However, because ocean freight costs would be cheaper in exporting from Thailand to Taiwan than to Japan or Korea, there is a possibility that exports could be made, by lowering the FOB price slightly relative to that for other ASEAN countries.

Present conditions regarding industrial salt in Taiwan are as shown in Table AII-29.

Table AII-28 EXPORT OF SALT TO ASIAN COUNTRIES (EXCL. ASEAN & AUSTRALIA)

	1976/77		1977/78		1978/79	
	Quantity (000 ton)	Unit Price (US$/ton)	Quantity (000 ton)	Unit Price (US$/ton)	Quantity (000 ton)	Unit Price (US$/ton)
Destination: 1)						
Japan	3,245.2	7.47	3,200.5	7.07	3,317.7	8.00
Korea, Rep. of	296.3	7.26	361.8	7.06	485.3	8.14
Taiwan	365.0	7.51	422.0	7.25	599.2	7.97
Bangladesh	–	–	43.2	8.25	–	–

(Note) 1) Export more than 1,000 t/y only.

Source: Official Trade Statistics, Australia

Table AII-29 SALT USER INDUSTRIES IN REP. OF KOREA AND TAIWAN

(000 ton)

	Soda Ash			Caustic Soda		
	Production	Consumption	Estimated Salt Requirement (A)	Production	Estimated Salt Requirement (B)	(A) + (B)
Korea, Rep. of [1]						
1976	164.9	139.4	230.9	65.0	104.0	334.9
1977	182.0	166.6	254.8	70.0	112.0	366.8
1978	189.0	196.8	264.6	75.0	120.0	384.6
Taiwan [2]						
1976	4.9		6.9	267.1	427.2	434.1
1977	6.9		9.7	301.0	481.6	491.3
1978	6.5		9.1	362.2	579.5	588.6

Sources: 1) Industrial Bank of Korea, ("Industries in Korea, 1979").

2) Council for Economic Planning and Development, "Industry of Free China, Vol. LII No. 4".

ANNEX III

ANNEX III-1 MINING LEVEL AND SIZE OF THE MINE FACE

1-1 DETERMINATION OF THE MINING LEVEL

When conducting excavation work, a roof sufficient to support the burden of soil overhead must be retained over the excavated space. That is, a certain thickness of rock salt must be left in place (it is called "crown pillar"). The thickness of the crown pillar will depend on the thickness of the overburden, physical properties of the rock salt, width of excavation and level of excavation. Of these factors, the thickness of the overburden and physical properties of the rock salt were ascertained at the time of the first evaluation study. As noted in the main text, the overburden is judged to be 84 m thick, on the basis of the geological cross-sections.

The greater the width excavated, the greater the thickness of the crown pillar required. The relationship between the two is as follows.[1)]

$$a \leqq \sqrt{\frac{2\,Sb\,b}{w\,f}}$$

Where:

a = Width of mine face
b = Crown pillar thickness
Sb = Bending strength
w = Unit load
f = Safety factor

This relationship is shown graphically in Figure AIII-1.

Here the safety factor is 4, the thickness of the crown pillar is 45 m and the maximum width of the mine face is 17.3 m. In the mine the maximum span is the length of the diagonal at the mine face heading intersection. Therefore the width of the mine face is,

$$17.3\ m \div \sqrt{2} = 12\ m$$

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1) Yataro Shimomura et al., "Mining Reader" (in Japanese), vol. 2, no. 9.

The average elevation of the surface of the ground is 202 m, and the elevation of the roof of the mine face is 73 m.

1-2 DETERMINATION OF PILLAR WIDTH AND TRUE MINE YIELD

The wider the pillar width, the less stress placed on the pillar, and the greater safety, but the lower the true yield of the mine. The maximum applied stress to a pillar is found by the following formula.[1]

$$\delta cr = K \gamma Z \frac{a + t}{t}$$

Where:

K = A coefficient
γ = Specific gravity of the rock salt
Z = Distance from the ground surface to the mining elevation
a = Width of mine face
t = Width of pillar
δcr = Maximum applied stress

The pillar width and maximum applied stress as found by use of this formula are shown in Figure AIII-2, where the true yield of the mine face is also shown.

Considering creep, one of the properties of rock salt, it is desirable to keep the applied stress in a pillar to 73 kg/cm^2 or less. [2] From the graph pillar width is found to be 36 m. In this case, the maximum applied stress is 68 kg/cm^2 and the true mine face yield is 43.8%.

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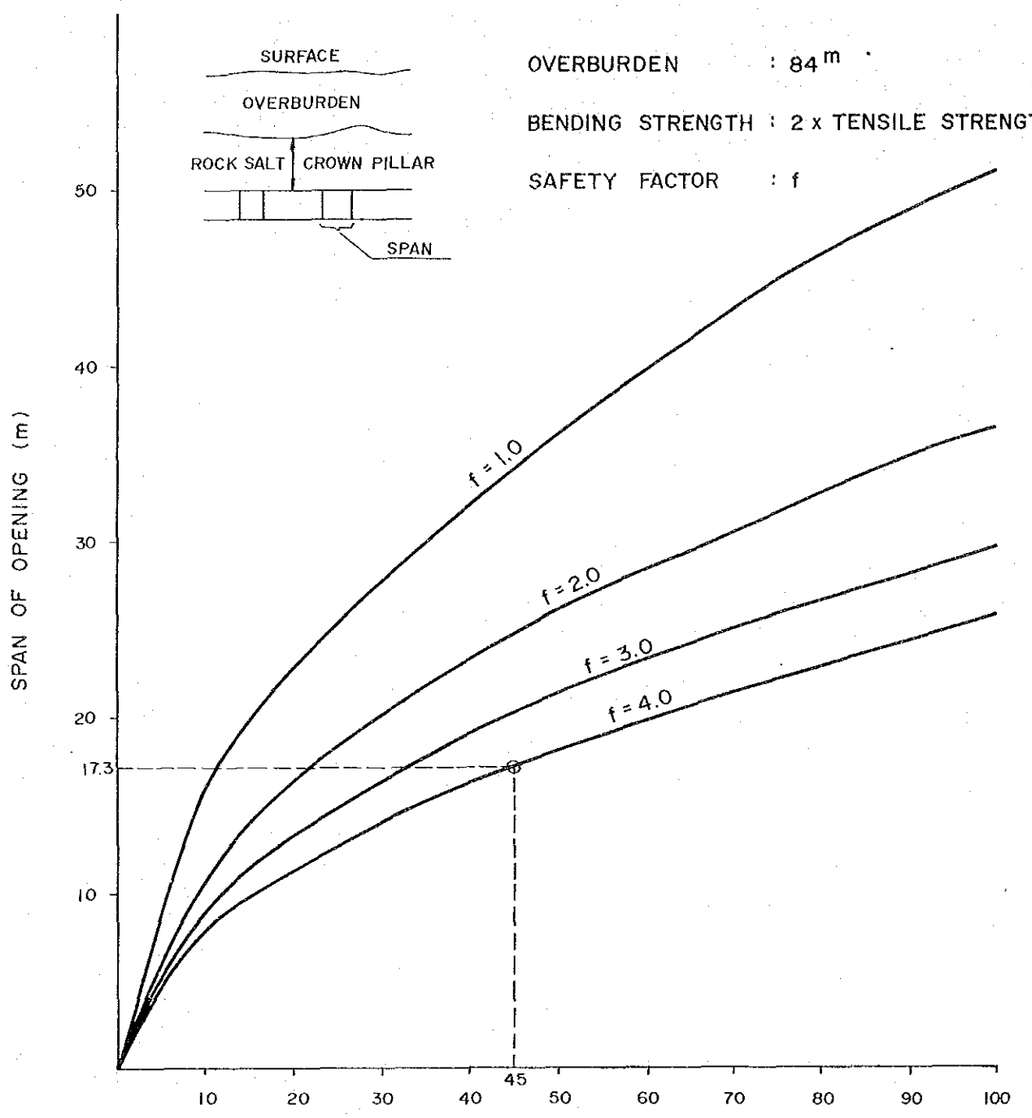
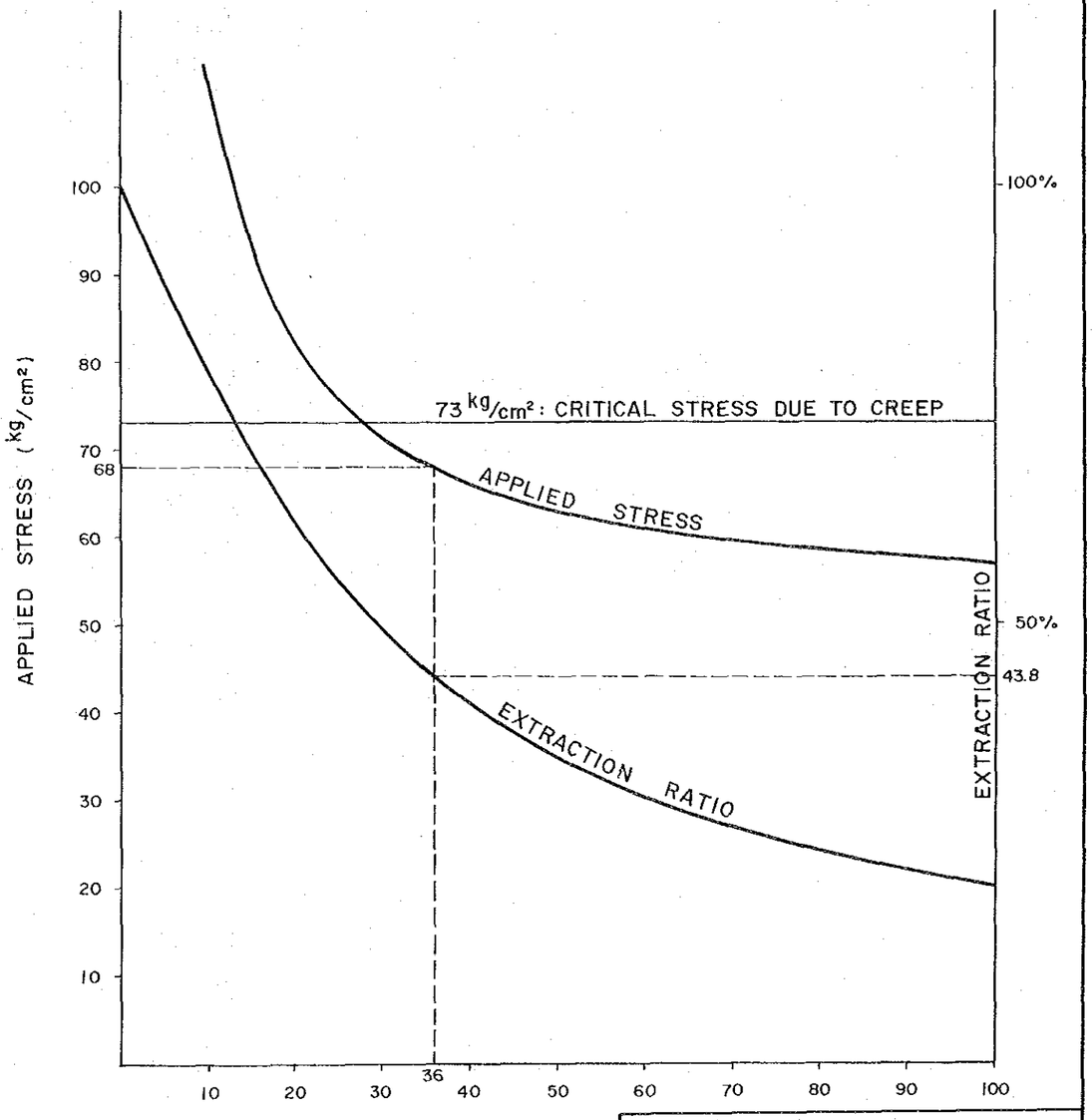
1 Yataro Shimomura et al., "Report of the Research Committee on Mine Pillar Strength, *J. Japan Mining Assoc.*, vol. 89, no. 1024

2 JICA, "Technical Report of the first-stage evaluation for ASEAN rock salt-soda ash project, August, 1980.

RELATION BETWEEN SPAN AND THICKNESS OF CROWN PILLAR



RELATION BETWEEN PILLAR WIDTH, APPLIED STRESS AND EXTRACTION RATIO



THE ASEAN ROCK SALT · SODA ASH PROJECT IN THAILAND

Relation Between Span and Thickness of Crown Pillar.	Relation Between Pillar Width, Applied Stress and Extraction Ratio.
JICA	FIG. AIII-1,2