THE FEASIBILITY STUDY REPORT
FOR
THE RENOVATION OF CAUSTIC SODA PLANT
OF
P. T. INDUSTRI SODA INDONESIA (PERSERO)
IN
THE REPUBLIC OF INDONESIA

(SUMMARY)

NOVEMBER, 1984

JAPAN INTERNATIONAL COOPERATION AGENCY

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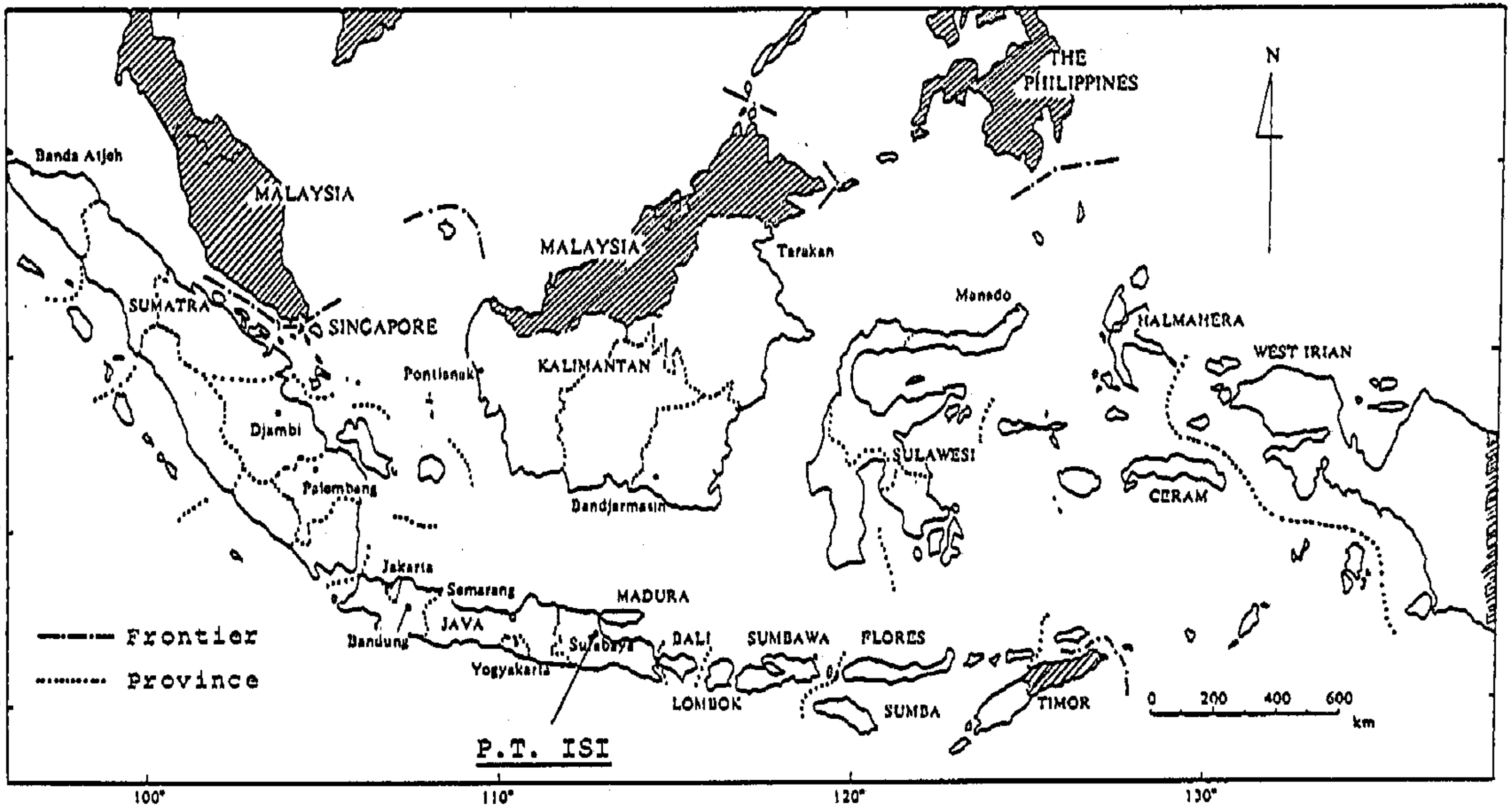
INDONESIA



(Source) : Atlas Indonesia, Yayasan Dwidjendra, 1976, Denpasar

OUTLINE OF THE PROJECT

1. The Factory to be Renovated

An electrolysis plant of P.T. Industri Soda Indonesia (PERSERO) located at Waru at 8 km distance from Surabaya.

2. The Existing Capacity of the Electrolysis

	Design Capacity	Actual Capacity
No. 1 Unit (M)	10 t/d	6 t/d
No. 2 Unit (M)	30 t/d	30 t/d
Total	40 t/d	36 t/d

3. Tentative Implementation Schedule

Contract award : April, 1986
Commencement of operation: January, 1988

4. Renovation Program and Profitability

	Case 1	Case 2	Case 3
(1) Production capacity			
No. 1 Unit	16 t/d (IM)	Stopped	16 t/d (IM)
No. 2 Unit	30 t/d (M)	47 t/d (IM)	47 t/d (IM)
Total	46 t/d	47 t/d	63 t/d
(2) Capital requirements			
Foreign currency	8.83	10.45	13.51
Local currency	8.29	8.96	10.80
Total (US$ Million)	17.12	19.41	24.31
(3) FRR (constant price)			
After tax	7.7%	7.4%	9.0%
Before tax	8.3%	8.0%	11.0%
(4) ERR (constant price)	17.4%	16.7%	18.5%

(Notes)

M : Mercury process
IM : Ion exchange membrane process
1US$ = Yen 230 = Rp 1,000

5. Demand/supply balance of chlorine (unit: 1,000 ton Cl)

	1985	1990	1995	2000
Demand				
max.	29.0	50.3	89.1	120.5
opt.	27.2	45.1	78.1	102.0
min.	25.2	40.8	69.6	89.4
Supply	26.6	37.5	59.1	71.9
Balance				
max.	2.4	12.8	30.0	48.6
opt.	0.6	7.6	19.0	30.1
min.	-1.4	3.3	10.5	12.7

6. Sales price forecast for each product (unit: US$/t)

	1984 (actual)	1988	1990	1995	2000
1. NaOH (100%)	300	359	403	540	722
2. L-CL	600	703	754	883	1,011
3. HCL (33%)	114	136	153	205	274
4. BLN (12%)	117	140	157	211	282
5. BLC (8%)	18	44	69	92	123
6. Pair Ton	740	875	956	1,188	1,463

7. Financial sensitivity analysis (FRR %, 1984 constant price)

	10% Up	10% Down
	Bfr.Tax/Aft.Tax	Bfr.Tax/Aft.Tax
Sales Price	13.2/10.7	8.7/ 7.1
Raw Salt Cost	10.9/ 8.9	11.2/ 9.1
Electricity Cost	10.9/ 8.9	11.2/ 9.1
Project Cost	9.6/ 7.9	12.7/10.3
Market Size	13.3/10.6 (maximum)	8.9/ 7.4 (minimum)
Basic Assumptions	11.0/9.0	

ABBREVIATIONS AND SYMBOLS

Unit and Conversion

mm	Millimeter
cm	Centimeter
m	Meter
km	Kilometer
in	Inch (1 in = 2.54 cm)
ft	Foot (pl. feet) (1 ft = 0.305 m)
cm^2	Square centimeter
m^2	Square meter
ha	Hectare (1 ha = 10,000 m^2 = 2.471 acres)
ft^2	Square foot (1 ft^2 = 0.0929 m^2)
Rai	(1 Rai = 1,600 m^2)
m^3	Cubic meter
Nm^3	Normal cubic meter
MMm^3	Million cubic meters
ft^3, cu ft	Cubic foot (1 ft^3 = 0.0283 m^3)
SCF	Standard cubic foot
MMSCF	Million standard cubic feet
l	Liter
gal	Gallon (1 British gallon = 4.546 liters, 1 U.S. gallon = 3.785 liters)
bbl	Barrel (1 barrel = 42 U.S. gallons)
g	Gram
kg	Kilogram
ton, t, T, Ton	Metric ton
lb(s)	Pound (1 lb = 0.454 kg)
sec	Second
min	Minute
hr, h, Hr	Hour
d, D	Day
m, M	Month

y, Y	Year
C	Degree centigrade
F	Degree fahrenheit
Cal	Calorie
Kcal, K cal	Kilo calorie
BTU, Btu	British thermal unit (1 BTU = 0.252 Kcal)
MMBTU, MMBtu	Million British thermal units
LHV	Low heating value
HHV	High heating value
A	Ampere
V	Volt
W	Watt
kW	Kilowatt
mW	Megawatt
kVA	Kilo-volt ampere
mVA	Mega-volt ampere
kWh, kWH	Kilowatt-hour
mWh, mWH	Megawatt-hour
HP	Horse power
%	Percent
ppm	Parts per million
ppb	Parts per billion
g/Nm^3	Gram per normal cubic meter
pH, PH	Hydrogen ion concentration
kg/cm^2	Kilogram per square centimeter
lb/in^2	Pounds per square inch
mmAq	mm aqua (= water)
t/d, ton/day, T/D, tpd	Metric tons per day
t/y, ton/year, MTA, MT/Y, T/Y, tpa, tpy	Metric tons per year

Technical Terms

BLC	Calcium hypochlorite
BLN	Sodium hypochlorite
CL	Chlorine
HCL	Hydrochloric acid
HTH	High test hypochlorite
MSG	Mono sodium glutaminate
VCM	Vinyl chloride monomer
EDC	Ethylene dichloride
NaOH	Caustic soda
PVC	Polyvinyl chloride
G-	Gaseous
L-	Liquefied
Aq-	Aqueous
S-	Solid
F-	Flake
D (process)	Diaphragm (process)
IM (process)	Ion exchange membrane (process)
M (process)	Mercury (process)
BOD	Biological oxygen demand
COD	Chemical oxygen demand
SCR	Silicon rectifier
MSL	Mean sea level
ISBL	Inside battery limit
OSBL	Outside battery limit

Financial and Economic Terms

DCF	Discounted cash flow
IRR	Internal rate of return
ERR	Economic internal rate of return
FRR	Financial internal rate of return
ROI	Return on investment

GDP	Gross domestic product
GNP	Gross national product
C & F	Cost and freight
CIF	Cost, insurance and freight
FOB	Free on board
NPV	Net present value

Currency and Exchange Rate

Rp	Indonesian Rupiah (1 U.S. dollar = Rp 1,000., 1984)
US$, $	U.S. dollar
yen	Japanese yen (1 U.S. dollar = 230 yen, 1984)

Organization and Company

BAPINDO	Bank Pembangunan Indonesia (Indonesian Development bank)
BI	Bank Indonesia
BKPM	Badan Koordinasi Penanaman Modal (Investment Coordinating Board)
BPS	Biro Pusat Statistik (Central Burean of Statistics)
DGBCI	Direcorate General of Basic Chemical Industry
GOI	The Government of the Republic of Indonesia
JETRO	Japan External Trade Organization
JICA	Japan International Cooperation Agency
MOI	Ministry of Industry in Indonesia
PLN	Perusahaan Umum Listrik Negara
PT. ISI	P.T. Industri Soda Indonesia
PUG	Perusahaan Umum Garam

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SUMMARY, CONCLUSION AND RECOMMENDATION

[SUMMARY]

I. OBJECTIVES AND SCOPE OF STUDY

(1) Background of Study

A lot of plants have been constructed with priority given to Asean countries owing to the economic cooperation programs of the Government of Japan, and because of superannuation or insufficient maintenance, there are many plants which declined in the efficiency of plant operation and resulted in the increase of production cost.

Under those circumstance, the requests were made for the Government of Japan to undertake the cooperation for the repair and renovation of those plants, and in response to the request, Mr. Nakasone, the prime minister of Japan, announced his intention to accept the requests while he made a round of visits to Asean countries at the end of April, 1983.

In accordance with this announcement, the Government of Japan dispatched the pre-study team to Asean countries on November, 1983 and confirmed the selection of the candidate projects, and thereafter in response to the request of the Government of the Republic of Indonesia, the Government of Japan dispatched the pre-study team to Indonesia and agreed with the scope of work for the execution of the detailed study on the proposed project on February, 1984. Hence, this study shall be implemented on the basis of this agreement.

According to the request of the Government of Indonesia, the plant which is the objective of this renovation study is the works of PT. ISI located at Waru 8 km away from the downtown of Surabaya.

The works was constructed in 1953-1956 by Asahi Glass Co., Ltd. in Japan as the first Chlor-alkalai plant owned by the Government of Indonesia manufacturing such major products as 10 t/d of NaOH, 10 t/d of HCl and 10 t/d of BLC based on a mercury process.

Since the production of NaOH decreased to the level of 30% of the designed capacity due to the insufficient maintenance and operation management, the rehabilitation project was carried out during 1967-1969 by utilizing Asahi Glass Co., Ltd. once again on the basis of Yen credit.

In 1977-1978, the installation of No. 2 unit with the designed capacity of 20 t/d NaOH as 100% basis was carried out based on a mercury process by Wah Chang International Corporation, an engineering company in Taiwan.

In 1983, the conversion of the anodes from carbon to titanium in No. 2 unit was carried out and the production capacity of the unit was increased to 30 t/d.

On the other hand, No. 1 unit on which the rehabilitation was made in 1969, was again superannuated, resulting in the lowering of the capacity up to 6 t/d, concurrently with the lowering of the efficiency as to the facilities of HCl and L-Cl as well as the common facilities for No. 1 and No. 2 units.

In the meantime, the poisonous nature of the mercury process which was adopted by the works of PT. ISI has become a worldwide controversial problem and a technology for preventing mercury leakage from the plant was developed and in addition ion exchange membrane process which does not use any mercury and excellent in efficiency has been invented and developed into actual application.

It becomes necessary for PT. ISI not only to establish the renovation project for No. 1 unit of which the production efficiency became lowered but also to make a comprehensive review for all the facilities on the conversion to ion exchange membrane process as well as the prevention of environmental pollution.

This is the reason why the study in this report was planned for implementation.

(2) Objectives of Study

The objectives of the study is to diagnose the works of PT. ISI at Waru and investigate the possibility of the renovation project from the comprehensive discussion in view of the product marketability, quality of raw salt, technical, financial and economic standpoints, and to formulate the renovation programs in order to contribute to increasing production capacity, production efficiency and improving product quality. Furthermore, the diagnosis will be made to suggest the improvement programs on the current aspects of the operation management, education and training, pollution and safety control, and maintenance activity.

(3) Scope of Study

The study will cover the following items.

1) The study on the caustic soda industry in Indonesia.

   i) Present situation of and national policy on the caustic soda industry in Indonesia.

   ii) The plant relocation plan and the future projects of PT. ISI.

2) Diagnosis on the management of the following aspect.

   i) Operation and quality control

   ii) Maintenance of the machinery and equipment

   iii) Cost control

   iv) Administration system

   v) Education and training

3) Technical diagnosis on the machinery and equipment of the plant in the following aspect

i) Production control

ii) Quality control

iii) Unit consumption

iv) Inspection for the superannuation of each machinery and equipment

v) Study for the improvement of power factor and the change of receiving voltage at the electrical substation

4) Investigation of raw salt

5) Survey for the domestic market

6) Study for an environmental aspect

7) Formulation of the renovation program

The renovation program for PT. ISI will be formulated, taking into account the economical and environmental effects including the followings.

i) Planning for the renovation program

ii) Survey for the plant relocation and the future projects

iii) Estimation of the total capital requirement

iv) Planning for the education and training plan

v) Planning for the implementation program of the renovation project

8) Financial analysis and evaluation of the project

9) Economic evaluation of the project

10) Conclusion and recommendation

II. DIAGNOSIS OF PT. ISI FACTORY

(1) Diagnosis of Facilities

Existing capacity of process plant is as follows.

	Design	Actual
i) Electrolizer (M process, as 100% NaOH)		
No. 1 Unit (1970)	10 t/d	6 - 8 t/d 1/
No. 2 Unit (1978)	30 t/d	25 - 30 t/d 1/
ii) Hydrochloric acid plant		
1st (1970)	20 t/d	16 t/d
2nd (1978) 2/	30 t/d	12 t/d
3rd (1982)	50 t/d	40 t/d
iii) Liquified chlorine plant		
(1978)	15 t/d	6 t/d
iv) Bleaching liquor plant		
(1970)	30 t/d	25 t/d
v) Sodium hypo plant		
(1970)	5 t/d	4 t/d

(Notes) 1/ Actual production capacity is deemed as 6 t/d for No. 1 Unit and 30 t/d for No. 2 Unit hereinafter.

2/ 2nd HCl consisted of two trains of 15 t/d, but one was exploded. It is now under reparing.

Actual production capacity is lower than design capacity in all process plants due to superannuation of the facilities, especially in plants built in 1970.

The following is diagnosis of machinery and equipment by type.

Vessels, towers and pipings are;

Well maintained and generally in good condition.

Rotating machines and heat exchangers are;

In a marked degree of obsoleteness, which might be due to difficulty of obtaining spare parts.

Structures and operation stages are;

Much corroded with the leakage of chlorine gas and hydrochloric acid gas, coupled with insufficient maintenance of painting and the like.

Instrumentation;

The majority of instruments, control valves, and various other gauges are either poorly working or do not work any more owing to the environmental pollution from the gas leakage and inadequate maintenance. This is one of the factors that has worsened the operation of the whole plant.

Machinery and equipment were inspected and diagnosed, and the degree of obsoleteness was classified into three ranks as below.

Rank A: The machinery and equipment which need to be replaced at once.

Rank B: The machinery and equipment which are desirable to be replaced.

Rank C: The machinery and equipment which need not be replaced (and are expected to last more than five years).

Details are explained in Part III in the main report. The machinery and equipment of Rank A are listed by each process plant as follows.

Brine purifier

- Brine reaction tank
- Slurry pump
- Return brine pump
- Stage for brine saturator

No. 1 series electrolizer (No. 1 unit)

- Caustic liquor cooler
- Washing water pump
- Caustic liquor cooler pump

Chlorine liquefaction plant

- Insulation of liq. Cl_2 tank
- H_2SO_4 cooler
- Cl_2 condenser
- H_2SO_4 cooler of drying tower

Bleaching liquor plant

- Reacting pump
- Ca-Hypo pump
- Cl_2 cooler

Sodium hypochlorite plant

- Cl_2 gas blower
- Reacting cooler

(2) Diagnosis of Plant Operation

Issues and countermeasures are enumerated below based on the diagnosis of the present plant operation.

Brine purification process

(Issues)

Insufficient brine purification causes losses of brine and leakage of mercury to outside of system more than expected amount.

(Countermeasures)

i) Selection of appropriate precipitants

ii) Automatic control of precipitants amount fed into the purifier

iii) Increase in rotating speed of the agitator

iv) Installation of a filter press

v) Addition of a certain amount of sodium hypochlorite to the dechlorinated depleted brine to transfer mercury into the brine mud

Electrolysis process

(Issues)

Leakage of chlorine gas and spill of a small amount of mercury was found.

The standard of the measurement and analysis is not always observed.

(Countermeasures)

i) Observance of the standard of measurement and analysis

ii) Inspection of the gas sealing and improvement of the recovery effects of mercury

Liquified chlorine and filling

(Issues)

The manual operation causes fluctuation of the plant operation as well as problems in safety.

The filling system of liquified chlorine is not sufficient in view of safety.

(Countermeasures)

i) Renewal of instrument for automatic control

ii) Establishment of a practical operation standard as far as manual operation continued

iii) Recovery of cylinders within a specified period for inspection and repairing

iv) Establishment of a double check system to prevent overfilling

Other processes

i) Hydrochloric acid process

Since lower production might come from decrease in heat transfer coefficient of tubes for cooling, inspection and acid washing is recommendable for removing scale of the tubes.

ii) Sodium hypochlorite

The lower production rate is due to the insufficient capacity of a titanium made heat-exchanger to remove the reaction heat and control the temperature of the reactant fluid. No other problem exists in operation of the process.

iii) Bleaching liquor process

There is no specific issues for the plant operation.

iv) Auxiliary facilities

- Since the capacity of the sand filter for water treatment is insufficient, the supernatant in the settling basins is directly used as cooling water.

  Re-utilization of a part of the used water which causes no qualitative problem among the used filtrated water a great amount of which is drained presently is recommendable to avoid the scaling.

- Installation of a dehumidifier to the instrument air compressor.

- Undertaking of overhaul of No. 2 Unit rectifier.

(3) Diagnosis of PT. ISI's Management System

PT. ISI has a well organized managing system and efforts have been continued in implementation. Nevertheless, improvement on the following recommendation will contribute to more productive plant management.

<u>Organization and personnel distribution</u>

i) To hold a regular general conference to have employees known of the company target and their role.

ii) Urgently to allocate experienced persons to the Market Development section which has at present no assignment. The sales promotion is one of the most important jobs for PT. ISI.

iii) To centralize engineers to Technical Department for concentration to technological issues being apart from plant operation.

iv) Not to increase numbers of employees even after implementation of the renovation.

Operation control

i) To prepare new manuals written in Indonesian language reflecting PT. ISI's experiences in the operation. the manuals should be kept in each control panel room for operators' use.

ii) To make supervisors check and approve not only analytical records but also operation records, and to print standard operation conditions in the record forms.

iii) To make operators keep cost mind in their operation.

Education and training

i) To have the employees informed of the nature of such poisonous substances as chlorine gas, caustic soda and mercury, and to perform the first aid training for an occasion when employees get poisoned.

ii) To carry out a regular training for emergencies such as fire, leakage of poisonous materials and stoppage of utility supply.

iii) To file records of accident experienced by PT. ISI for trouble shooting as well as a training book for operators.

iv) To introduce OJT system in the education curriculum for new employees.

v) To compile training material by PT. ISI herself and to furnish them easy for use.

Management of maintenance

i) To oblize production department to be peimarily responsible for initiation and scheduling of maintenance works. The maintenance depertment is to follow the production depertment in performance of maintenance and repairing.

ii) To reflect results of inspecton, being made through periodical PM work, immediately and correctly to the actual maintenance works.

iii) To study implementation of periodical shut-down repairing.

iv) To make efforts to secure imported spare parts and to survey possibility of usage of domestic supplies.

v) To keep the factory site clean removing unnecessary equipment and machinery.

vi) To implement periodically scheduled painting of machinery and equipment, structures and pipings.

vii) To prevent leakage of chlorine gas and protect the factory from corrosion.

III. MARKET STUDY

(1) Demand/Supply Forecast

Table-1 shows the outcome of the demand forecast for caustic soda and chlorine in Indonesia. As to chlorine, the potential demand for PT. ISI was projected by each chlorine product as shown in Table-2.

i) Demand/supply balance of chlorine

(Unit: 1,000 ton Cl)

	1985	1990	1995	2000
Demand				
Indonesia 1/	27.2	45.1	78.1	102.0
for PT. ISI 2/	9.9	13.7	17.4	22.2
Supply Capacity				
Indonesia	26.6	37.5	59.1	71.9
for PT. ISI 3/	9.5	9.5	9.5	9.5
Balance (Supply shortage)				
Indonesia	0.6	7.6	19.0	30.1
for PT. ISI 4/	0.4	4.2	7.9	12.7

(Notes)
1/ "Indonesia" includes figures "for PT. ISI".
2/ "Demand for PT. ISI" means total potential market for PT. ISI.
3/ "Supply for PT. ISI" means the existing capacity of PT. ISI Waru.
4/ "Balance for PT. ISI" is additional potential market to PT. ISI existing capacity.

As chlorine supply capacity is in surplus to the extent of 800 t/y in 1984 (see Table-1), it is projected that chlorine supply capacity will be almost equivalent to the demand in 1985, assuming that the existing plants of non-integrated companies are operated at 100% of capacity. In a long-term view, the existing production capacity is not able to satisy chlorine demand in Indonesia. It was apparently observed in the past that the non-integrated companies were obliged to operate the plants at low levels of capacity utilization due to a shortage of chlorine demand and as a consequence, the financial situations of these companies deteriorated. But in medium and long range views, chlorine demand will steadily increase and according to projection the existing production capacity is expected to become unable to fulfill the total demand.

The potential market for PT. ISI is projected exclusively on the basis of a demand increase of existing customers and does not include the demand increase to be expected if new customers are found and the new chlorine compounds are produced in the future.

ii) Demand/supply balance of caustic soda

As shown below, an absolute shortage of supply capacity is projected, since supply capacity is calculated as chlorine supply capacity/0.88.

(Unit: 1,000 ton as 100% NaOH)

	1985	1990	1995	2000
Demand	128.6	180.9	254.0	323.1
Supply Capacity	30.2	42.6	67.2	81.7
(Supply Capacity of PT. ISI)	(10.8)	(10.8)	(10.8)	(10.8)
Balance (Demand/Supply Gap)	98.4	138.3	186.8	241.4

At this point it is necessary to discuss the possible change of the market structure in the event that an electrolysis plant is constructed together with the VCM plant in the future.

It is anticipated that the start-up year of the VCM plant will be 1988 at the earliest and that production capacity will be less than 150,000 t/y. In this case, the production of caustic soda which may be released to the market as surplus production is estimated as about 106,000 tons/year. On the other hand, a caustic soda shortage in 1988 is projected, as 122,300 t/y, as shown in Table-2, so that the balance becomes 16,300 t/y or 54.3 t/d, which will be marketable room by PT. ISI in addition to the existing production capacity of 36 t/d.

Hence, as stated above, chlorine demand is projected to be a factor limiting the capacity utilization after the renovation project of PT. ISI.

iii) Production plan of PT. ISI after renovation

As stated later, three cases are discussed for the renovation project, and the production capacity of each case is as shown below.

Existing	:	36 t/d
Case 1	:	46 t/d
Case 2	:	47 t/d
Case 3	:	63 t/d

The maximum operating days of the existing plant is regarded to be 300 days a year if the renovation project is not implemented.

It is supposed that the possible operating days of the plant will become 330 days a year after the renovation. the production capacity as chlorine equivalent of chlorine products is designed to be 1.4 times greater than the generated chlorine gas since it is a common design practice to have such a surplus capacity in an electrolysis plant for the purpose of enabling flexible operations.

PRODUCTION CAPACITY OF PT. ISI

(Unit: ton as 100% NaOH & Cl)

	Existing	Case 1	Case 2	Case 3
a. NaOH	10,800 1/	15,180 2/	15,510 3/	20,790 4/
b. CL gas 5/	9,500	13,358	13,649	18,296
b-1) L-CL	1,800	4,950	4,950	4,950
b-2) HCL	24,900	41,250	42,900	66,000
b-3) BLN	1,200	1,650	1,650	1,650
b-4) BLC	7,500	9,900	9,900	9,900

(Notes)
1/ 36 t/d x 300 d/y
2/ 46 t/d x 330 d/y
3/ 47 t/d x 330 d/y
4/ 63 t/d x 330 d/y
5/ (a) x 0.88

It is supposed that the resumption of production after the renovation will be the beginning of 1988.

Assuming that production will be made in accordance with demand, the capacity utilization of electrolytic cells for each case is calculated as follows.

(Unit: %)

	Existing	Case 1	Case 2	Case 3
1984	90	-	-	-
1985	90	-	-	-
1986	90	-	-	-
1987	90	-	-	-
1988	90	90	90	73
1989	90	100	100	76
1990	90	100	100	80
1991	90	100	100	84
1992	90	100	100	88
1993	90	100	100	93
1994	90	100	100	97
1995	90	100	100	100
2000	90	100	100	100

(Note) The capacity utilization in Case 1 and Case 2 in 1988 is assumed to be 90%, taking into account the warming up stage in view of the plant operation technique in the initial start-up year.

iv) Comments on sales promotion activity

It is not believed that the potential market for PT. ISI mentioned above can be actualized in a natural course of events while the current sales system continues as it is.

The study team fully realized that the efforts for sales promotion or market development made by PT. ISI were a little better than nothing. In other words, it is believed that there is a large marketable room for PT. ISI to develop new customers.

For example, it is said that there are the companies in Indonesia who have been importing the chlorine products which PT. ISI has produced and promoting the new project for imports. Hence on the basis of information elaborately to be collected, it is necessary for PT. ISI to make door to door visits to those importing companies even if they are the companies in a small scale and request them to substitute the products of PT. ISI for the imported products.

If such an effort continues, the potential market for PT. ISI will be realized upwards and it is expected that a long interval will not be needed to reach the full operation of the plant even in the renovation project of Case 3.

(2) Price Forecast for Products

Table-3 shows the historical ex-factory price (including tax) of PT. ISI, and Table-4 shows the ex-factory price forecast (including tax) of PT. ISI.

i) Sales price of caustic soda

Sales price of caustic soda in Indonesia has varied almost in accordance with the price of imported caustic soda. Although the imported caustic soda occupied more than 75% of the total demand, of which solid caustic soda was the major portion of imports, the import of aqueous caustic soda has been dominant in recent years since construction of the storage tanks has shown a rapid progress. In view of the current trend, the price of imported solid caustic soda is high while the price of imported aqueous caustic soda is low, thus the sales price of domestic caustic soda is determined by weighing their relative pricing balance.

In view of the regional aspect, it is observed that the sales competition has been made at the lower price level in the district of Surabaya and Jakarta where the storage tanks for imported aqueous caustic soda have been provided, while in the district of Sumatra and Kalimantan, the domestic caustic soda has been sold at the relatively higher price level since imported solid caustic soda has been functioned as a price determinant.

Assuming that a VCM plant will be constructed in the near future and a large quantity of caustic soda (about 100,000 t/y) as co-product of chlorine which is the raw material for VCM will be released to the domestic market, the domestic supply ratio for the total caustic soda demand will be more than 70% at the end of 1980s. In this case, it is evident that the key deciding factor for caustic soda price will be the said caustic soda to be produced at a VCM plant, as a co-product of chlorine.

In view of the comprehensive review for the price trend in the past and the upward possibility of the domestic supply ratio in the future, the ex-factory price of PT. ISI in 1984 is projected as US$300/t (on 100% basis) and the sales price in 1985 onward is projected by multiplying the escalation rate to US$300/t.

The outcome of projection is shown in Table-4. Since 4% sales tax is included in the above projection of price, a portion of tax has to be deducted for projection of the real ex-factory price of PT. ISI.

ii) Sales price of chlorine products

Since chlorine products is difficult for the bulk transportation by sea and the transport cost is higher than the product price, the international trade has scarcely been made except the urgent and spot basis. Hence, the domestic sales price is to be determined exclusively due to the domestic situation.

The feature of pricing mechanism for chlorine products in Indonesia is that the price of liquefied chlorine is abnormally high when compared with the price of other countries because of the difficulty of transportation by sea. Although in the developed countries, the price of liquefied chlorine is almost equivalent to the price of caustic soda, it becomes about double in Indonesia.

The price of chlorine is comparatively cheaper even in those countries where demand for chlorine is pressing and a surplus of caustic soda becomes a serious matter, whereas the reverse price structure is seen in Indonesia where the reverse market situation is observed. The reason is as follows.

1) In Indonesia, production cost for the electrolysis products such as caustic soda and chlorine is high as a whole, because of small production capacity, low capacity utilization, high price of raw salt with low quality and high price of electric power.

2) Liquefied chlorine, import of which is difficult due to the difficulty of transport, is the product which has not been exposed to the international price competition. (If imported, the import price will be about two times of the current high pirce of the domestic product).

3) PT. ISI is in the monopolistic position for supply of liquefied chlorine in Indonesia. Hence, the high production cost as described in the item (1) above has to be covered by the high sales price of liquefied chlorine.

The study team assumed that demand for chlorine products in Indonesia will increase in accordance with the progress of the industries and will be vital to be fulfilled by the domestic supply in any form or other. In other words, unless a competitor comes into being or supply of liquefied chlorine is made in the lower price, the progress of the associated industries is obliged to be deteriorated. In this point of view, it is projected that the sales price of liquefied chlorine is inclined to make a gradual decline in the future.

Hence, the price was projected on the assumption that the price is obliged to decline ultimately up to the ratio of the production cost for caustic soda (projected as 1.4) until the year of 2,000.

Among chlorine products, the sales prices of hydrochloric acid, and BLN were projected in proportion to the ratios of the production cost of PT. ISI, since the price trend in the past has been varied almost complying with those ratios of the production cost, and when compared with the price structure in the developed countries, the similar structure on the price ratios can be observed.

On the other hand, BLC is currently produced as a means of disposal of surplus chlorine, so that the production cost is not properly reflected in the sales price of BLC, resulting in the abnormally lower price. Hence, it is projected that the reasonable price will be gradually recovered complying with demand increase for chlorine.

iii) Outlook of sales price forecast

The following table shows the sales prices which were projected on the basis of the procedure described above. The increase of the price due to the inflation is included in these figures.

SALES PRICE FORECAST FOR EACH PRODUCT

(Unit: US$/t)

	1984 (actual)	1988	1990	1995	2000
1. NaOH (100%)	300	359	403	540	722
2. L-CL	600	703	754	883	1,011
3. HCL (33%)	114	136	153	205	274
4. BLN (12%)	117	140	157	211	282
5. BLC (8%)	18	44	69	92	123
6. Pair Ton	740	875	956	1,188	1,463

IV. PRERERQUISITE CONDITIONS OF THE RENOVATION PROGRAM AND STUDY ON THE RELATED TECHNICAL SUBJECTS

(1) Project Site

The prerequisite for implementing the renovation is to utilize the existing equipment of PT. ISI's Waru plant as much as possible so as to keep down investment and reduce expenditure. Accordingly, relocation of the plant site is not considered in formulation of the renovation program.

(2) Electrolysis Process

Examinating advantages and disadvantages among mercury process, diaphragm process and ion exchange membrane process (membrane process), the survey team has deemed that the replacement of the existing mercury process unit(s) with membrane process is to be appropriate.

i) It will be especially profitable for PT. ISI which has been paid considerably expensive electric charge. Moreover, it is able to scheme increased production of chlor-alkali with existing rectifier.

ii) Harmful substance such as mercury or asbestos does not used, the process has no environmental problems.

iii) High quality caustic soda product like that of mercury process is also obtainable by the process.

iv) As membrane electrolyzers and auxiliary equipments can be constructed compactly, it is possible to utilize the existing cell room and other facilities at maximum.

v) When converting from existing mercury process, membrane process enable to require less construction cost than diaphragm process. In addition, no additional operator is required for the membrane process.

Membrane electrolyzers are classified monopolar type and bipolar type according to the difference of electric circuit of unit cells contained in an electrolyzer. The former is arranged in parallel and the latter is arranged in series.

On the premise that the existing No. 1 silicon rectifier (DC output 30 KA x 55 V) and/or No. 2 silicon rectifier (DC output 75 KA x 65 V) which are so called "low voltage and high current rectifier" is re-utilized, it is concluded that the adoption of monopolar electrolyzer arranged in parallel is adequate.

(3) Supply of Raw Salt and Washing the Salt

Solar salt being produced in Indonesia is relatively high in price and inferior in quality when compared with the salt imported from Australia or Canada.

As the GOI, however, insists on the maximum utilization of domestic production in view of national benefit, the utilization of the domestic salt is to be deemed as a prerequisite condition for the project.

In terms of raw salt availability in volume, no shortage will be foreseen as far as the requirement of the project concerned.

As a method of quality improvement, washing of raw salt to remove impurities in the salt has been studied in view of economics. Perum Garam which is the state-owned salt producing company had no interest in salt washing at her salt field because of small requirements for PT. ISI.

Accordingly, if the salt would be washed, a facility shall be located inside of the PT. ISI factory site. In such case, loss of raw salt by washing, which is estimated as 10% from experiences, exceeds the expected profit derived from the saving of chemicals consumed for purification of the low quality salt. Therefore, the facility for salt washing will not be installed in this project.

(4) Economical Utilization of Electricity

In the chlor-alkali industry an electric fee occupies 40% to 50% of the production cost. Hence, the electric fee is the most important factor in plant management. According to Indonesian tariff for electricity charge, the lower rate of charge is applied to higher voltage and higher power factor.

Taking such tariff system into account, economic study has been made on alternation of the receiving voltage from the present 20 KV to 70 KV as well as improvement of power factor from the present 0.84 to 0.94. As the result, the modification is decided to be included in the renovation program since it is confirmed that these modification can contribute to plant economy if investment would be made for the modification.

(5) Environmental Control

No pollution problem has taken place yet from the factory. The following countermeasures to prevent coming problems, however, are provided with in the project since the factory site has been surrounded by dwelling houses.

Besides the installation of such facilities, it shall be emphasized that daily works for measurement, inspection and control is vital for the environmental control.

i) Air pollution

Instrumentation and processing facilities are to be rehabilitated to prevent the leakage of chlorine gas and hydrochloric acid gas.

ii) Waste water

A pit is installed at the crossing point of drainages in order to control pH in the drainages before disposal to the outside.

iii) Mercury

The following countermeasures will be provided only for Case 1 which has continuous operation of No. 2 mercury electrolyzer.

(a) Spill of liquid mercury

The floor in the electrolytic cell room is coated with resin so that the floor surface become flat and mercury is prevented from staying on the floor, which makes it easier to recover mercury. Mercury must also be prevented from penetrating into the ground through the concrete by coating it.

A vacuum pump is installed and a vacuum line is set up to suck and recover the mercury on the floor.

Water remained on the floor will be led to a pit to absorb mercury by activated carbon before the water is disposed.

(b) Mercury amalgam butter

The existing mercury recovery system still will be effectively employed to increase the recovery of mercury and amalgam butter.

(c) Treatment of mud coming from a brine purifier

A filter press will be installed to dehydrate and separate the mud so as to prevent the release into the drainage. The dehydrated mud containing mercury will be hardened with cement to prevent mercury from elution. The filter press shall be provided for all the cases.

(d) Removal of mercury vapor in hydrogen gas

A washing tower will be installed so as to lead hydrogen gas, which is generated in the electrolyzer, and is washed with refined brine, to remove mercury vapor.

V. OUTLINE OF THE RENOVATION PROGRAM

(1) Formulation of Renovation Program

The following three cases has been set for a techno-economic evaluation as the renovation program through the diagnosis of the existing factory and discussion with PT. ISI.

The principle for the program formation is to utilize the existing machinery and equipment at the maximum extent aiming at the lowest investment cost for the plant economy.

Case 1:

i) No. 1 Unit of electrolyzer of mercury process is replaced by a new membrane process electrolyzer.

The production capacity expands to the limit of the capacity of No. 1 rectifier.

No. 2 Unit electrolyzer is continuously operated as it is.

ii) Total production capacity becomes as much as 46 t/d totaling 16 t/d for No. 1 Unit and 30 t/d for No. 2 Unit

iii) Expected advantages of this case is the lowest investment cost among three cases.

Case 2:

i) No. 1 Unit electrolyzer is stopped the operation together with No. 1 rectifier. No. 2 Unit electrolyzer of mercury process is replaced by that of membrane process.

ii) Production capacity is increased upto the limitation of the capacity of No. 2 rectifier, which is equivalent to 47 t/d of NaOH.

iii) One of the expected advantages for this case is to be free from environmental problem caused by mercury. In addition, the lower electricity unit consumption can be enjoyed.

Case 3:

i) Both electrolyzers of No. 1 and No. 2 are replaced by membrane process. Production capacity is designed to meet the capacity of each rectifier.

ii) Total production capacity will be 63 t/d as a summation of 16 t/d for No. 1 Unit and 47 t/d for No. 2 Unit.

iii) The expected advantages for the case is defined as its scale merit in production capacity in addition to the advantages for Case 2.

Furthermore, the following renovation works are involved in each case, though the scale of renovation varies by the total production capacity of the cases.

i) Modification and rehabilitation of the existing facilities to recover the originally designed capacity.

ii) New installation of secondary brine purifier.

iii) New installation of caustic soda concentration facility.

iv) New installation of electrical equipment for alternation of the receiving voltage and improvement of power factor.

v) New installation of environmental control facility of mercury. (only for Case 1)

vi) New installation of a hydrochloric acid plant.

vii) Necessary renovation of related facilities.

(2) Implementation Schedule

Construction period is estimated as long as 21 months from the contract awards to the plant acceptance.

On the assumption that arrangement of required funds and project preparation will be properly carried out, a time table for the implementation is made as follows:

Contract award	:	April, 1986
Start of field construction	:	November, 1986
Completion of erection	:	November, 1987
Plant acceptance	:	December, 1987
Commencement of commercial operation	:	January, 1988

(3) Organization for Project Implementation

As PT. ISI has experience in the renovation works similar to the proposed project, PT. ISI will be able to manage the construction works hiring supervisors to be dispatched by contractor(s).

Therefore, CIF plus supervisor contract in lump sum basis with foreign contractor(s) which is capable to provide the technology of membrane process is appropriate.

As for local works such as civil and erection, PT. ISI makes contract directly with local contractor(s) which is to be under supervision of PT. ISI.

PT. ISI shall organize a project team led by a project manager consisting of a process group and a construction group in order to manage and control the whole project.

Hence, no consultant as a technical advisor is assumed to be required for construction works. Nevertheless, advisors for project preparation is necessary for assistance to PT. ISI in preparation of the bid specification, evaluation of bids and selection of contractor(s) because the membrane process is new technology for PT. ISI.

Moreover, it is recomendable for PT. ISI to hire operation advisors for an initial operation in order to familiarize operators with the new process.

VI. CAPITAL REQUIREMENTS AND FINANCING PLAN

(1) Capital Requirements

Table-5, -6 and -7 show estimated capital requirements for three cases to be studied. Summary is as follows:

(Unit: US$1000)

	Case 1	Case 2	Case 3
Base Project Cost (BPC)	10,289	11,798	14,628
Physical Contingency	800	852	1,048
Price Contingency	1,108	1,262	1,563
Tax and Duties	1,283	1,452	1,799
Pre-operating Expenses	580	580	630
Additional Working Capital	1,300	1,500	2,200
Interest During Construction	1,759	1,972	2,446
	17,119	19,416	24,314

(2) Financing Plan

As financing plan including source(s) and terms and conditions of loans are not determined yet, the following conditions are assumed as a base case for the study purpose on the basis of discussion with MOI and PT. ISI.

Financing source; all financing requirements will be met by borrowing.

Foreign loan;

Demarcation : For all requirements in foreign currencies.

Interest rate : 10% per annum

Repayment : 8 year-repayment in equal installments after 2 year-grace-period.

Local loan;

Demarcation	:	For all requirements in local currency.
Interest rate	:	18% per annum
Repayment	:	3 year-repayment in equal installments after 2 year-grace-period.

The above presumed conditions as well as increase of paid-up share capital shall be carefully examined taking feasibility of the project into consideration.

VII. FINANCIAL AND ECONOMIC ANALYSIS

(1) Method for Financial and Economic Analysis

i) Escalation rate

The US dollar terms is used for the prices of financial analysis. The exchange rate is set as 1 US$ = 1,000 RP = 230 Yen which was the rate as of June, 1984. The same escalation rates are used for both of the foreign and local currency portions as follows.

1983	3.0 (%)
1984	3.5
1985	3.5
1986	4.0
1987	5.0
1988 onwards	6.0

ii) Method for measuring investment effect by incremental comparison

The return on investment can be measured by the comparison of increments in cost and return. First, the projection has to be made for cost and revenue up to 2,000 in the case named W/O Case (Without Case) where no renovation project is made and the plant is operated at the existing conditions.

On the other hand, the same projection has to be made for cost and revenue up to 2,000 in each case as defined where the renovation project is implemented.

The internal rate of return computed on the basis of difference between each case and W/O in cost and return will indicate the investment effect of each case. A financial internal rate of return is hereinafter referred to as FRR to discriminate a economic rate of return (ERR) from FRR.

Furthermore, a net present value (NPV) with a discount rate of 10% is computed.

Since the financial reports are computed on the current price basis by means of the escalated costs and prices, IRR and NPV is to be computed by discounted value on 1984 constant price basis by using the deflator which is equivalent to the escalation rate.

(2) Financial Analysis

i) FRR

Table-8 shows the indices of financial profitability for each case. FRR is as follows.

FRR IN 1984 CONSTANT PRICE

	(After Tax)	(Before Tax)
Case 1	7.7%	8.3%
Case 2	7.4%	8.0%
Case 3	9.0%	11.0%

Case 3 which is planned to implement the largest scale of the renovation and make the largest expansion of production capacity shows the highest return on investment. Hence, unless a particular reason is found, it is recommendable that Case 3 renovation project has to be selected.

The comprehensive comparison summarizing the advantages and disadvantages for each case is shown below.

COMPARISON OF ADVANTAGES AND DISADVANTAGES FOR EACH CASE

	Case 1 (46 t/d)	Case 2 (47 t/d)	Case 3 (63 t/d)
Increase in Production (t/y)	x(4,488)	Δ(4,818)	o(10,098)
Construction Cost per Ton of Increased Production (US$1,000/t)	Δ(3.81)	x(4.03)	o(2.41)
Year of Capacity Utilization Reaching 100%	o(1988)	o(1988)	x(1995)
Year of Sales Quantity Reaching Full Capacity	x(1988)	x(1988)	o(1995)
Electricity Consumption (kWh/t)	x(2,940)	o(2,394)	o(2,394)
Salaries/Wages per Ton	x	Δ	o
Expense of Membrane and Anode per Ton	o	x	x
Investment for Environmental Control	Δ	o	o

(Notes) O: most advantageous for the Case.
Δ: neutral in advantages comparing with other two Cases
X: disadvantages for the Case.

ii) Financial ratio and cash flow

Table-9 shows the major financial ratios for each case. DSR (Debt Service Coverage Ratio) which indicates the capability for repayment of loan is 1.0 or below for Case 1, Case 2 and Case 3 in the period of 4 years, 5 years and 7 years respectively after the commencement of operation, so that repayment of the loans and payment of the interest become unable. Therefore, an additional financing is required for reimbursement of the loans, which amount is projected to be as follows.

(Unit: US$1,000)

	1989	1990	1991	1992	1993	1994	1995
Case 1	1,325	2,761	3,204	1,164	0	0	0
Case 2	1,909	3,646	4,250	2,300	334	0	0
Case 3	3,477	6,760	8,716	7,446	5,997	3,491	39

The terms and conditions which are tentatively assumed as a base case for the project seem so severe that the implementation of this project is deemed to be very difficult due to the deteriorated cash flow unless the terms and conditions of the loans are moderated.

(3) Economic Evaluation

Economic price is estimated for economic evaluation of the project.

i) Taxes and duties

Since all taxes and duties are deemed as a transferrable cost, they shall be excluded from the cost.

ii) Sales price of products

CIF price (international price) of imported goods shall be used as the economic sales price of the products. As a result of assessment, economic price of caustic soda has been measured to be a half of the prevailing market price, while that of chlorine products has been measured as two times of the market price.

iii) Raw salt

Economic price is measured to be a 90% of the market price of the raw salt domestically produced due to the comparison for price and quality of raw salt at the international market.

iv) Salaries and wages

The shadow wages of the unskilled labours are projected to be a half of the current nominal wages, which is equivalent to 10% of the total salaries and wages of PT. ISI.

The following table shows economic internal rate of return (ERR) and net present value (NPV) with the discount rate of 10%, both of which are calculated by the economic price. Either one is projected on the basis of the incremental comparison with W/O.

	ERR (%)	NPV (US$1,000)
Case 1	17.4	4,680
Case 2	16.7	4,771
Case 3	18.5	8,532

ERR is more than 15% for all cases and can be regarded as economically feasible. In the comparison among the cases, both of ERR and NPV show the higher investment effect in the order of Case 3, Case 1 and Case 2 as in the same order as the financial analysis.

The reason of the high economic indices is attributable to that unless the renovation project would be implemented, the same amount of products which should have been additionally produced from the project shall be imported at the international (economic) prices for the relevant industries in Indonesia. Extremely high import price of chlorine products which can not be transported in bulk causes such high economic rate of return.

In other words, even if it can be said that caustic soda domestically produced is sold at the price two times higher than that of the imported one, the contribution of the chlor-alkali industry to the industries of Indonesia is so great that it is supposed to be valuable to foster the chlor-alkali indusry. At least, it is believed indispensable to promote the expansion of the plants to satisfy the domestic demand of chlorine.

[CONCLUSION]

(1) Salable Possibility of Products

As the supply of caustic soda is in shortage of a large amount, no problem is found on its demand for the project. The demand for chlorine is also projected which enables a full operation of the plant in Case 1 and Case 2 from 1988 onward when the project is scheduled to be placed into the commercial operation.

In Case 3, it is supposed that the plant will be able to operate at full capacity from 1995 onward. Even in this case, since PT. ISI's share for the demand/supply gap in Indonesia is about 65% at that time, the sales quantity of the products will increase if an effort for sales promotion is piled up in order to improve the share ratio.

(2) Selection of Electrolysis Process

The conversion from a existing mercury process to an ion exchange membrane process is deemed to be reasonable taking into account the financial feasibility in addition to the physical conditions such as a location and a site space of the existing factory. It is also deemed to be reasonable to use a monopolar type of electrode in order to find the effective use of the existing rectifier.

(3) Raw Salt Supply and Preliminary Washing

No problem is found for raw salt supply situation in terms of volume. The preliminary washing (water washing) to remove the impurities of raw salt seems not so economical that the problem is to be coped with increasing injection of the chemicals into the brine purification process.

(4) Measure for Economical Use of Electricity

The investment for a receiving voltage change and a power factor improvement is to be incorporated into the project because of its remarkable effect on decrease of the unit electricity price.

(5) Measure for Environmental Protection

The problems can be solved by repairing the superannuated facility for the exhaust gases and by making pH control for the waste water. In case that the electrolytic cells of a mercury process are continuously operated, mercury contained in the mud will be solidified by cementing after filtlation by a newly installed filter press, and for mercury vapour mixed in hydrogen gas, a mercury absorber washing tower is also newly installed. Thus, the closed system is completed.

(6) Selection of Renovation Project Scheme

Since Case 3 shows the highest financial and economic feasibility, this case shall be selected unless a particular reason is found. This case is also feasible in technical viewpoint.

(7) Financial and Economic Feasibility

Caustic soda and chlorine are very important basic chemicals for the relevant industries and in particular a domestic supply of chlorine has a remarkable economic effect. If a domestic supply of chlorine becomes unable, the industrial development in Indonesia will be greatly retarded. This point is realistically reflected on ERR in that a higher internal rate of return of 18.5% is indicated.

Although the supply capacity surely exceeds the demand at present, the supply shortage is projected to come within a few years. In this context, the expansion of production capacity of this project is expected to contribute greatly to the economy of Indonesia.

Regarding the financial aspect, FRR shows a feasible value of 9.0%. In view of cash flow, however, this project is infeasible as far as the assumed terms and conditions of the loan are applied to the project. In order to achieve the economic effect mentioned above, the financial stability shall be given by moderating the terms and conditions of the loans.

[RECOMMENDATION]

It is recommended that the following items have to be implemented in order to have this project viable.

(1) Although the system and organization for administration, education and training seem to have been well provided, the countermeasures proposed in this report shall be followed in the actual application. The production capacity of the factory shall never be decreased once again within a few years after the renovation project is implemented.

(2) In order to make a market development and sales promotion, new demand cultivation and service for the customers shall be throughly promoted by investing specialists as well as expenses. The sales has not shown a smooth progress due to a lack of effort for cultivating the potential demand and for grasping the needs of the customers.

(3) As mentioned in the report, the improved transport method shall be studied and the efforts for all the more stable and cheaper supply of the products shall be made. It is desirable to study these problems by organizing a project team.

(4) The moderate terms and conditions of the loans and increase in paid-up equity shall be provided so as to give a sound financial feasibility.

(Example 1)

In the event that all capital requirements have to be financed by loans, the minimum terms and conditions on the average basis for foreign and local currency portions are shown below.

Grace period : 2 years after resumption of operation, in total about 4 years including construction period

Interest : 10% per annum

Repayment period : 10 years after grace period

(Example 2)

Another measure which is usually taken for this sort of projects is to provide increase in paid-up share capital. The followings show, for an example, a minimum requirement for viability of the project.

Debt/equity ratio : 70/30
(Equity is to be used for the local currency requirements)

Foreign currency requirements is to be met by borrowing with the following conditions:

Interest rate : 7.5% per annum

Repayment : 10 year-equal-installment of principal after 2 year-grace-period

Deficit amount of the local currency requirements is to be met by borrowing with the following terms and conditions:

Interest rate : 13.5% per annum

Repayment : 5 year-equal-installment of principal after 2 year-grace-period

There might be various alternatives other than above mentioned terms and conditions. Nevertheless, given that the more severe financing plan than the above would be provided with the project, the implementation of the project shall be reconsidered.

(5) Taking into account the current situation that the increase of salaries and wages have been oppressing profitability, the opera-

tion of the factory shall be made by the current number of employees even after the renovation takes place.

Table-1 NaOH/CL SUPPLY CAPACITY AND DEMAND BALANCE IN INDONESIA

(Unit : 1000 t)

			1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1. NaOH (100%)																			
Total Demand	A	Table II-1.7	118.6	128.6	139.8	149.2	159.0	169.9	180.9	193.4	206.6	221.1	236.8	254.0	266.3	278.8	294.1	308.7	323.1
Total Supply	B	C + F	28.6	30.2	32.0	34.2	36.7	39.2	42.6	46.1	50.8	55.3	60.7	67.2	69.8	72.4	76.0	79.0	81.7
(Integrated)	C	D + E	11.8	13.4	15.2	17.4	19.9	22.4	25.8	29.3	33.6	38.5	43.9	50.3	53.0	55.6	59.2	62.2	64.9
Pulp & Paper	D	M/0.88	8.6	10.1	11.8	13.7	16.0	18.4	21.6	24.9	29.0	33.6	38.7	45.0	47.3	49.7	53.0	55.7	58.1
MSG	E	N/0.88	3.2	3.3	3.4	3.6	3.9	4.0	4.2	4.4	4.7	4.9	5.1	5.3	5.7	5.9	6.2	6.5	6.8
(Non-Integrated)	F	G + H	16.8	16.8	16.8	16.8	16.8	16.8	16.8	16.8	16.8	16.8	16.8	16.8	16.8	16.8	16.8	16.8	16.8
PT. ISI	G	36 t/d x 300 d/y	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8
PT. Soda Sumatra	H	Q/0.88	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Demand/Supply Balance	I	A-B	90.0	98.4	107.8	115.0	122.3	130.7	138.3	147.3	155.8	165.8	176.1	186.8	196.5	206.4	218.1	229.7	241.4
2. CL																			
Total Demand	J	Table II-1.7	24.4	27.0	29.8	32.9	36.4	40.0	45.1	50.0	56.0	62.5	69.7	78.1	82.3	86.8	92.3	97.3	102.0
Total Supply	K	L + O	25.2	26.6	28.2	30.1	32.3	34.5	37.5	40.6	44.4	48.7	53.4	57.1	61.4	63.7	66.9	69.5	71.9
(Integrated)	L	M + N	10.4	11.8	13.4	15.3	17.5	19.7	22.7	25.8	29.6	33.9	38.6	44.3	46.6	48.9	52.1	54.7	57.1
Pulp & Paper	M	Demand x 0.8	7.6	8.9	10.4	12.1	14.1	16.2	19.0	21.9	25.5	29.6	34.1	39.6	41.6	43.7	46.6	49.0	51.1
MSG	N	Demand x 0.5	2.8	2.9	3.0	3.2	3.4	3.5	3.7	3.9	4.1	4.3	4.5	4.7	5.0	5.2	5.5	5.7	6.0
(Non-Integrated)	O	P + Q	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8
PT. ISI	P	1/	9.5	9.5	9.5	9.5	9.5	9.5	9.5	9.5	9.5	9.5	9.5	9.5	9.5	9.5	9.5	9.5	9.5
PT. Soda Sumatra	Q	2/	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3
Demand/Supply Balance	R	J-K	-0.8	0.4	1.6	2.8	4.1	5.9	7.6	9.4	11.6	13.8	16.3	19.0	20.9	23.1	25.4	27.8	30.1
Potential Market for PT. ISI	S	Table II-1.9	9.4	9.9	10.7	11.5	12.3	13.0	13.7	14.4	15.1	15.8	16.6	17.4	18.3	19.2	20.1	21.1	22.2
Additional Demand for PT. ISI	T	S-P	0	0.4	1.2	2.0	2.8	3.5	4.2	4.9	5.6	6.3	7.1	7.9	8.8	9.7	10.6	11.6	12.7

Note: 1/ P (9.5) = 36 t/d x 0.88 x 300 d = 9.5 x 10^3t (PT.ISI)

2/ Q (5.3) = 20 t/d x 0.88 x 300 d = 5.3 x 10^3t (PT. Soda Sumatra)

Table-2 CL POTENTIAL MARKET FOR PT. ISI (OPTIMUM CASE)

(Unit: ton)

Item	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1. Potential Market for PT. ISI																	
(1) L-CL	1,780	1,820	1,890	1,950	2,270	2,410	2,540	2,670	2,800	2,930	3,060	3,170	3,320	3,450	3,580	3,710	3,850
(2) 33% HCL	23,000	24,690	26,680	28,730	30,240	31,790	33,400	35,140	36,930	38,710	40,630	42,630	44,770	47,000	47,420	51,930	54,660
(3) 12% BLN	600	650	750	750	800	850	910	970	1,030	1,090	1,150	1,210	1,280	1,340	1,420	1,490	1,570
(4) 8% BLC	2,500	2,630	2,890	3,100	3,330	3,580	3,850	4,140	4,450	4,790	5,150	5,530	5,950	6,390	6,870	7,390	7,740
2. CL Equivalent of Product																	
(1) L-CL	1,780	1,810	1,890	1,950	2,270	2,410	2,540	2,670	2,800	2,930	3,060	3,190	3,320	3,450	3,580	3,710	3,850
(2) HCL	7,360	7,840	8,540	9,190	9,680	10,170	10,690	11,250	11,820	12,390	13,000	13,640	14,330	15,040	15,810	16,620	17,490
(3) BLN	70	80	80	90	100	100	110	120	120	130	140	150	150	160	170	180	190
(4) BLC	200	210	230	250	270	290	310	330	360	380	410	440	480	510	550	590	640
Total	9,410	9,940	10,740	11,480	12,320	12,970	13,650	14,370	15,100	15,830	16,610	17,420	18,280	19,160	20,110	21,100	22,170

(Notes) CL production capacity (as CL ton) excluding plant losses.
Existing capacity: 8,468 ton/y
After renovation:
Case 1 12,690 ton/y
Case 2 12,967 ton/y
Case 3 17,380 ton/y

Table-3 HISTORICAL EX-FACTORY PRICE (INCL. TAX) OF PT. ISI

(Unit: US$/t)

	1976	1977	1978	1979	1980	1981	1982	1983
1. NaOH (100%)	235	290	200	328	450	490	395	293
2. L-CL (99%)	548	619	535	736	775	735	690	617
3. HCL (33%)	97	173	72	89	143	96	86	108
4. BLN (12%)	156	173	115	123	146	157	137	95
5. BLC (8%)	70	75	44	42	40	22	19	14
6. PAIR TON	637	744	592	868	1,018	1,029	901	745
(NaOH Price for Reference)								
1. CIF Indonesia (incl Tax)	207	187	221	279	310	410	344	290
2. Ex-Factory Japan	168	207	224	174	257	262	262	270
3. FOB Japan	162	134	100	90	152	218	218	128
4. FOB USA	110	109	118	104	160	217	220	147

(Notes) 1. CIF Indonesia: Solid NaOH

2. Ex-Factory Japan, FOB Japan, FOB USA: Converted to 100% NaOH

Table-4 EX-FACTORY PRICE FORECAST OF PT. ISI (INCL. TAX)

(Unit: US$/t)

Product		1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
(Escalation Index)		0.8347	0.8639	0.8985	0.9434	1.0000	1.0600	1.1236	1.1910	1.2625	1.3382	1.4185	1.5036	1.5938	1.6895	1.7908	1.8982	2.0122
1. NaOH	(100%)	300	310	323	339	359	381	403	428	453	480	509	540	572	607	643	681	722
2. HCL	(33%)	114	118	123	129	136	145	153	163	172	182	193	205	217	231	244	259	274
3. BLN	(12%)	117	121	126	132	140	149	157	167	177	187	199	211	223	237	251	266	282
4. BLC	(8%)	18	22	28	35	44	55	69	73	77	82	87	92	97	103	109	116	123
5. L-CL		600	626	651	677	703	728	754	780	806	831	857	883	908	934	960	985	1,011
6. PAIR TON		740	769	800	835	875	915	956	1,000	1,044	1,089	1,137	1,188	1,238	1,292	1,347	1,403	1,463

(Note) Pair ton price is calculated as NaOH + H-CL/1.2 x 0.88

Table-5 ESTIMATED PROJECT COST
- CASE 1 (46 t/d) -

(Unit: US$ 1,000)

	Foreign	Local	Total
A. Plant Direct Cost			
(1) Equipment, Materials & Spare Parts	4,726	1,397	6,123
(2) Civil & Erection	288	425	713
Sub-Total	5,014	1,822	6,836
B. Construction Equipment	-	628	628
C. Ocean Freight, Insurance & Local Handling	215	32	247
D. Indirect Field Expenses	-	741	741
E. Engineering Services	1,648	109	1,757
F. Project Management	80	-	80
Base Project Cost (BPC) (in June, 1984 Prices)	6,957	3,332	10,289
G. Physical Contingency (% of BPC)	469 (6.6%)	331 (9.9%)	800 (7.7%)
H. Price contingency 1/ (% of BPC)	733 (10.5%)	375 (11.3%)	1,108 (10.8%)
Erected Plant Cost (End of 1987)	8,159	4,038	12,197
I. Tax and Duties	-	1,283	1,283
J. Pre-Operating Expenses	-	580	580
K. Additional Working Capital	-	1,300	1,300
L. Interest during Construction 2/	673	1,086	1,759
Total Project Cost	8,832	8,287	17,119

(Notes) 1/ Escalation Rate: 3.5% for 1984 and 1985,
4.0% for 1986 and 5.0% for 1987

2/ Interest Rate : 10% for the foreign currency portion
18% for the local currency portion

Table-6 ESTIMATED PROJECT COST
- CASE 2 (47 t/d) -

(Unit: US$ 1,000)

	Foreign	Local	Total
A. Plant Direct Cost			
(1) Equipment, Materials & Spare Parts	6,025	1,397	7,422
(2) Civil & Erection	288	458	746
Sub-Total	6,313	1,855	8,168
B. Construction Equipment	-	722	722
C. Ocean Freight, Insurance & Local Handling	276	41	317
D. Indirect Field Expenses	-	788	788
E. Engineering Services	1,619	104	1,723
F. Project Management	80	-	80
Base Project Cost (BPC) (in June, 1984 Prices)	8,288	3,510	11,798
G. Physical Contingency (% of BPC)	503 (6.1%)	349 (9.9%)	852 (7.2%)
H. Price contingency 1/ (% of BPC)	865 (10.4%)	397 (11.3%)	1,262 (10.7%)
Erected Plant Cost (End of 1987)	9,656	4,256	13,912
I. Tax and Duties	-	1,452	1,452
J. Pre-Operating Expenses	-	580	580
K. Additional Working Capital	-	1,500	1,500
L. Interest during Construction 2/	797	1,175	1,972
Total Project Cost	10,453	8,963	19,416

(Notes) 1/ Escalation Rate: 3.5% for 1984 and 1985,
4.0% for 1986 and 5.0% for 1987

2/ Interest Rate : 10% for the foreign currency portion
18% for the local currency portion

Table-7 ESTIMATED PROJECT COST
- CASE 3 (63 t/d) -

(Unit: US$ 1,000)

	Foreign	Local	Total
A. Plant Direct Cost			
(1) Equipment, Materials & Spare Parts	8,050	1,397	9,447
(2) Civil & Erection	376	584	960
Sub-Total	8,426	1,981	10,407
B. Construction Equipment	-	865	865
C. Ocean Freight, Insurance & Local Handling	368	54	422
D. Indirect Field Expenses	-	900	900
E. Engineering Services	1,833	121	1,954
F. Project Management	80	-	80
Base Project Cost (BPC) (in June, 1984 Prices)	10,707	3,921	14,628
G. Physical Contingency (% of BPC)	658 (6.1%)	390 (9.9%)	1,048 (7.1%)
H. Price contingency 1/ (% of BPC)	1,117 (10.4%)	446 (11.4%)	1,563 (10.7%)
Erected Plant Cost (End of 1987)	12,482	4,757	17,239
I. Tax and Duties	-	1,799	1,799
J. Pre-Operating Expenses	-	630	630
K. Additional Working Capital	-	2,200	2,200
L. Interest during Construction 2/	1,030	1,416	2,446
Total Project Cost	13,512	10,802	24,314

(Notes) 1/ Escalation Rate : 3.5% for 1984 and 1985, 4.0% for 1986 and 5.0% for 1987

2/ Interest Rate : 10% for the foreign currency portion 18% for the local currency portion

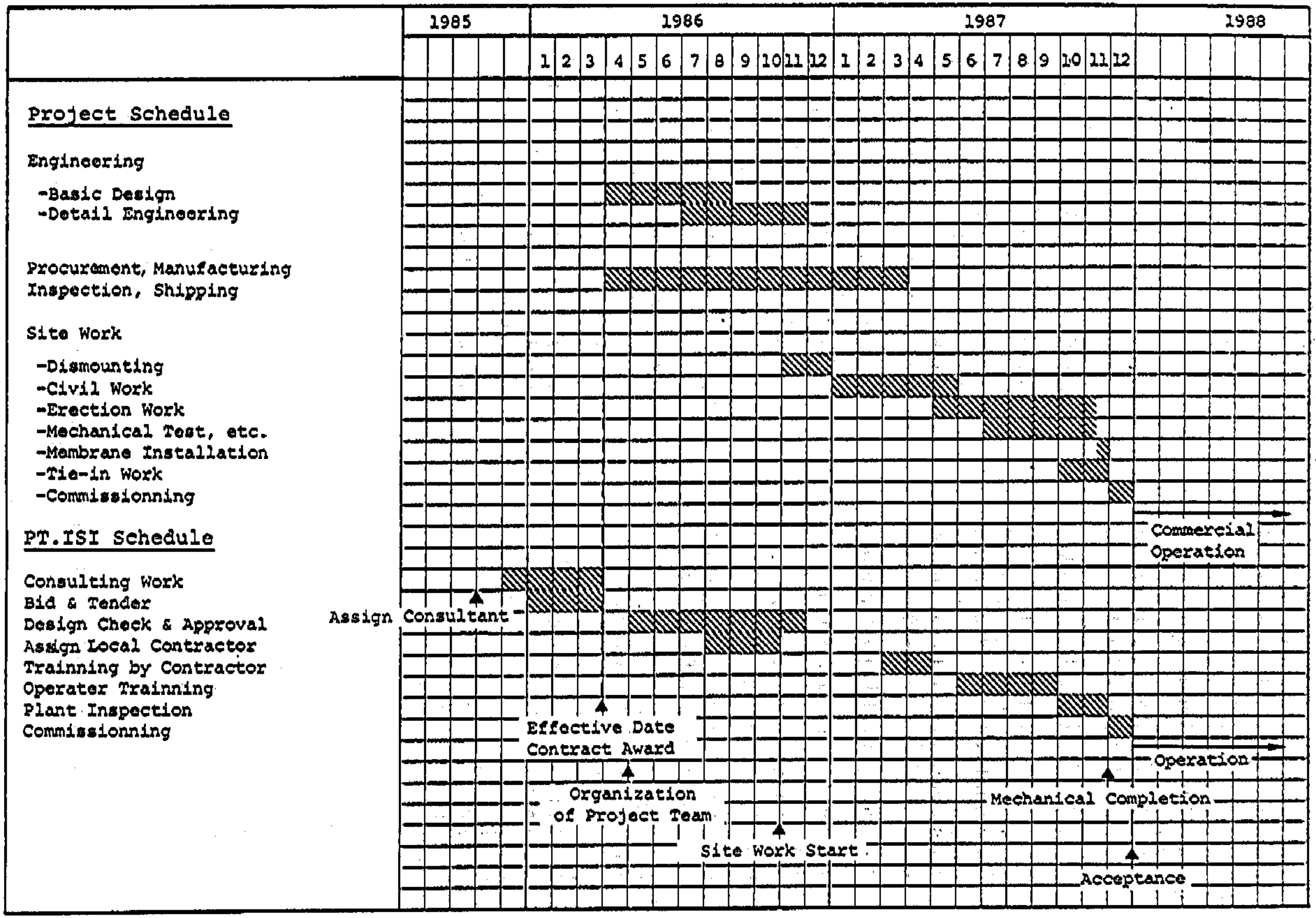

Figure-1 PROVISIONAL PROJECT SCHEDULE

Table-8 FRR AND NPV FOR INCREMENTAL

	Case 1	Case 2	Case 3
(1) FRR-In 1984 Constant Prices			
After Tax (%)	7.7	7.4	9.0
Before Tax (%)	8.3	8.0	11.0
(2) FRR-In Current Prices			
After Tax (%)	13.6	13.4	15.0
Before Tax (%)	14.3	14.1	17.3
(3) NPV-In 1984 Constant Prices, 10% Discount Rate			
After Tax (US$1,000)	-1,203	-1,487	-1,846
Before Tax (US$1,000)	-1,027	-1,316	1,045

Table-9 SUMMARY OF FINANCIAL RATIO

	1986	1987	1988 3/	1989	1990	1991	1992
Without Renovation							
Current Ratio	2.69	2.99	3.12	4.18	5.86	6.03	6.03
D.S.R. 1/	1.54	1.76	1.97	2.17	5.26	-	-
B.E.P. (%) 2/	64.0	60.3	49.4	41.1	38.6	40.8	41.1
Case 1							
Current Ratio	2.69	1.64	0.90	0.83	0.81	1.12	1.89
D.S.R. 1/	1.54	1.51	0.84	0.67	0.79	0.96	2.46
B.E.P (%) 2/	64.0	58.5	114.0	93.2	81.7	73.9	67.9
Case 2							
Current Ratio	2.69	1.54	0.86	0.74	0.70	0.93	1.39
D.S.R. 1/	1.54	1.44	0.81	0.65	0.76	0.93	2.19
B.E.P. (%) 2/	64.0	58.0	116.9	96.6	86.3	78.7	72.8
Case 3							
Current Ratio	2.69	1.39	0.77	0.56	0.50	0.58	0.71
D.S.R. 1/	1.54	1.44	0.74	0.53	0.63	0.74	1.73
B.E.P. (%) 2/	64.0	58.0	91.6	74.5	68.9	64.7	61.8

(Notes)
1/ Debt Service Coverage Ratio
2/ Break Even Point in percentage of capacity utilization
3/ Starting year of the commercial operation after renovation for Case 1, Case 2 and Case 3