9.1.2 Financial evaluation of No.1 CDU Project

(1) Considerations for the "With" case and "Without" case for purposes of financial evaluation

Generally speaking, for the evaluation of financial performance of the renovation projects in comparison with the continued operation and rationalization of the existing plant, financial analysis of the project, in principle, should be prepared on an additional or incremental investment basis.

Therefore the effect of investment is to be measured by the difference in cash flow between a "Without" case where the existing plant continues to be operated without renovation, and a "With" case where renovation works for rationalization are implemented.

In the "Without" case, investment for renovation which is absolutely necessary for the continued operation is included; While in the "With" case, investment for purposes of rationalization is taken into consideration besides the above mentioned investment for indispensable renovation. This sort of financial analysis procedure for assessing investment for rationalization is usually made on an incremental basis, for the difference between the "With" case minus the "Without" case.

This method is applied widely in international financing institutions like the World Bank, Asian Development Bank as well as the OECF (Overseas Economic Cooperation Fund) in Japan. Absolutely necessary investment means, investment without which production could not be continued any more. Then, financial evaluation of the investment is made by determing whether the investment makes a net contribution to the profit. A frequently employed method is by calculating the financial internal rate of return (FIRR) on

investment.

In this Study, the following two cases are assumed for "Without" cases:

- "Without" A case : No investment at all; and
- "Without" B case : Some minimum necessary retrofittings are made for continuation of production.

Investments which have to be made in the "Without (B)" case include:

a) Installation of stabilizer and splitter for removal of LPG from A10 fraction and for removing SO_2 from LPG;
b) Replacement of present pneumatic system by DCS to cope with shortage of supply of spare parts for the present system;
c) Installation of short pieces of pipe connections and water sealings for reduction of offensive odor and substances harmful to workers' health; and
d) Installation of coalescers in relation with stripping steam injection, to minimize off-specification intermediates.

On the other hand, the "With" case stands on the situation where renovation works aiming mainly for production increase, upgrading of products' specifications, and saving energy are implemented in addition to the above indispensable retrofittings.

These renovation works include:

e) Re-arrangement of heat exchangers for improvement of heat exchange between products and crude oil;
f) Installation of Jungstrom and related equipment for improvement of process heater efficiency; and
g) Installation of related facilities for reduction of oxygen content in flue gas.

(2) Essential items for financial evaluation

1) Crude oil

a) The crude oil for the study is Ural crude oil. Price of Ural crude oil is US$ 17.60/bbl, which is equal to US$ 130/ton, including all the necessary duties and charges.
b) Throughput capacity of No.1 CDU is 308 metric tons/hour. Bottom oil of 10.7 t/h is included, which bypasses the vacuum distillation unit in "Without" case.

2) Major inputs and outputs

a) Major inputs and outputs volume to and from No.1 CDU in both "Without" and "With" cases is set on a simplified scheme based on an alternative described in Section 4.9.2 of this Report which was simulated by the Team. The result is illustrated in Figures 9.1-1, 9.1-2 and Table 9.1-1.

b) Evaluation of each intermediate product was made by the following procedure:
- First, the policy was made by the PPSA counterpart to take international market prices at Rotterdam as the basis of evaluation, taking into consideration Poland's intention of joining the EC in the future;
- Second, the Team investigated the Rotterdam market prices further;
- Third, the Team estimated the price of vacuum gas oil (V.G.O.) which could not be obtained at Rotterdam, taking into consideration the relative position of V.G.O. in prevailing market prices in Japan; and
- Finally, as for evaluation of fuel gas, the Team estimated this on the basis of gross heating value of methane, which is the main component.

c) Detailed procedures of estimating price of crude oil and products is attached in ANNEX 4.

3) Treatment of cost and price escalation

All costs and price items are assumed to remain constant. For projection analysis, it is considered not reasonable for project level evaluation to predict future costs and prices over a long term period due to the macro-economic and cyclic nature of fluctuations in prices of crude oil and petroleum products in the world markets.

4) Project life

Project life for financial analysis is assumed to be 15 years after the completion of renovation as described in Chapter 8 of the Report. Salvage value includes land purchase cost, an undepreciated portion of investment cost, and working capital, which are generally credited in the last year of the projeot life.
However, in the Study for PPSA, other salvage values are assumed zero and from the beginning, and land cost is not budgeted.

(3) Preconditions of Financial analysis

1) Production plan

Hourly throughput capacity of No.1 CDU in both "With" and "Without" cases are 308t/h. Annual operating days are assumed to be 330 days per year for both cases. This is assumed as the operational rate of 100%. However, the operational rate of 80% -the actual average rate at PPSA in recent years- is taken as the base case for the evaluation. Sensitivity analysis is made for several other operational rates in (5) below.

2) Sales plan

Outputs from No.1 CDU are fed to down stream facilities. The estimated volume and unit value of intermediates are shown in Table 9.1-1.

3) Sales taxes on revenue

Although income tax is levied on net profit of PPSA as a whole, the assumption was made that No.1 CDU bear the same rate of 40% on "net profit"(= outputs' value - production cost) as a Unit within the company.

4) Variable cost

Major variable cost items are crude oil, electricity, steam, cooling water, fuel gas and fuel oil. The unit price for variable cost items are also projected in Table 9.1-1. As for fuel oil, evaluation was made on the assumption of using low sulfur oil, but the benefits were calculated on the case of using high sulfur oil.

5) Direct labor cost

In accordance with the organization explained in Chapter 3, the average monthly personnel wage at No.1 CDU is estimated as US$ 470. The number of direct personnel for the Unit is 31.

In addition to the above, overhead costs for welfare expenses, office expenses, personnel protection expenses, consumables and others, are assumed to be 139.9% of direct labor cost, which is the present ratio applied in the accounting practice of the PPSA.

6) Maintenance costs

Maintenance cost incurred in the normal maintenance services for No.1 CDU was actually US$ 517,028 annually in 1993, taking consideration of present accounting practice at PPSA.
In this Study, no tear and wear factor is taken into consideration for the "Without" case, in accordance with the current practice in PPSA.

7) Depreciation and Amortization

In this Study, the erected plant cost is depreciated by the following rule which is the present accounting system of PPSA.

- Mode of Depreciation : Straight-line method
- Salvage Value : Zero
- Project Life : 15 years

Interest during construction is amortized for five years in equal amounts. As for "Sunk cost" which is incidental to existing facilities, PPSA evaluate its value as zero because of the fact that a 30-year depreciation period has already passed.

8) Other fixed costs

Other fixed costs include sales expense (0.6% of the total outputs' value) and administration cost (set at the same amount as sales expense), and technical development cost (0.1% of total outputs' value).
These formulas are derived from the present accounting scheme at PPSA.

9) Investment

Capital cost for No.1 CDU estimated in Chapter 7 of the Report are:

- Zero for "Without (A)" case;
- US$ 3,270,272 for "Without (B)" case; and
- US$ 8,641,560 for "With" case

(Each case excludes VAT. However, such costs as pre-operational expenses and interest during construction are added into this financial evaluation. Estimated total investment amount for No.1 CDU are
- US$ 3,435,000 for "Without (B)" case ; and
- US$ 9,075,000 for "With" case.)

10) Source of funds

50% of the source of investment for PPSA is from self finance and the remaining 50% from domestic financial organizations. The interest rate for external finance is 12.5% per year, with no grace period and 5 years repayment period.

(4) Result of financial evaluation of the Project

Effects can not be quantified either in "Without (A)" case where no investment is made or in "Without (B)" case where investment is for renovation which is absolutely necessary for continued operation. However, the following benefits are expected in the "With" case, or investment for rationalization:

1) Increase in intermediates output value

Table 9.1-2 shows comparison of major outputs volume and value based on the material balance shown in Figures 9.1-1 and 9.1-2. The total amounts of increase from "Without" to "With" case is calculated as US$ 3,996,000.

2) Reduction of fuel oil consumption

Consumption of fuel oil will be reduced by 1,816 kg/h, from 7,931 kg/h to 6,115 kg/h.

In this evaluation, US$ 85/ton of low sulfur fuel oil was used. However, results of calculation based on US$ 65/ton of high sulfur fuel oil are shown in parentheses.

Estimated cost reduction of fuel oil is calculated as follows:

Before : 7,931 kg/h = 62,814 t/y
62,814 t * US$ 85/t = US$ 5,339,190
After : 6,115 kg/h = 48,431 t/y
48,431 t/y * US$ 85/t = US$ 4,116,635
Reduction: 11,383 t/y or US$ 1,222,555 (US$ 934,895)

3) Increase of other utilities

Accompanying the modernization, consumption of such utilities as electricity, steam and cooling water will increase because of installation of preheaters, and heat exchangers.
The results of calculation are as follows:

- Electricity:
1,058 kw/h * 24 h * 330 d/y * US$ 0.05 = US$ 418,968

- Low pressure steam:
  4.5 t/h * 24 h * 330 d/y * US$ 6.95 = US$ 247,698
- High pressure steam:
  11.8 t/h * 24 h * 330 d/y * US$ 7.05 = US$ 658,865
- Cooling water:
  335 t/h * 24 h * 330 d/y * US$ 0.03 = US$ 79,596

The total amount of the above four items is US$ 1,405,127.

From the energy point of view, the utility cost will increase by US$ 182,572 (US$ 470,232).

4) Reduction of fees and fines related to the reduction of SO_2 and NOx emission

a) Reduction of SO_2

As reported in Section 4.5.3 of the Report, emission of SO_2 after the modernization will be reduced by 22.9%, a reduction of 101.6 kg/h, from 444.1 kg/h to 342.5 kg/h.

b) Reduction of NOx

As also described in Section 4.5.4 of the Report, emission of NOx after the modernization will be reduced by 27.8%, a reduction of 13.5 kg/h, from 48.5 kg/h to 35.0 kg/h.

c) Fees and Fines for environmental pollutants of the nation and the region

Fees are levied on emission quantities of pollutants and the actual unit amounts are:

- 1,100 Zl./kg for SO_2; and

- 1,000 Zl./kg for NOx

Fines are levied on the quantities exceeding emission standards, in the amount of 10 times the level of fees.

Details of the pollution regulation of Plock province are described in Section 2.9.2 of the Report.

d) Reduction of fees and fines related to the reduction of the SO2 and NOx emission

d-1) Fees

Calculated amounts of the fees reduction are as follows:

- SO_2: US$ 41,752
- NOx: US$ 5,043

d-2) Fines

- SO_2: It is difficult to calculate individual, separate amounts of fines for No.1 CDU. So it was assumed that No.1 CDU's share in the total amount of PPSA's fines is the same as the share of No.1 CDU's emissions in the company's total, that is 2.5%. The calculated amount of the reduction amount is US$ 19,498.

- NOx: Volume of NOx emission from PPSA, 6,616 t/y is within the standard of Plock province. PPSA has no need to pay fines for NOx.

Gross benefits of the items above totaled to US$ 3,879,721 (US$ 3,592,061) in the case of 100% operational rate.

According to the estimates of capital requirements and the basis for financial analysis described in Section (3) above, financial analysis of the Project at operational rates of 80% was made by Financial Internal Rate of Return (FIRR) method. Full financial analysis sheets are attached in ANNEX 5.1, which include the following financial statements during project life:

- Production and Sales Plan;
- Production Cost Statements;
- Working Capital Statements;
- Income Statements;
- Funds Flow Statements;
- Balance Sheet;
- Medium Term Debt;
- Profitability and Financial Indicators;
- Return on Investment including IRR; and
- Net Present Value.

Table 9.1-3 shows comparison of major financial aspects between the "Without (B)" case (investment for indispensable renovation) and the "With" case (including investment for renovation for purposes of rationalization.) Here the "Increment" means investment for rationalization. Each case was analyzed for basic operational rate of 80%. Table 9.1-4 shows comparison of six cases of investment through the project life (15 years from 1999 to 2013). Table 9.1-5 shows a summary of the comparison among the six cases, which includes additional financial indicators such as yearly benefits and payback years.

The results of financial analysis are described in brief below:

1) The ratio of before-tax profit to investment at 80% operation is about 2.1 times in the "With" case and about 2.9 times in the "Without (B)" case. The gross capital expenditure is about 20 to 35% of before tax profit.

2) The debt service ratio at 80% operation is more than 2.4 times in any case, which means PPSA will be able to make smooth repayment of debt and payment of interest.

3) The payback years, which is obtained by dividing gross capital expenditure with yearly benefits, is about 2.9 years in the "With" case at 80% operational rate. From this indicator, this project is judged as a sound one.

4) The ratio of gross cash in-flow to gross capital expenditure calculated on the "Increment" ("With" minus "Without"), which is used for evaluation of investment for rationalization, is fairly high: about 5.2 times in the "Without (A)" case and abut 8.3 times in the "Without (B)" case, both at 80% operation.
Financial internal rates of return(FIRR) are 30.1% at the before-tax stage and 21.7% after-taxes for the "Without" and 46.5% and 33.0% for the "With" respectively. These figures justify this investment for rationalization.

5) As described above, no fault is found in this Project from the financial point of view at an operational rate of 80%. Implementation of this Project is clearly justified.

(5) Result of the sensitivity analysis

Sensitivity analysis was made on the operational rates of 95%, 90%, 85%, 75%, 70% and 65% besides the base case of 80%, taking into consideration of the effect of the operational rate on FIRR of the Project, as described in Section (3) above.

Following table shows the calculated FIRR figures of both before and after tax stage:

Case	FIRR before tax	FIRR after tax
Base Case (Operational rate : 80%)	46.5%	33.0%
Operational rate : 95%	53.9	38.1
90%	51.5	36.4
85%	49.1	34.7
75%	43.9	31.2
70%	41.3	29.5
65%	38.6	27.6

Operational rate gives much influence on FIRR as commonly recognized in the process industries.

Sensitivity analysis was made on the effect of fuel oil price used as utilities upon the Project. The FIRR of the case using high sulfur fuel oil (US$ 65/t) gives about one point drop compared with that of the base case of using low sulfur fuel oil (US$ 85/t), which shows that the effect of cost reduction is bigger in the case of higher cost.

In case of crude oil price, which seems to be the most sensitive factor, it does not give any effect on the Project because there is no difference of throughput capacity of 308t/h between "WITHOUT" case and "WITH" case, so the raw material cost will be offset when calculating the variable cost.

9.1.3 Financial Evaluation of Thermoelectric Power Plant Project

Financial evaluation of the thermoelectric power plant project is made on the basis of alternative plants for modernization, as described in Chapter 6 of this Report. Discussion on physical merits of the individual parts of each modernization plan were already made in that Chapter, so in this Chapter only financial evaluation is made using the results of the discussion and utilizing the data.

Modernization plans consist mainly of three parts:

- modernization of No.1 - No.3 boiler plants;
- modernization of boiler feed water processing system; and
- installation of a condensing turbine generator.

(1) Basic preconditions of evaluation of thermoelectric power plant

1) Production capacity

Production capacities of three facilities are assumed as follows:

- Boiler plants: 960 t/h of high pressure steam
- Boiler feed water processing system:
  740 t/h of pure water
- Condensing turbine generator:
  65,000 kw of electricity

2) Operation

330 days per year was assumed as a base case (100% operational rate). In case of boiler plants, an operational rate of 80% was assumed as an alternative.

3) Sales taxes on revenue

The same as in the case of No.1 CDU, the thermoelectric power plant bears 40% taxes on "net profit".

4) Variable cost

Major variable cost items for each of the facilities are as follows:

- Raw water	: US$ 0.03/t
- Boiler feed water	: US$ 1.00/t
- High pressure steam	: US$ 8.05/t
- Electricity	: US$ 0.05/kwh
- High sulfur fuel oil	: US$ 65/t
- Low sulfur fuel oil	: US$ 85/t
- HCl	: US$ 126.08/t
- NaOH	: US$ 300.00/t

Two types of fuel oil -high sulfur and low sulfur- are assumed, taking into consideration of calculating the benefits brought by the installation of the flue gas desulfurization unit.

5) Direct labor

The average monthly personnel wage at the thermoelectric power plant is US$ 460. The number of direct personnel for the unit is 649. Indirect cost of 139.9% is added as in the current accounting practice of PPSA.

6) Maintenance cost

Maintenance cost for the thermoelectric power plant was actually US$ 5,289,481 following present accounting practice of PPSA, this has been assumed to remain constant in the future.

7) Depreciation and amortization

8) Other fixed costs

Assumed under the same conditions as with No.1 CDU.

9) Capital cost

Estimated capital cost for the thermoelectric power plant is US$ 32,089,797 exclusive of VAT. The estimated investment amount for this Project is US$ 33,880,000 including pre-operational expenses and interest during construction.
Financing sources and their conditions were assumed the same as those of No.1 CDU.

(2) Modernization of boiler plant

1) Installation of remolding of burner tips and installation of soot blowers

a) Reduction of fuel oil

Improvement in thermal efficiency as the result of remolding of burner tips and installation of soot blowers, is estimated as 354 kg per hour of the fuel oil equivalent per boiler.

The yearly amount of saving in the case of an operational rate of 100% is calculated by multiplying the hourly volume above by 24 (hours per day), 330 (operative days per year), 3 (number of boilers) and US$ 65 (estimated price of high sulfur fuel oil per metric ton or US$ 85 in case of low sulfur fuel oil).

354 kg/h * 24 h/d * 330 d/y * 3 unit * US$ 65/t
= US$ 546,780 (US$ 714,938 in case of low sulfur fuel oil)

In the case of an operational rate of 80%, the above amount will be US$ 437,424 (US$ 571,950).
In order to get the above reduction in fuel oil consumption, it is necessary to use high pressure steam for fuel jets, and the estimated volume is 1,366 kg per hour per boiler.

The yearly necessary consumption volume of steam in the case of an operational rate of 100% is calculated using the same formula as above, with only the difference of a steam price of US$ 8.05 per metric ton, set on the basis of the result of discussion.

1,366 kg/h * 24 h/d * 330 d/y * 3 unit * US$ 8.05/t
= US$ 261,279
In case of 80% operation, the above figure will be changed to US$ 176,145.
Yearly net saving amount is calculated as US$ 285,501 (US$ 453,659).

b) Reduction of maintenance cost and utility cost

As the effects of installation of soot blowers, as shown in Table 5.10-6, reduction of both labor cost for

maintenance and reduction of utility loss, mainly that for fuel, is expected. Each of these cost items is estimated by PPSA as Zl. 240 million per year per boiler.

Yearly reduction of each item is:

Zl. 240 million / @ 21,200 Zl./US$ * 3 = US$ 33,963

As the exchange rate for the calculation, Zl. 21,200/US$, a figure as of the end 1993, is applied.

c) Reduction of Nox emission

Reduction of NOx emission is estimated as 19 kg per hour per boiler. There is no difference of NOx emission between high sulfur oil and low sulfur oil.

Yearly decrease of the fees (Zl. 1.0 million/t for NOx) in case of 100% operation is calculated as:
19 kg * 24 h * 330 d/y * 3 units * Zl. 1.0 million/t
= Zl. 451 million = US$ 21,225
In the case of 80% operation, this figure will be changed to US$ 16,980.

2) Effects of replacing the Jungstrom

a) Total reduction of electricity consumption is 420 kw per boiler in case of using high sulfur oil and 260 kw in case of low sulfur oil.

Yearly reduction of electricity consumption in the 100% operation case is calculated as:

420 kw * 24 h * 330 d/y * 3 units * US$ 0.05
= US$ 498,960 (US$ 308,880)
In the 80% case, this figure will be US$ 399,168 (US$ 247,104).

b) Reduction of fuel consumption

Increase of heat exchange volume is estimated as 95.3 kg per hour of the fuel oil equivalent per boiler.

Yearly gain in the 100% operation case is calculated as:

95.3 kg * 24 h * 330 d/y * 3 units * US$ 65
= US$ 147,225 (US$ 192,525)
In the 80% case, this figure will be US$ 117,780 (US$ 154,020).

c) Reduction of SO_2 emission is estimated as 231 kg per hour per boiler.

Yearly decrease of the fees (Zl. 1.1 million/t for SO_2) in the 100% operation case is calculated as:

231 kg * 24 h * 330 d/y * 3 units * Zl. 1.1 million/t
= Zl. 6,351 million
= US$ 299,646 (US$ 1,010,921)
In the 80% case, this figure will be US$ 239,717 (US$ 808,737).

(3) Modernization of boiler feed water processing system

Total capacity of the boiler feed water processing system is 740 t/h : 80 t/h each for system A,B and C and 100 t/h each for systems D through H.

1) Reduction of regenerants consumption

By adopting a countercurrent regeneration system, consumption of regenerants which are used for cleaning ion exchange resin will be reduced as follows:

regenerants	Before	After	Reduction
HCl	0.696 kg	0.400 kg	0.296 kg
NaOH	0.898 kg	0.500 kg	0.398 kg

Note: Figures shown are consumption of regenerants per cubic meter product pure water per hour.

The calculated total reduction of regenerants for the system are 219 kg/h for HCl and 295 kg/h for NaOH. Each system is cleaned for 1.5 hours after operation of 16 hours which means the actual servicing rate is about 90%. Price of regenerants are those listed in Section (1) - 4) above.

The yearly saving amount by reduction of regenerants is calculated as follows:

HCl : 219 kg/h * 24 h * 90% * 330 d/y US$ 126.08/t
= US$ 196,815

NaOH : 295 kg/h * 24 h * 90% * 330 d/y * US$ 330/t
= US$ 630, 828

Total saving amounts US$ 827,643.

2) Reduction of raw water consumption

By adoption of a waste water treatment system and sludge separator, consumption of raw water for getting product pure water, in another words the yield of pure water, improves by 0.1 cubic meter per hour - from 1.4 cubic meter

per hour to 1.3 cubic meter per hour.

The yearly saving amount by reduction of raw water consumption is calculated as follows:

740 t/h * 0.1 cu.m/h * 24 h * 330 d/y * US$ 0.03
= US$ 17,582

(4) Installation of a condensing turbine generator

Capacity of the condensing turbine generator recommended in Chapter 6 is 65,000 kw.

Table 9.1-6 shows the monthly demand/supply balance of electricity from a condensing turbine generator based on actual purchase figures of PPSA in 1992. It is assumed that for most of the year there will be a surplus of electricity even when the maximum amount of generated electricity from a new generator is consumed in the complex and that the excess is sold to the national grid. To the contrary, in August and September, when electricity is assumed to be short in supply, PPSA must purchase it from the national grid.
The Table also shows the necessary volumes of high pressure steam and cooling water to produce 65,000 kwh of electricity.

Self consumption of electricity contributes to PPSA by reduction of utility cost, and sales of electric power means income.
At the same time, consumption of steam and that of cooling water are cost factors for PPSA.

The yearly amounts of each of these factors are calculated as follows on the basis of volume from Table 9.1-6:

a) Cost reduction and income factors:

- Self consumption of electricity:
  264,595,050 kwh * US$ 0.05/kwh = US$ 13,229,752
- Sales of electricity:
  250,204,950 kwh * US$ 0.03.kwh = US$ 7,506,149

b) Cost factors:

- Consumption of steam:
  1,473,450 t * US$ 8.05/t = US$ 11,861,273
- Consumption of cooling water:
  60,930,830 t * US$ 0.03/t = US$ 1,827,925

The balance amount of the above factors is the saving of US$ 7,064,703 per year.

Summing up the effects of the above modernization in the case of 100% operation, the savings are as follows (Figures in parentheses show the case of using low sulfur fuel oil.)
The merit of using low sulfur fuel oil, though the price is comparatively high, is the saving of US$ 200,000 roughly, or about 30% reduction of fuel cost. The biggest advantage of adopting low sulfur fuel oil, however, is brought by reducing the fees which amounts more than US$ 700,000, caused by reduction of SO_2 emission.

- Reduction of utilities cost (▲ shows increase)

Fuel	US$	727,968	(US$	941,426)
Electricity		21,234,861	(	21,044,781)
Water		▲ 1,810,343	(	▲ 1,810,343)
Steam		▲ 12,122,552	(	▲ 12,122,552)
Sub-total	US$	8,029,934	(	8,053,312)

- Reduction of raw materials cost

Chemicals	US$	827,643	(US$	827,643)

- Reduction of labor cost

  Labor US$ 33,963 (US$ 33,963)

- Reduction of fees

  SO_2, NOx US$ 320,871 (US$ 1,032,146)

  Grand Total US$ 9,212,411 (US$ 9,947,064)

(5) Result of financial evaluation of the Project

The following table shows the summary of the results evaluated in (2), (3) and (4) above.

Facility	Investment(US$)	Benefits(US$)	Payback Years
Boiler plants			
100% operation			
(high sulfur)	6,463,000	1,320,483	4.89
(low sulfur)	6,463,000	2,055,136	3.14
80% operation			
(high sulfur)	6,463,000	1,017,716	6.35
(low sulfur)	6,463,000	1,644,109	3.93
Boiler feed water Processing system	594,000	845,225	0.70
Condensing turbine	26,638,000	7,026,703	3.78
Total			
100% boiler operation			
(high sulfur)	33,695,000	9,212,411	3.59
(low sulfur)	33,695,000	9,947,064	3.38
80% boiler operation			
(high sulfur)	33,695,000	8,909,644	3.78
(low sulfur)	33,695,000	9,536,037	3.53

As payback years of each facility are comparatively small, each investment is judged as a sound one. Cost reduction of about US$ 730,000 yearly is expected in case of using low sulfur fuel oil, compared with the case of using high sulfur fuel oil. Payback years are also shortened be 40%. However, further comparison is difficult because the plant cost of the flue gas desulfurization unit is not provided.

Financial evaluation of this Project was made by FIRR method on the basis of the result of the capital cost estimation in Chapter 7 of this Report. The summary is shown as Table 9.1-7 and detailed output data from the computer is attached in ANNEX 5.2.

The following are the results of the analysis:

1) The rate of before tax profit to investment is about 31% which means investment will be recovered by 3 years' profit before tax. Debt service ratio in 2000 is about 6.5 times which is ranked as a quite safe level from the financier's point of view.

2) The ratio of gross cash in-flow to gross capital expenditure is calculated as about 6.8 times. The IRR calculated is 38.7% at before tax stage and 27.6% at after tax which shows the Project is certainly worth investing.

Table 9.1-1 MAJOR INPUTS AND OUTPUTS FOR NO.1 CDU IN "WITHOUT" AND "WITH" CASES

Inputs and Outputs	Unit		Unit value
	Without	With	Without & With
1) Crude oil (100% Ural)	308 t/h	308 t/h	US$ 130/t
2) Electricity	11.90 kWH/t	8.24 kWH/t	US$ 0.05/kWH
3) Steam (MP)	0.065 t/h	0.140 t/h	US$ 7.05/t
4) Cooling water	9.09 cu m/t	9.09 cu m/t	US$ 0.03/cu m
5) Fuel gas	0.005 t/t	0.005 t/t	US$ 105/t
6) Fuel oil (low sulfur)	0.015 t/t	0.0072 t/t	US$ 85/t
7) Labor	31 men	31 men	US$ 470/mm
8) Fuel gas	1.2 t/h	0.7 t/h	US$ 105/t
9) LPG	0	4.3 t/h	US$ 120/t
10) L/H Naphtha	59.5 t/h	55.0 t/h	US$ 170/t
11) Kerosene	20.5 t/h	0	US$ 190/t
12) Gas oil	62.7 t/h	93.7 t/h	US$ 180/t
13) V.G.O.	86.3 t/h	83.9 t/h	US$ 160/t
14) Fuel oil (low sulfur)	10.7 t/h	10.0 t/h	US$ 85/t
15) Fuel oil (high sulfur)	67.1 t/h	60.4 t/h	US$ 65/t

Source: Estimated by the Team

Table 9.1-2 COMPARISON OF OUTPUT VOLUME AND AMOUNT BETWEEN "WITHOUT" AND "WITH" CASES (OPERATIONAL RATE : 100%)

Intermediates	Output Volume (t/h)		Price (US$)	Output Amount (US$ 1,000)	
	Without	With		Without	With
<Topping>					
Fuel Gas	1.1	0.7	105	915	582
LPG	-	4.3	120	0	4,087
L/H Naphtha (A10/11/12)	59.5	-	170	80,111	0
L/H Naphtha (R12/13,A11/12)	-	55.0	170	0	74,052
Kerosene (A13)	20.5	-	190	30,848	0
Gas Oil (A13/14)	-	93.7	180	0	133,579
Gas Oil (A14/15/16)	62.7	-	180	89,385	0
Fuel Oil	10.7	-	65	5,508	0
Sub Total	154.5	153.7		206,767	212,300
<Vacuum>					
Fuel Gas	0.1	0.0	105	83	0
Vacuum Gas Oil (P10/11/12/13)	86.3	83.9	160	109,359	106,318
Fuel Oil (Low Sulfur)	10.7	10.0	85	7,203	6,732
Fuel Oil (High Sulfur)	56.4	60.4	65	29,035	31,094
Sub Total	153.5	154.3		145,680	144,144
Grand Total	308.0	308.0		352,448	356,444

Source: Estimated by the Team

Table 9.1-3 COMPARISON OF MAJOR FINANCIAL ASPECTS BETWEEN "WITHOUT (B)" AND "WITH" CASES IN YEAR 2000 (OPERATIONAL RATE : 80%)

(Unit: US$ 1,000, %)

Item	WITHOUT(B)	WITH	INCREMENT
<Income Statement>			
Sales Revenue	281,958	285,155	+ 3,197
Cost of Sales	260,366	260,883	+ 517
Gross Profit on Sales	21,592	24,272	+ 2,680
Non Operating Expenses	1,612	1,917	+ 306
Net Profit Before Tax	16,315	18,648	+ 2,333
Net Profit After Tax	9,789	11,189	+ 1,400
<Profitability Indicators>			
Before Tax Profit to Investment(%)	448.0	193.8	-
After Tax Profit to Sales Revenue(%)	3.5	3.9	-
Debt Service Ratio	2.42	2.41	-

Source: ANNEX 5

Table 9.1-4 COMPARISON OF RETURN ON INVESTMENT THROUGH PROJECT LIFE (1999-2013) (OPERATIONAL RATE : 80%)

(Unit: US$ 1,000, %)

Item	WITHOUT(B)	WITH	INCREMENT
Gross Capital Expenditure (1)	3,435	9,075	5,640
Gross Cash In-flow (2)	273,280	320,052	46,772
Income Tax (3)	105,438	121,296	15,858
Before Tax Net Inflow ((4)=(2) - (1))	269,846	310,978	41,132
After Tax Net Inflow ((5)=(4) - (3))	164,408	189,682	25,274
IRR on Before Tax In-flow(4) (%)	- 1/	- 1/	46.5
IRR on After Tax In-flow(5) (%)	- 1/	177.9	33.0

Source: ANNEX 5
Note:1/ shows that IRR can not be obtained because of extremely high

Table 9.1-5 COMPARISON AMONG CASES OF FINANCIAL EVALUATION THROUGH PROJECT LIFE
(OPERATIONAL RATE : 80%)

Case	WITHOUT		INCREMENTAL		WITH
	(A)	(B)	(W-W/O (A))	(W-W/O (B))	
Gross Capital Expenditure (US$ 1,000)	0	3,435	9,075	5,640	9,075
Gross Cash Inflow (US$ 1,000)	273,280	273,280	46,772	46,772	320,052
Before Tax Net Inflow (US$ 1,000)	273,280	269,846	37,698	41,132	310,978
After Tax Net Inflow (US$ 1,000)	166,113	164,408	23,569	25,274	189,682
FIRR on Before Tax Inflow (US$ 1,000)	-	-	30.1	46.5	-
FIRR on After Tax Inflow (US$ 1,000)	-	-	21.7	33.0	177.9
Debt Service Ratio in 2000 (Times)	2.68	2.42	1.62	2.38	2.41
Yearly Benefit (US$ 1,000)	-	-	3,104	3,104	3,104
Payback Years	-	-	2.92	1.82	2.92

Source: Table 9.1-3, 9.1-4

Table 9.1-6 DEMAND/SUPPLY BALANCE OF ELECTRICITY FROM CONDENSING TURBINE GENERATOR BASED ON ACTUAL FIGURES IN 1992

Month	Factory consumption (kwh/h)	Sales (kwh/h)	Purchase (kwh/h)	Steam demand (t/h)	Cooling water (t/h)
Jan.	2,960	62,040	0	174	4,350
Feb.	7,440	57,560	0	179	5,470
Mar.	11,290	53,710	0	182	6,260
April	24,860	40,140	0	185	7,270
May	38,300	26,700	0	191	8,750
June	57,780	7,220	0	191	10,500
July	58,870	6,130	0	196	11,000
Aug.	65,000	0	10,000	196	10,800
Sept.	65,000	0	2,220	191	8,750
Oct.	34,950	30,050	0	184	7,230
Nov.	20,140	44,860	0	183	6,290
Dec.	12,900	52,100	0	180	5,500
TOTAL	264,595,050	250,204,950	8,171,700	1,473,450	60,930,830

Source: Estimated by the Team based on data of 1992 supplied from PPSA

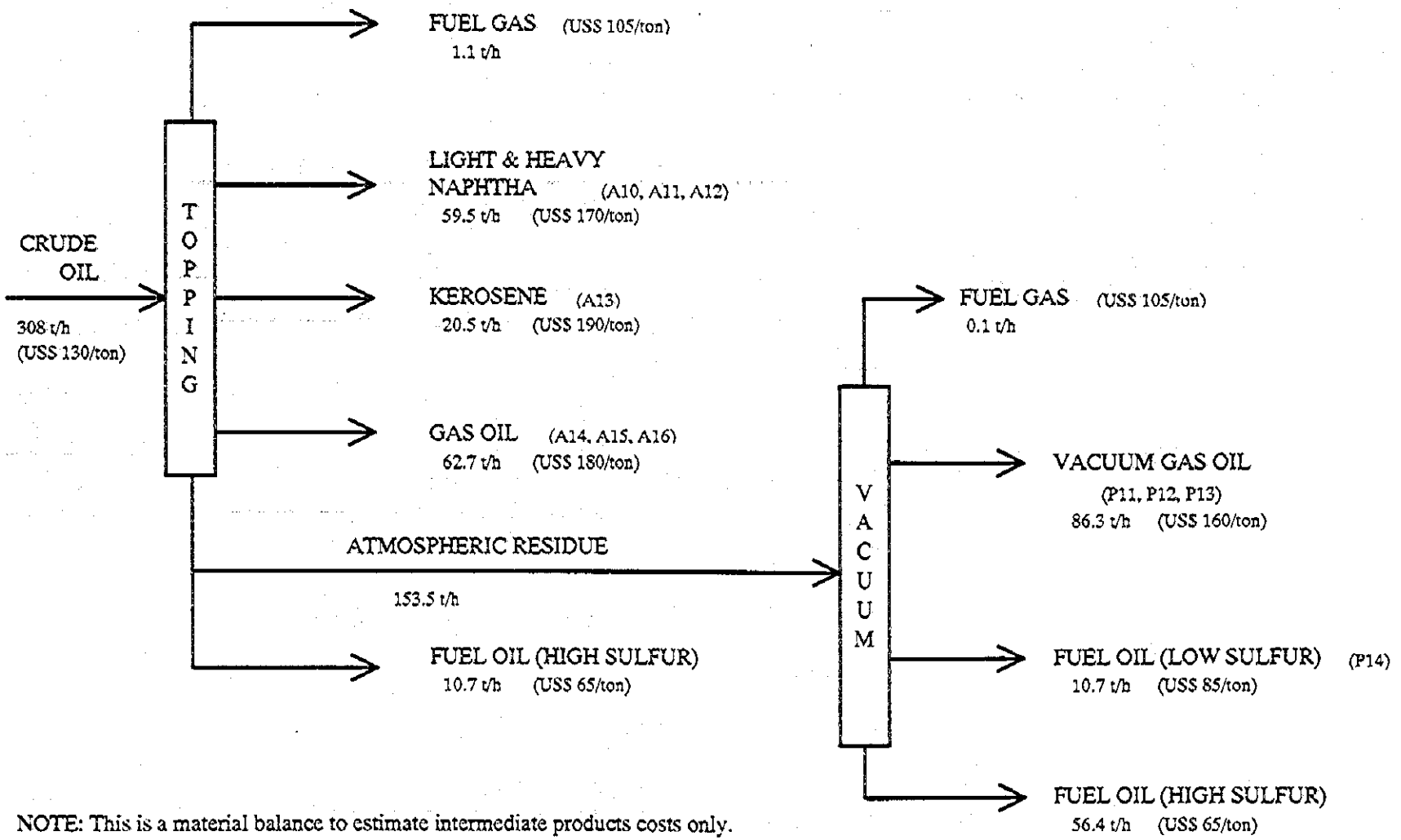
Table 9.1-7 FINANCIAL INDICATORS OF POWER PLANT THROUGH PROJECT LIFE (1999-2013)

(Unit: US$ 1,000 %)

ITEM	INDICATOR
Gross Capital Expenditure (1)	33,880
Gross Cash In-flow (2)	229,145
Income Tax (3)	74,704
Before Tax Net Inflow ((4)=(2) - (1))	195,265
After Tax Net Inflow ((5)=(4) - (3))	120,561
FIRR on Before Tax In-flow (4)	38.7
FIRR on After Tax In-flow (5)	27.6
Debt Service Ratio in 2000 (Times)	6.52
Yearly Benefit	8,910 - 9,947
Payback Years	3.78 - 3.38

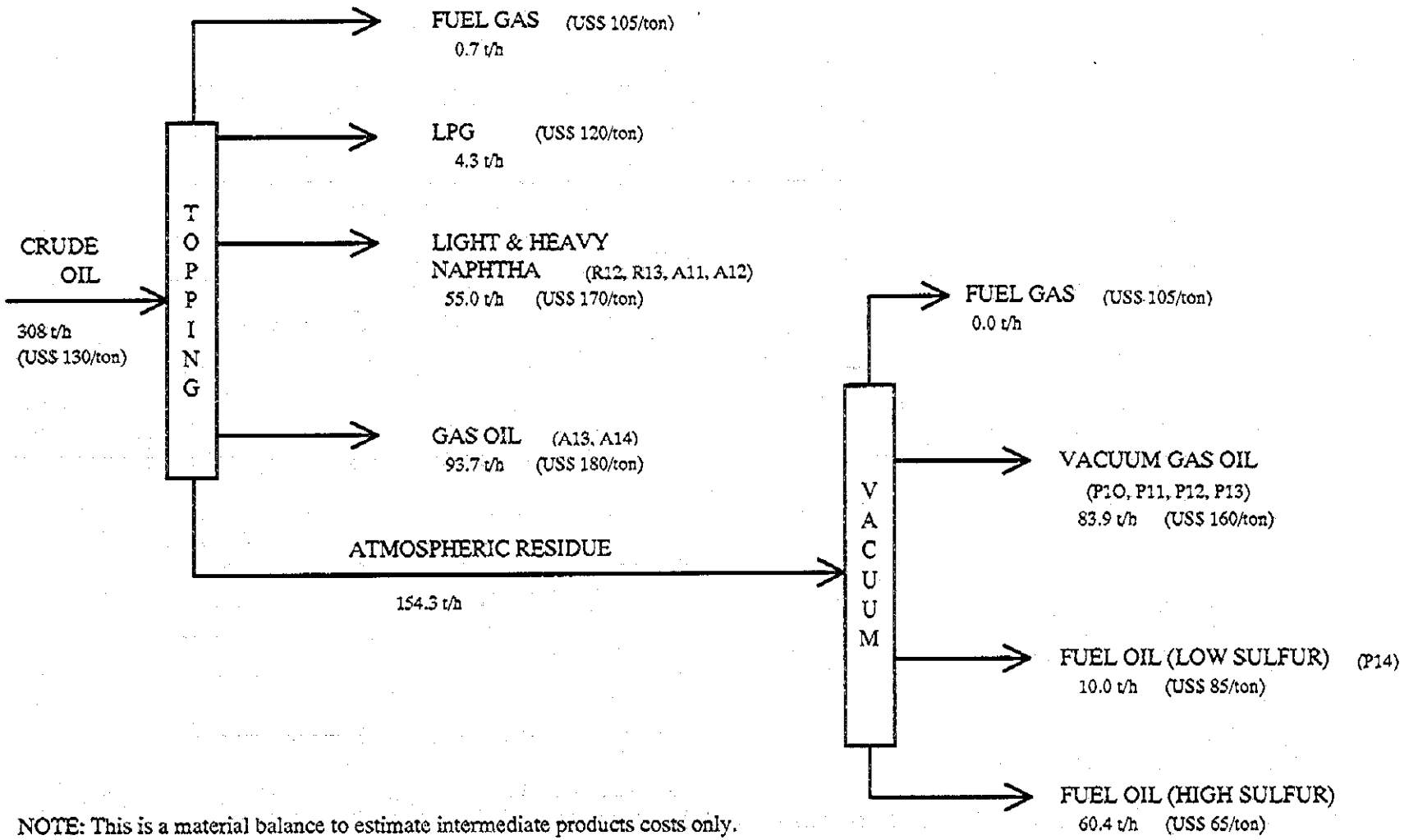
Source: ANNEX 5

Figure 9.1-1 MATERIAL BALANCE OF INTERMEDIATE PRODUCTS ("WITHOUT" CASE)



NOTE: This is a material balance to estimate intermediate products costs only.

Figure 9.1-2 MATERIAL BALANCE OF INTERMEDIATE PRODUCTS
("WITH" CASE)



NOTE: This is a material balance to estimate intermediate products costs only.

9.2 Economic Evaluation of the Projects of Both No.1 Crude Oil Distillation Unit and Thermoelectric Power Plant

9.2.1 Economic Evaluation of No.1 Crude Oil Distillation Unit Project

Economic evaluation of No.1 CDU is made on the basis of the modernization plan described in Chapter 4 of this Report.

(1) Quantifiable economic benefits

1) Economic internal rate of return (EIRR)

Generally speaking, when calculating the economic internal rate of return (EIRR), the result of the FIRR is adjusted, applying shadow wages, shadow prices and taxes. The wages and prices supplied in domestic currency need to be converted into the international currency like US dollar using the shadow exchange rate.
In this Study, however, it was agreed between PPSA and the Team not to use shadow wages, and all the prices of raw materials, utilities and product intermediates are indicated in US dollar as shown in Section 9.1.2.
As for taxes (import duties levied on plant facilities for this Study), it is general practice to make calculations excluding it both from the benefits and from the cost.
As the FIRR are quite high as described in Section 9.1.2, it is easily inferred that the EIRR after import duty is to be more.

2) Increase in the government's revenue

One of the contribution factors of this Project is the increase of the government's revenue through import related duties and VAT.

Capital cost estimation is made in Chapter 7 of this Report and the calculated amount of import duty and VAT are US$ 633,644 for import duty and US$ 1,477,639 for VAT. The amount of increase in income tax is US$ 1,057,000.

3) Increase of value added:

The value added created by the modernization project will contribute to enhancing the growth of national product. For the economic evaluation of this project, however, it is difficult to show concrete figure because the outputs from the project are intermediates to be processed in the down stream facilities.

(2) Non-quantifiable economic benefits

Here, discussion on such economic benefits as are non-quantifiable, are summarized as follows:

1) Import substitution of petroleum products:

Generally, discussion on foreign exchange earnings or savings would be made for this kind of analysis. In this project, however, it is necessary to take into consideration the capacities of downstream facilities. So it is difficult to quantify the foreign exchange benefits. It may be said that better quality of intermediates will improve the quality of final products which will enable Poland to substitute for presently imported final products after the completion of the project. Required foreign currency necessary for this modernization is the rather small amount of US$ 1,551,150. The effect of import substitution of petroleum products is bigger than the effects of foreign exchange earnings and savings.

2) Contribution to increased regional developments in Plock:

The modernization project implementation will enhance further regional developments including various commercial, industrial, services and governmental activities, and relevant public investments will have the same effects through increase of procurement of related goods and increase of employment.

3) Technology transfer:

The introduction of the new technology related to this plant's equipment will enhance the development of national technology.

4) Employment opportunities:

Employment opportunities for construction engineers and workers are created during the construction stage of the modernization project. Permanent employment for the management, operation and maintenance will be maintained during the production stage of the proposed modernization project.

9.2.2 Economic Evaluation of Thermoelectric Power Plant

(1) Quantifiable economic benefits

1) Increase in the government's revenue

Capital cost estimation is made in Chapter 7 of this Report and the calculated amount of import duty and VAT are US$ 4,919,159 for import duty and US$ 9,403,159 for VAT. Increased amount of income tax is US$ 3,699,030. Investigation for EIRR is also omitted for the power plant

project because a high enough value is expected.

(2) Non-quantifiable economic benefits

Economic benefits to Poland of modernization of the thermoelectric power plant are basically same as those of No.1 CDU.

9.3 Possible Alternative Sources of Financing for the Project

Although it is a principle of PPSA to finance the required funds for implementation of the modernization plan by itself - its own financial means and loans from domestic and foreign financial organizations - , it was agreed by the Team to suggest possible additional alternatives with the terms and conditions which are prevailing for similar projects. Following are the results of a study of possible alternative sources of financing for the Project.

9.3.1 Present foreign sources of loans

According to the information obtained at the Central Office of Planning and other related offices, there are now six international sources of finance utilized in Poland - International Bank for Reconstruction and Development (IBRD) or World Bank, International Monetary Fund (IMF), International Finance Corporation (IFC), European Bank for Reconstruction and Development (EBRD), European Investment Bank (EIB) and European Cooperation Fund.

(1) International Bank for Reconstruction and Development (IBRD) or World Bank

According to the Central Office of Planning, IBRD has a US$ 3 billion budget available for crediting to Poland, but only US$ 1 billion had actually been used as of November, 1993.

This organization concentrates on assistance in the fields of:

1) reforming of the economic system;

2) change in the structure of production; and

3) development of infrastructure like telecommunications and transportation.

Table 9.3-1 shows IBRD loans to Poland approved as of the end of 1992. Although the concrete project names are not listed in this Table, they include loans for such projects similar to the present one, like environmental protection management, energy production development, and privatization and restructuring of industry, which were approved by the organization.
It is also pointed out that the amount actually drawn so far has come to only about 35% of the approved amount in total.

Terms and conditions of IBRD are:

1) Objectives of the loans should be projects which contribute to economic development of the country and which can not be financed by borrowing from commercial markets. Generally IBRD projects are financed only for the foreign currency portion;

2) Not only government and governmental organizations but also enterprises in the private sector are entitled to borrow from the IBRD, but in the case of private enterprises, the Bank requires the government's guarantee;

3) Repayment period: 15 to 20 years;

4) Grace period: 5 years; and

5) Interest: floating rate (calculated on the average borrowing costs of major currencies of the past 6 months, adding an increment of 0.25% per annum).

As Poland's needs in restructuring its economy currently exceed the financial capacities of the IBRD, it is said necessary to raise funds from other sources like the IFC, EIB, EBRD and European Cooperation Fund.

(2) International Monetary Fund (IMF)

The IMF has been one of the major supporters of Polish economic transformation. The objective of the IMF is to provide finance to the government with comparatively short term funds required for purposes like settling foreign trade accounts. This source can not be recognized as a suitable finance source of this Project.

(3) International Finance Corporation (IFC)

The IFC primarily supports private investment projects in developing countries, through private reconstruction and development banks of these countries. In Poland, the Export Development Bank has that function.

Projects to be financed are ones which belong to such sub-sectors as manufacturing, agricultural processing, mining, transportation, storage, hotels and the financial sector.

Terms and conditions of the Corporation are:

1) Projects should be of high profitability, should contribute to economic development of the country and should be "environment friendly"

2) The minimum scale of projects should be 4 million US dollars;

3) Repayment period: 7 to 12 years;

4) Grace period: Depends on the nature of the project;

5) Interest: Depends on the nature of the project (usually fixed with reference to rates on major currencies); and

6) The maximum share for financing should be kept within 25% of total project cost.

(4) European Bank for Reconstruction and Development (EBRD)

The EBRD was established in 1991 by 40 countries, including Japan. At present, it has membership of 57 countries and two international organizations, the EC and EIB. Japan, contributing an 8.77% share of the capital, is the second largest investing country next to the USA (10.30%). A primary objective of the EBRD is to facilitate transformations to market economies in the countries of Central and Eastern Europe and the FSU by investing its funds in private enterprises, improvement of infrastructure, and technical assistance.

According to the publications of the Bank, 4.0 billion ECU (currency unit of European Community which is calculated by the weighted mean of currencies of member nations, currently around 1.2 US$) of the Bank's investment resources have been approved, and 2.8 billion ECU committed as of March 1994.

Table 9.3-2 shows a list of projects approved by the EBRD in Poland as of June 7, 1994. The number of projects

approved for Poland were 4 (88.94 million ECU) in 1991, 13 (349.89 million ECU) in 1992, 10 (321.55 million ECU) in 1993 and 4 (75.52 million ECU) in 1994 as of June 7 this year.

Examination of this Table reveals the following:

1) Not only loans but also equity participation have been welcome by the Bank. Recently new forms of financial arrangements have appeared, such as "purchase of receivables" (For example the borrower - Bielsko Biala Cogeneration Plant-will sell its product electricity to the Bank, which will in turn sell the power, to Austria);

2) The Bank has financed both public and private sectors;

3) There are 4 modernization projects included among the 31 projects financed; and

4) About half of the projects financed in fact exceed the Bank's funding limit of 35% of total project cost, which is prescribed in the basic conditions below, although total cost of each project is bigger than 5 million ECU. The representative of the Bank in Poland stated that for projects which the Bank evaluates to be promising and profitable, the Bank will form a syndicate with other financial organizations in order to provide finance up to the ultimate limit of 60%.

Terms and conditions of the Bank are:

1) Projects should be bigger than 14.3 million in total ECU (because the Bank's fund which has the maximum limit of 35% of total cost, should be bigger than 5 million ECU);

2) Repayment period:
   - Maximum 10 years for private enterprises with no grace period
   - Maximum 15 years for development of infrastructure with no grace period; and

3) Interest: LIBOR (London Inter Bank Official Rate) plus
   - margin of 1% for public sector
   - margin of 3% for private sector

(5) European Investment Bank (EIB)

The EIB was established by EC in 1958. Paid up capital of this organization is 4,321 million ECU. In 1990-1992, some 10% of EIB's credit operations were involved with transformation and development programmes in East-Central European countries, including Poland. Its activities were a supplement and continuation of programmes initiated by the IMF and IBRD. Financial cooperation between Poland and the EIB started as a result of an agreement concluded with the EC. In July 1990 a framework agreement was signed between Poland and the Bank. The EIB extends long and medium-term loans to be repaid in 7 to 12 years, depending on the project in the case of industrial developments. EIB credits cover 50% of the total costs of an investment project. The grace period may change, but may not be longer than 5 years.

Table 9.3-3 shows a sector-wise breakdown of EIB loans to Poland in 1992.

(6) European Cooperation Fund (ECF)

This fund will not be appropriate for PPSA to apply for, because the ECF aims to render assistance in development of small and medium-scale private enterprises.

9.3.2 Possible alternative sources of financing

After reviewing these six international financing sources, the Team recommend EBRD as the most probable alternative lender.

The reason why the Team recommend EBRD are:

Firstly, the objective of this organization is, as described in (4) above, to support Central and Eastern European countries including Poland, in transformation to market economy.

Secondly, EBRD is empowered to give not only financial but also technical assistance.

Thirdly, the interest rate of EBRD is comparatively low. As the LIBOR is currently around 5% p.a., it is possible for PPSA to borrow funds at an interest rate of around 8% p.a. This rate is about 4.5% lower than the prevailing commercial interest rate of 12.5% p.a.

Lastly, EBRD seems to have an understanding of plant modernization projects, because it has actually financed four such modernization projects.

On the other hand, one problem is foreseen. EBRD requires the government's guarantee for projects in the public sector, although they do not require it for the private sector.

As described in Chapter 1, Poland is now promoting privatization, and PPSA is involved in this policy to some extent. Actually, However, the government wants to slow down the pace of privatization for basic industries like petroleum, because they contribute to the nation's revenue through their payment of taxes and dividends - this causes some degree of dilemma.

If PPSA is recognized as a state enterprise by EBRD, the Polish government has to provide a guarantee for PPSA's

loan, although in that case there is an advantage that the interest rate would be 2% lower than the 10% rate which EBRD charges for the private sector.

Apart from the Team's recommendation, there exists the possibility of a request from the Ministry of Finance being made on financing for PPSA. According to the comments of an official in charge of the Ministry of Finance, local financing sources should have the priority for projects of this kind of basic industry. Local banks, after the privatization, have been seeking sure and promising projects in such basic industries as petroleum, because they think petroleum related business is profitable. In case of a shortage of funds, the official states, they will form a consortium of several local banks and cope with the need.

Table 9.3-1 IBRD LOANS EXTENDED TO POLAND, 1992

(Unit: US$ million)

	Items	Approved	Drawn
1.	Industrial export development	260.0	39.8
2.	Agricultural exports development	100.0	56.4
3.	Environmental protection management	18.0	6.8
4.	Transport	149.8	34.6
5.	Energy production development	250.0	78.8
6.	Structural adjustments program	300.0	300.0
7.	Telecommunications project	120.0	21.4
8.	Job creation	100.0	5.1
9.	Privatization and restructuring of industry	280.0	48.3
10.	Finance institutions development	200.0	75.1
11.	Heat engineering development	285.0	105.4
12.	Development of agriculture	100.0	0.2
13.	Development of small- and medium-size enterprises	60.0	0.0
	Total	2,222.8	771.9

Source: National Bank of Poland statistics

Table 9.3-2 LIST OF PROJECTS APPROVED BY EBRD IN POLAND AS OF JUNE 7, 1994

(Unit: Million ECU)

Year of Approval	EBRD Funds	Total Cost	Loan/Equity	Type	Project
1991	37.29	74.30	loan	public	WBK Bank of Poznan – credit line for heat supply/restructuring – Energy
1991	44.75	134.24	loan	private	Polska Telefonia Komorkowa – cellular telephones – Telecommunications
1991	1.64	10.73	loan	private	Lodom cold storage – Food
1991	5.26	14.70	loan	private	IBG food processing and cold storage – Food
1992	31.15	96.29	loan 28.74 / equity 2.41	private	Banking Centre Warsaw – tenancy by National Bank of Poland – Buildings
1992	5.53	15.44	loan	private	ABB Dolmel – Power Generation
1992	5.91	17.65	loan	private	Pubrex/Ringnes – Bydgoszcz Coca Cola Bottlers Ltd – Food
1992	39.10	90.84	equity	private	Polish Private Equity Fund – Finance
1992	85.60	284.04	loan	public	Telekomunikacja Polska (TPSA) – Warsaw telecommunications network
1992	55.33	275.00	loan	public	Housing Credit Line
1992	30.00	214.10	loan	private	Huta Warzsawa–Lucchini steel plant modernisation – Steel
1992	12.38	45.42	loan	private	Legler–Polonia denim textile plant – Textiles
1992	13.21	20.80	loan	private	Konspol–Bis poultry processing – Food
1992	6.13	18.56	loan	private	Rockwool modernisation of Cigacice mineral wool production lines
1992	41.20	138.00	loan 27.40 / equity 13.80	private	Pilkington Sandoglass float glass producion
1992	7.84	21.64	loan 6.00 / work cap. 1.84	private	Prime Food meat processing
1992	16.51	30.97	loan	private	Amerbank subordinated loan & co–financing of investment projects by SMEs
1993	22.00	34.70	loan	private	Polspan chipboard manufacturing
1993	11.00	n/a	equity	private	Privatisation of Wielkopolski Bank Kredytowy
1993	4.20	6.30	equity	private	Caresbac Polska – equity investments in SMEs
1993	8.50	21.25	loan	private	Kredty Bank – Co–financing and Guarantee Agreement for loans to Polish SME's
1993	28.60	51.20	loan	private	Trebruk/Kostrzyn–restructuring and modernisation of pulp and paper mill
1993	45.00	76.60	loan	public	A–4 Motorway
1993	38.14	60.97	loan	private	Huta Szkla Jaroslaw – privatisation of glass factory
1993	106.40	829.00	loan 72.20 / equity 34.20	private	Fiat Auto Poland
1993	10.61	17.50	loan	private	Batpress Sp. z o.o.
1993	47.10	297.80	loan	private	Kwidzyn Paper Mill–modernisation
1994	30.90	54.20	loan	private	Kronospan–Szczecinek :installation of a fibroboard production line and resin plant
1994	32.80	97.40	purchase of receivables	private	Polish Power Grid Company's financing of Bielsko Biala Cogeneration Plant Project
1994	3.72	10.56	equity	private	Azur Zycie/Ostoja – establishment of non–life and life insurance companies
1994	8.10	30.18	loan	private	Atrium Business Center–Construction of an office property in Warsaw
TOTAL	835.90	3090.38			

Source: EBRD

Table 9.3-3 EIB LOANS TO POLAND, 1992

(Unit: US$ million)

	Branches	Approved	Drawn
1.	Transport	24.8	3.0
2.	Energy production development	62.0	30.6
3.	Telecommunications	86.8	12.6
4.	Credit line	31.0	24.6
5.	Credit line	93.0	33.5
6.	Airports	65.0	0.0
	Total	362.6	104.3

Source: National Bank of Poland statistics

Chapter 10

Conclusion and Recommendation

Contents of Chapter 10

Chapter 10 Conclusion and Recommendation

This study is for the modernization of No.1 distillation unit and the power plant of PPSA, which is the largest refinery and also the langest petrochemical factory in Poland. With the change of economic structure in Poland, PPSA is obliged to cope with the liberalized market among of petroleum products European countries, both in terms of quality and price, and also has to take the environmental standards of European countries into consideration. Several modernization steps have been steadily taken by PPSA in preparation for such situations.

The purposes of the modernization of No.1 Distillation Unit are as follows;-

(1) Prevention of production of off-grade intermediate products (This is a must to produce end products compatible with the liberalized European market);
(2) Elimination of odor and toxic substances emissions for improving environmental condition of workers.;
(3) Change of the present instrument and control system to distributed control system (DCS), which is absolutely required because of the difficulty of securing spare parts for the present system, and because DCS offers much more responsive control performance and for better control of the facilities. (It is also the policy of PPSA to adopt DCS for all the facilities);
(4) Alteration of intermediate products to adapt to the changing patterns of products specifications and demand structures;
(5) Energy saving; and
(6) Reduction of emission of pollutants

These objectives are classified into two categories, one which is absolutely required for sustaining operation and another for better profitability of operation. (1) to (3) are the former and (4) to (6) can be considered the latter.

(1) through (3) shall be implemented absolutely, although there may be several options for modernization. However, it is almost impossible to measure the effects of such modernization quantitatively. On the other hand, the measures (4) to (6) are optional items and implementation can be decided based on the return on investment because the merits can be measured for these items.

In planning the modernization of No.1 distillation unit, operating conditions of the unit were obtained at the first field survey, and a simulation model was established based on the data acquired. This model has been used for the simulation in the modernization planning.

As the results of the simulation and study, it has been technically confirmed that the targets can be attained without major modification of atmospheric tower, vacuum tower and fired heaters, but instead through effective utilization of fractionators, proper heat recovery, change of operating conditions such as injection of steam, etc.

Based on those technical studies, investment cost requirements for the modernization and viability analyses were performed. For the sake of evaluation, international prices of crude oils and intermediate products at Rotterdom were referenced in consideration of the European market. No transportation cost, import duties or value added tax are included for the evaluation. As can be seen in table 9.1.-3 and 9.1-5, even at an operational rate of 80%, the total investment requirement is within the range of 20-35% of the annual profit after tax, and amortization of the

loan, including repayment of interest, can be done in five years without any problem. For the investment for the modernization, the financial internal rate of return is quite high, and payout period is adequate.

As for the power plant, following are the subjects of the modernization;-

(1) Increase of efficiency (reduction of fuel consumption) and reduction of SO_2 and NO_X for No.1, No.2 and No.3 boilers;
(2) Reduction of chemical consumption and water consumption for the boiler feed water treatment system, and increase of treating capacity; and
(3) Increase of power generation capacity by installing a condensing turbine generator, without any longer being affected by the seasonal change of steam demand.

Installation of flue gas desulfurization facilities is separately under planning by PPSA, therefore, this study does not include that subject.

With regard to the modernization of boilers, reduction of fuel consumption and longer continuous operation period can be attained by installation of soot blowers, change of air pre-heaters, and change of burner tips.

The modernization of the water treatment facilities through change of operation mode (including regeneration operation), installation of distributors and collectors for uniform flow, etc., can attain a reduction of chemical consumption. However, increase of the capacity of the water treatment is difficult with the existing facilities.

Installation of a condensing turbine generator will make it possible to reduce dependence on the outside power supply and

reduce the purchase cost of power, especially in the summer season when the demand for steam is quite low.

Based on the modernization plans of explained above, investments and returns are as shown in table 9.1-3-(%), and even at the boiler operational rate at 80 %, payout period for the investment is quite justifiable, and it is recommended to implement the modernization plans.

As the final summary statement, the investment for the modernization of the No.1 distillation unit and the power plant are rational both technically and financially.

Since this study is based on the assumption that existing equipment has no deterioration in terms of performance as well as mechanically, it is necessary to inspect the facilities in detail before implementing the modernization.

For both distillation unit and power plant, the profitability of investment greatly depends on operational rates. In order to secure higher profitability, it is preferable to keep a higher operational rate of the facilities. For this, it is prerequisite that crude oil shall be supplied constantly and petroleum products can be marketed smoothly. AT the same time, mechanical troubles of the facilities shall be made minimal. Proper maintenance of the facilities is required. PPSA already has the planned maintenance system of preventive maintenance and post maintenance, however, introduction of a well established system and technology for plant diagnosis for preventive maintenance, will be required.

Further, in addition to the increase of operation rates, it is required to control the facilities well, responding to changes of the operation conditions. Introduction of DCs will help make more accurate and timely measurements, and enable the plant to operate more efficiently than before.

Regarding air contamination, the objective item is exhausted gas from the heating furnace and boilers (1 through 3). SO_2 and NOx is reduced to some extent owing to the effect of energy saving. But this measure is not sufficient, so boilers are required to have facilities installed for desulfurization and denitrification, according to determination by PPSA, and also a shift to fuel of low sulfur content has to be taken into consideration.

Concerning water discharge, measures have been elaborated for prevention of offensive odor contained in waste water coming from each refinery top receiver.

As countermeasures, a method of installation of waste water strippers has been compared with a method of connection of waste water piping between gathering vessel and equipment, and the latter approach is recommendable.

And as a countermeasure against hydrogen sulfide contained in the receiver tank of the reduction refinery and in the slop tank (Zb-3), installation of amine purification equipment has been contemplated but this is not economical. The method of combustion in the heating furnace, just like the present method, may still be the best one.