8.3 Matrix Investigation of Environmental Impact Factors

Recently the environmental problem has become of increasing by important, not only as a domestic issue but as an international issue. These circumstances require that environmental precautions should be taken effectively and efficiently.

The environmental considerations in the development assistance programs are aimed at assisting developing countries' self-help efforts to carry out the development programs by environmentally acceptable methods.

This means that, in view of continuous development, the emphasis on the balance between the development and the environment and, in case there are for the items for established standards and regulations for prevention of pollution, the observance of such standards and regulations constitute the basis for judgment of the environmental precautions.

This basis also includes the observance of the provisions set forth in international treaties and conventions, the protection of endangered animals and plants, and the prevention of drastic alteration of the existing environment.

Before proceeding into the discussion of the investigation on the environmental impact factors, a rough outline of the environmental impact investigation is presented in the following.

The investigation is aimed at sufficiently grasping the environmental influences of the locations of power plants so that appropriate protection can be sought for the environment of the power plants and their construction sites.

The investigation includes:

- Execution of an environmental impact investigation
  - Outline of the power plant program
  - Existing environmental conditions
- Environmental protection measures to be adopted

- Prediction and assessment of environmental impact

- Other environmental protection measures scheduled for adoption, environmental monitoring plan, etc.

- Overall assessment

8.3.1 Thermal Power Plant

The environmental factors surrounding thermal power plants and their effects are summarized in Table 8-3-1.

For reference, the present environmental conditions around the respective thermal power plants are compared with the data from the investigation of present environment, and, concerning atmosphere, water quality and noise, the results were as stated in section 8.1.3 Present State of Environmental Management. In the vicinity of the power plants, no protected plants or animals are found.

Lacking historically or culturally important remains in the vicinity, no particular adverse precautions would be needed. However, with Manila Power Plant, located in the central part of Metro Manila, special care should be taken to prevent air pollution as there are historical churches and buildings in the vicinity.

Table 8-3-1 Environmental Impact Matrix Investigation on Thermal Power Plant During operation

ENVIRONMENTAL CONSTITUENTS	ENVIRONMENTAL IMPACT FACTORS							
	Cooling water intake	Thermal effluent	Exhaust gas	Waste heat	Fuel receiving	Waste matter	House-hold waste water	Start-up/ shutdown
Air Quality dust scattering SO_2 scattering NOx scattering Meteorology change in weather & wind Noise Offensive odor			◎ ◎ ◎	◎			◎	◎
Water Quality organic substances acidity state of flow bottom sediment water temperature	◎ ○	○ ○ ◎	○				◎	
Beach terrain Surface water Vibration	○ ◎	○						◎
Plants Terrestrial animals Aquatic animals		※	※		※		※	※
Landscape visibility obstacle			◎	○				
Use of environment			○			○	○	○

Note: ◎ directly related
○ indirectly related
※ possibly related

8.3.2 Geothermal Power Plant

The environmental factors surrounding geothermal power plants and their impacts are given in Table 8-3-2.

The investigation should proceed with comparisons to the items for the investigation of present status of the environment.

Concerning air quality, high concentration hydrogen sulfide gas is currently emitted from the ejector discharge port. It is desired that this will be remedied by introducing the gas into the cooling tower to be diluted before emission after due consultation with the manufacturer.

According to the information from NAPOCOR, there are no protected plants or animals, nor any historically or culturally important remains in the vicinity.

Table 8-3-2 Environmental Impact Matrix Investigation on Geothermal Power Plant During operation

ENVIRONMENTAL CONSTITUENTS	ENVIRONMENTAL IMPACT FACTORS						
	Steam/ hot water intake	Thermal effluent	H_2S emission	Water vapor emission	Under ground reinjection of hot-water	Cooling water intake	Start-up/ shutdown
Air Quality							
H_2S scattering			◎				
Sunlight obstacle				◎			
Noise							◎
Offensive odor	◎		◎				
Water Quality							
arsenic, boron and mercury	◎	◎					
souring		◎	◎				
change in water temperature		◎					
Terrain							
induction of ground subsidence	※				※		
Soil souring			◎				
Change in ground temperature	◎				◎		
Change in ground water	※				※		
Vibration							◎
Plants	※		※	◎	※		
Terrestrial animals							※
Aquatic animals	※	※	※				
Landscape							
visibility obstacle				◎			
Use of environment	◎		○	○			○

Note: ◎ directly related
○ indirectly related
※ possibly related

8.4 Recommendations regarding Environmental Management

8.4.1 Reinforcement of Environmental Management System

The Environment Management Department of NAPOCOR, consisting of two divisions of Environmental Impact Assessment Division (EIAD) and Environmental Service Division (ESD), has been endeavoring to push forward the environmental administration.

In order to enhance the efficiency of the administrative operation, we recommend the following:

The environmental management calls for widely ranged expertise. In order to conduct such widely ranged technical investigations, it is essential to have the guidance of university professors, scholars and specialists from research institutions to collect accurate and reliable results.

Recommendations for future policy are:

1. To establish the following specialized affiliates for specific investigations:

   - Affiliate specializing in chemical analysis of air quality, water quality, soil and offensive odors

   - Affiliate specializing in acoustics of noise and vibration measurement, sound-proofing and vibration-proofing measures, and prediction

   - Affiliate specializing in geology, ground subsidence, and limnological investigations

   - Affiliates specializing in meteorological observation and prediction of air diffusion

2. To seek assistance from governmental agencies, universities and research institutions for the following:

   . Investigation of hydrographic conditions and marine life including fish, larvae and planktons

   . Investigation of flora and fauna

   . Investigation of government agencies' statistical data on nature conservation, population, industry, traffic, education, regional finance, etc.

A purpose of the Environmental Impact Assessment Department (EIAD) in the Head Office should be to put together the investigation results received from the specialists, make explanations to the concerned authorities regarding the environmental protection measures for the power development area, respond to the citizens in the area, seek solutions to complaints, and to make every possible effort to facilitate smooth electrical power development to meet the electric power demand.

8.4.2 Expansion of Environmental Measurement System

Presently ESD is operating with a staff of 30.
All environmental measurements are performed by understaffed ESD. In view of the fact that ESD has the additional responsibility of coping with and seeking solutions to complaints from citizens of the area, we recommend the following:

   . To create the position of Environmental Section Chief, (full-time or part-time) at power plant/Regional Center to take charge of coping with the local communities, processing grievances, and promoting environmental protection work.

   . To delegate some measuring work to the Regional Center or to the power plants.

CHAPTER 9

IMPLEMENTATION PROGRAM, REHABILITATION COST, AND DISBURSEMENT SCHEDULE

CHAPTER 9 IMPLEMENTATION PROGRAM, REHABILITATION COST, AND DISBURSEMENT SCHEDULE

9.1 General

9.1.1 Implementation Program

1. Scope of Works

Rehabilitation/Renovation Items for the thermal, geothermal, and hydro power plants and transmission lines and substations are as described in Chapter 6 and Sections 9.2 to 9.5 of Chapter 9.

In consideration of the necessary procedure prior to the rehabilitation works, it is anticipated that the commencement of the works will be in or after 1994.

In the meantime, it is desirable that the other items not included in the rehabilitation/renovation items be carried out systematically by NAPOCOR in the ordinary maintenance works.

2. Contracting Scheme for Rehabilitation/Renovation Works

(1) Thermal and Geothermal Power Plants

Since the rehabilitation works are the repair of the existing equipment, it would be the most reliable method to select the original main equipment manufacturer as the main contractor.

Especially in the case of thermal and geothermal power plants, it is not advisable to entrust the rehabilitation works to other manufacturers for fear of unforeseen technical troubles.

Other manufacturers do not have the design and manufacturing drawings of the equipment to be rehabilitated. And even if they get hold of the drawings, they could not get the know-how not explicitly shown on the drawings.

For the above reasons, the contract of the rehabilitation works should be made in as small number of packages as possible centering on the original manufacturer of the main equipment and the condition of delivery after test operation and readjustment should be stipulated so that the responsibility of the contractor may be clearly defined.

The direct works carried out by NAPOCOR will be excluded from the rehabilitation work, but the works should be carried out in close coordination with the contractor.

(2) Hydro Power Plant and Transmission and Substation Facilities

The same consideration and arrangement as with the thermal power plants should be made for the rehabilitation of the hydro power plants.

On the other hand, the transmission and substation facilities are composed of the unit equipment and materials, and the replacement of these unit equipment and materials need not always be by the original manufacturers. And therefore, the rehabilitation equipment and materials will be procured by the competitive bidding from the pre-qualified contractors (manufacturers).

3. Engineering Service

The rehabilitation/renovation works will be carried out under the control of NAPOCOR, but since there are many and varied rehabilitation/renovation items, it would be necessary to hire the services of a consultant to assist NAPOCOR.

The engineering covering the services of preparation of the procurement specifications through the construction supervision should be let to an outside consultant.

4. Timing of Rehabilitation/Renovation Works

Even though there still remain the financing problem and other problems to be solved, the timing of the works will be set as follows. (Refer to Table 9-1-1)

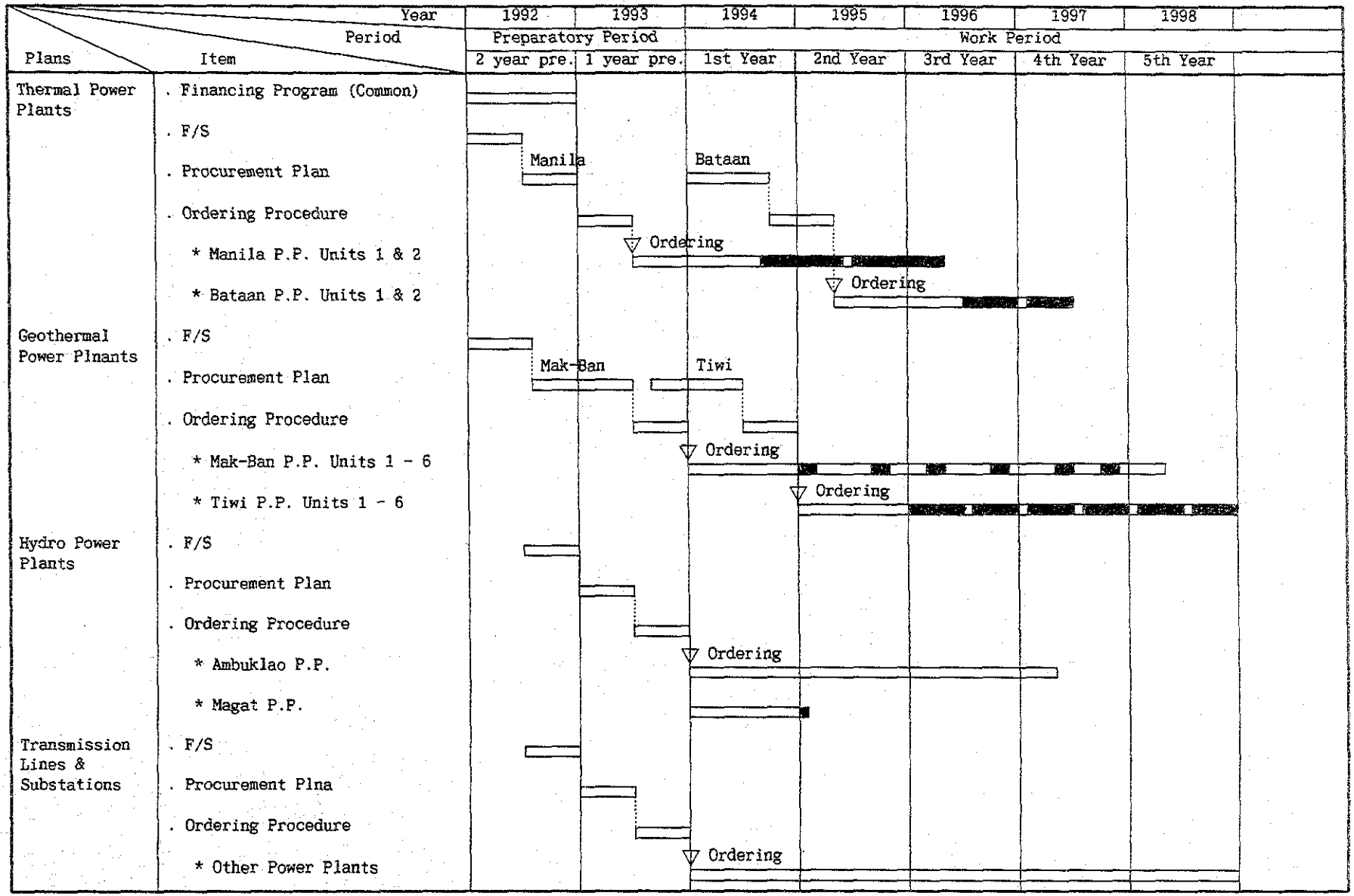
(1) Preparatory Period: 1992 - 1993
(Extension may be necessary, depending on the progress of situations)

a. Financing program
b. Feasibility study
c. Procurement plan (Hiring of consultant, preparation of procurement specifications, tendering)
d. Ordering procedure (Evaluation, negotiation, approval by organizations concerned, etc.)

(2) Work Period: 5 years from 1994

However, with Manila Power Plant, August 1993 is set for the target time of start of the rehabilitation works so that the rehabilitation may be completed before 30 years of the elapsed time from the commissioning of the power plant is exceeded.

Table 9-1-1 Rehabilitation Works Schedule



9.1.2 Rehabilitation Cost and Financing

1. Rehabilitation Cost

(1) Basic Conditions for Cost Estimation

a. Commodity prices escalation rate during the rehabilitation work period is assumed to be 3% per annum.

b. The cost estimate is made as of December 1991, and the following exchange rates are used.

1 US$ = ¥ 130 (¥ 129.85 is rounded up)
1 US$ = P. 27

c. Import duties are exempted; corporate tax and other taxes and levies are not considered.

d. Financing (both F.C. and L.C.) will all be in foreign currency and by foreign loan in principle.

e. Land for site offices and electric power and water for rehabilitation works will be supplied by NAPOCOR free of charge.

(2) Rehabilitation Cost

The estimated costs for the rehabilitations/renovation works are summarized in Table. 9-1-2.

2. Financing

The rehabilitation/renovation work period will be 5 years from August 1994.

Based on this work period, the financing is considered for the following cases.

Facilities	Rehabilitation work period	Financing
Thermal P.P. Geothermal P.P.	Work started in 1st year	Case 1
	Work started in 2nd year	Case 2
Hydro P.P.	Work started in 1st year	Case 1
	Work started in 2nd year	Case 2
Transmission & Substations	Work started in 1st year	Case 1
	Work started in 2nd year	Case 2

	Interest Rate	Repayment Period
Case 1	7.5%	8 years (incl. 6 months grace period)
Case 2	3.0%	25 years (incl. 10 years grace period)

Note: Case 1: Export-Import Bank Loan
Case 2: ODA, etc

9.1.3 Annual Disbursement Schedule

The annual disbursement schedule is as summarized in Table 9-1-3.

9.1.4 Implementation Schedule

The implementation schedule will be according to the schedules for individual facilities described in Section 9.2 and the following sections.

Table 9-1-2 Rehabilitation Costs (Summary)

Unit : 1,000US$

Rehabilitation Plans	Item	Rehabilitation Cost			Remarks
		F.C.	L.C.	Total	
Thermal Power Plants	Manila P.P.	99,298	16,202	115,500	Manila Units No.1 & No.2
	Bataan P.P	66,402	12,998	79,400	Bataan Units No.1 & No.2
	Total	165,700	29,200	194,900	
Geothermal Power Plants	Mak-Ban P.P.	46,768	1,340	48,108	Mak-Ban Units No.1～No.6
	Tiwi P.P.	48,140	1,490	49,630	Tiwi Units No.1～No.6
	Total	94,908	2,830	97,738	
Hydro Power Plants	Ambuklao P.P.	12,522	6,828	19,350	Reconstruction of intake
	Magat P.P	192	12	204	Replacement of excitation transformer
	Total	12,714	6,840	19,554	
Transmission Lines & Substations	Transmission Lines	1,551	812	2,363	Replacement of overhead Ground wires, steel towers for river and road crossings, rerouting of T/L section
	Substations	14,350	528	14,878	
	Total	15,901	1,340	17,241	
Grand Total		289,223	40,210	329,433	

Table 9-1-3 Rehabilitation Costs Annual Disbursement Schedule (Summary)

Unit : 1,000US$

Rehabilitation Plans		Previous Year	1st Year	2nd Year	3rd Year	4th Year	5th Year	Total
Thermal Power Plants	F.C.	26,365	36,644	44,228	50,673	7,790	—	165,700
	L.C.	2,089	3,884	8,108	11,776	3,343	—	29,200
	Total	28,454	40,528	52,336	62,450	11,133	—	194,900
Geothermal Power Plants	F.C.	—	7,016	17,046	30,342	26,202	14,302	94,908
	L.C.	—	201	504	903	790	432	2,830
	Total	—	7,217	17,550	31,245	26,992	14,734	97,738
Hydro Power Plants	F.C.	—	663	6,332	3,479	2,240	—	12,714
	L.C.	—	1,711	3,305	1,284	540	—	6,840
	Total	—	2,374	9,637	4,763	2,780	—	19,554
Transmission Lines & Substations	F.C.	—	3,147	2,996	3,468	3,440	2,850	15,901
	L.C.	—	228	324	445	230	113	1,340
	Total	—	3,375	3,320	3,913	3,670	2,963	17,241
Grand Total	F.C.	26,365	47,470	70,601	87,962	39,672	17,152	289,223
	L.C.	2,089	6,024	12,241	14,408	4,903	545	40,210
	Total	28,454	53,494	82,842	102,370	44,575	17,697	329,433

9.2 Thermal Power Plants

9.2.1 Rehabilitation Cost

The rehabilitation costs for the thermal power plants are tabulated in Table 9-2-1, and are summarized as follows.

Unit: 1000US$

Rehabilitation Plans	F.C.	L.C.	Total
Manila P.P. Units No. 1 & No. 2	99,298	16,202	115,500
Bataan P.P. Units No. 1 & No. 2	66,402	12,998	79,400
Total	165,700	29,200	194,900

9.2.2 Rehabilitation Schedule

The rehabilitation schedule is shown in Table 9-2-2.

9.2.3 Annual Disbursement Schedule

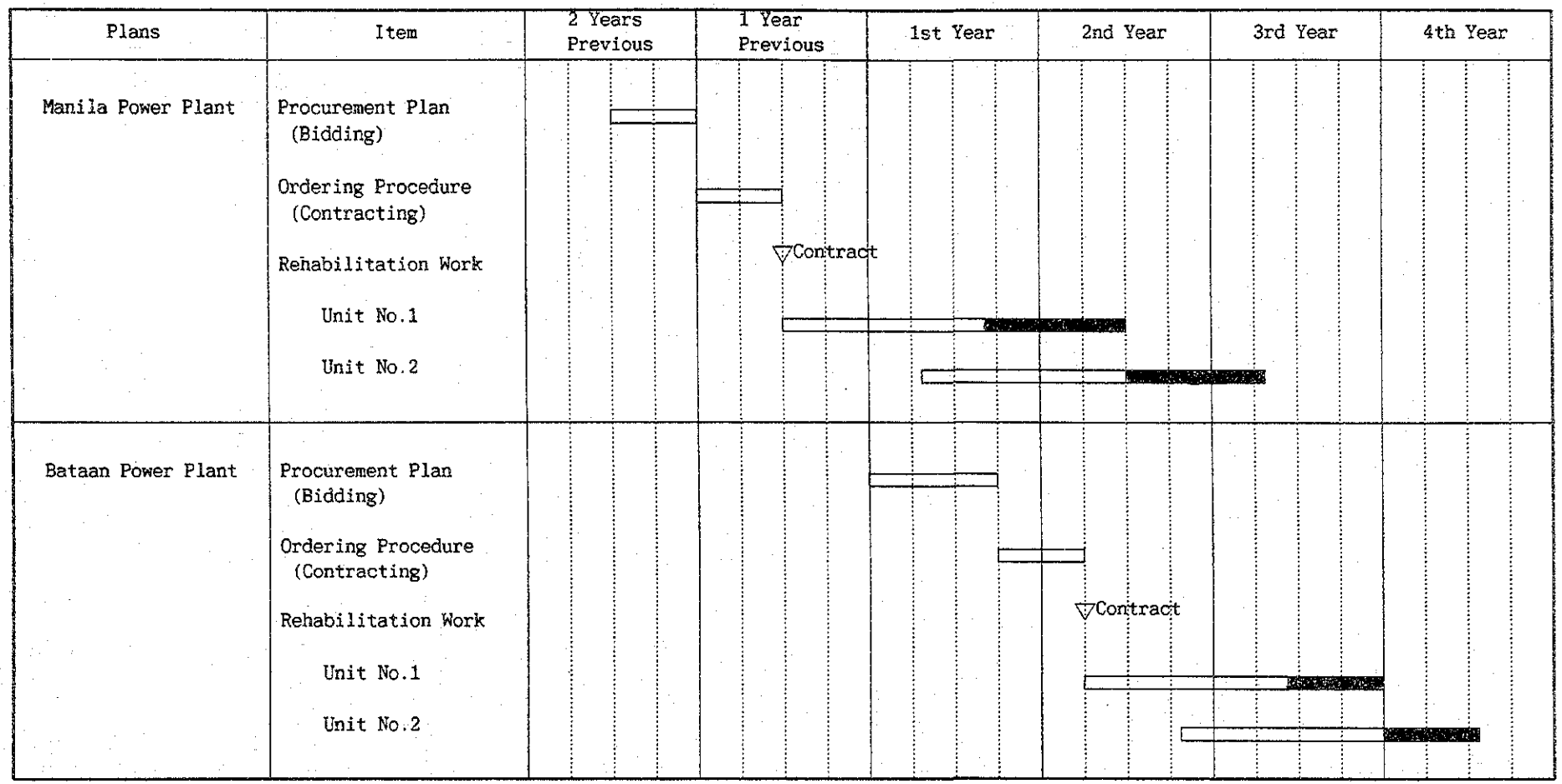
The annual disbursement schedule of the rehabilitation costs is shown in Table 9-2-3.

Table 9-2-1 Thermal Power Plant Rehabilitation Costs (Summary)

Unit : 1,000US$

Plans	Item	Cost			Remarks
		F.C.	L.C.	Total	
Manila Power Plant Units No.1 & No.2	Rehabilitation Cost	89,500	8,400	97,900	
	Consultant Fee	4,900	(Included in F.C.)	4,900	
	Contingency	4,898	7,802	12,700	
	Total	99,298	16,202	115,500	
Bataan Power Plant Unit No.1	Rehabilitation Cost	28,877	3,854	32,731	
	Consultant Fee	1,638	(Included in F.C.)	1,638	
	Contingency	1,612	3,176	4,788	
	Total	32,127	7,030	39,157	
Bataan Power Plant Unit No.2	Rehabilitation Cost	30,947	2,808	33,755	
	Consultant Fee	1,688	(Included in F.C.)	1,688	
	Contingency	1,640	3,160	4,800	
	Total	34,275	5,968	40,243	
Bataan Power Plant	Total	66,402	12,998	79,400	

Table 9-2-2 Thermal Power Plant Rehabilitation Work Schedule



Procurement Plan : Hiring of consultant, preparation of specifications, tendering
Ordering Proceduce : Evaluation, negotiation, approval by offices concerned

Table 9-2-3 Thermal Power Plant Rehabilitation Costs Annual Disbursement Schedule

Unit : 1,000US$

Plans		Previous Year	1st Year	2nd Year	3rd Year	4th Year	5th Year	Total	Remarks
Manila P.P. Units No.1 & No.2	F.C.	26,365	35,314	23,857	13,762			99,298	
	L.C.	2,089	3,844	5,808	4,461			16,202	
	Total	28,454	39,158	29,665	18,223			115,500	
Bataan P.P. Units No.1 & No.2	F.C.		1,330	20,370	36,912	7,790		66,402	
	L.C.		40	2,300	7,315	3,343		12,998	
	Total		1,370	22,670	44,227	11,133		79,400	
Total	F.C.	26,365	36,644	44,227	50,674	7,790		165,700	
	L.C.	2,089	3,884	8,108	11,776	3,343		29,200	
	Total	28,454	40,528	52,335	62,450	11,133		194,900	
Remarks									

9.3 Geothermal Power Plants

9.3.1 Rehabilitation Cost

The rehabilitation costs for the geothermal power plants are tabulated in Table 9-3-1, and are summarized as follows.

Unit: 1000US$

Rehabilitation Plan	F.C.	L.C.	Total
Mak-Ban P.P. Units No. 1 - No. 6	46,768	1,340	48,108
Tiwi P.P. Units No. 1 - No. 6	48,140	1,490	49,630
Total	94,908	2,830	97,738

9.3.2 Rehabilitation Schedule

The rehabilitation schedule is shown in Table 9-3-2.

9.3.3 Annual Disbursement Schedule

The annual disbursement schedule of the rehabilitation costs is shown in Table 9-3-3.

Table 9-3-1 Geothermal Power Plant Rehabilitation Costs (Summary)

Unit : 1,000US$

Plans	Item	Cost			Remarks
		F.C.	L.C.	Total	
Mak-Ban Geothermal P.P Units No.1～No.6	Rehabilitation Cost	42,518	1,220	43,738	
	Consultant Fee	2,125	60	2,185	
	Contingency	2,125	60	2,185	
	Total	46,768	1,340	48,108	
Tiwi Geothermal P.P Units No.1～No.6	Rehabilitation Cost	43,759	1,355	45,114	
	Consultant Fee	2,190	68	2,258	
	Contingency	2,191	67	2,258	
	Total	48,140	1,490	49,630	
Total		94,908	2,830	97,738	

Table 9-3-2 Geothermal Power Plant Rehabilitation Work Schedule

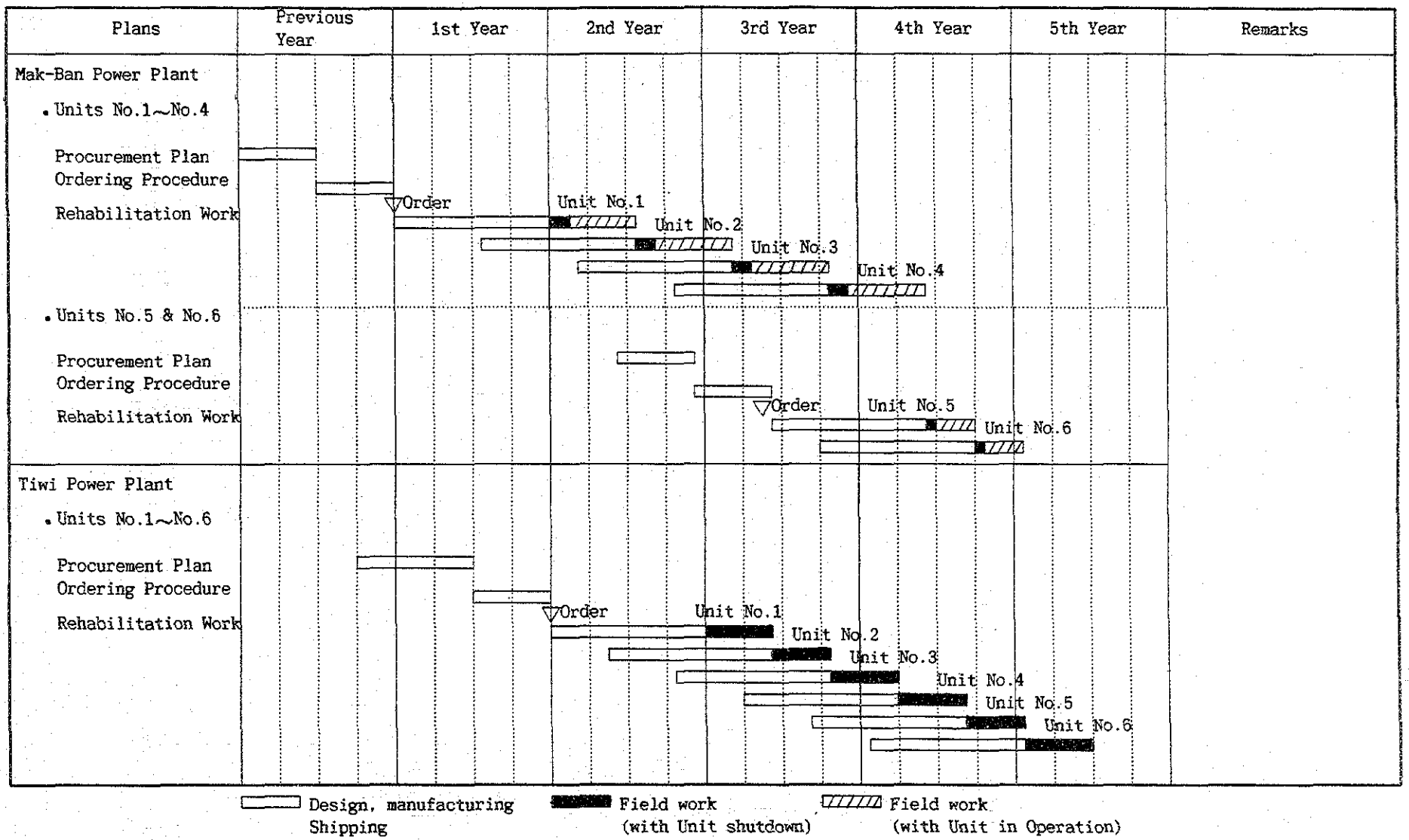


Table 9-3-3 Geothermal Power Plant Rehabilitation Costs Annual Disbursement Schedule

Unit : 1,000US$

Plans		Previous Year	1st Year	2nd Year	3rd Year	4th Year	5th Year	Total	Remarks
Mak-Ban Geothermal P.P Units No.1～No.6	F.C.	—	7,016	9,824	15,902	9,352	4,674	46,768	
	L.C.	—	201	281	456	268	134	1,340	
	Total	—	7,217	10,105	16,358	9,620	4,808	48,108	
Tiwi Geothermal P.P Units No.1～No.6	F.C.	—	—	7,222	14,440	16,850	9,628	48,140	
	L.C.	—	—	223	447	522	298	1,490	
	Total	—	—	7,445	14,887	17,372	9,926	49,630	
Total	F.C.	—	7,016	17,046	30,342	26,202	14,302	94,908	
	L.C.	—	201	504	903	790	432	2,830	
	Total	—	7,217	17,550	31,245	26,992	14,734	97,738	
Remarks									

9.4 Hydro Power Plants

9.4.1 Rehabilitation Cost

The rehabilitation cost of hydro power plants is as shown in Table 9-4-1 and is summarized as follows.

Unit: US$1,000

Plans	F.C.	L.C.	Total
Reconstruction of Ambuklao Power Plant intake	12,522	6,828	19,350
Replacement of Magat Power Plant excitation transformers	192	12	204
Total	12,714	6,840	19,554

9.4.2 Rehabilitation Schedule

Table 9-4-2 shows the rehabilitation schedule of hydro power plants.

9.4.3 Annual Disbursement Schedule

Table 9-4-3 shows the annual disbursement schedule for rehabilitation of hydro power plants.

Table 9-4-1 REHABILITATION COST OF HYDRO POWER PLANTS (1)

Unit : US$ 1,000

Plans	Items	Quantities	Rehabilitation cost			Remarks
			F.C.	L.C.	Total	
Reconstruction of Ambuklao Power Plant intake	Construction road	500 m		970	970	Excavation:5,000m³, Crusher-run:26,000m³ Slope protection:500m² Concrete pavement :700m²
	Warking area	1 LS		200	200	Cutting:25,000m³
	Pneumatic caisson	1 LS	471	1,229	1,700	Excavation:5,000m³, Concrete:1,100m³ Temporary facility
	Shaft	88.7 m	1,091	2,819	3,910	Excavation:7,000m³, Concrete:3,100m³ Temporary facility
	Plugging work	12.0 m	74	276	350	
	Stop log	1 LS	353	167	520	
	Intake tower	1 LS	10,533	1,167	11,700	Intake tower, Sleeve gate, Hoisting winch, Bridge
	Sub total	—	12,522	6,828	19,350	
Replacement of Magat Power Plant excitation transformers	Excitation transformer	4 Units	192	12	204	1,400kVA, 13,800/940V, Molded type
Total		—	12,714	6,840	19,554	

Table 9-4-1 REHABILITATION COST OF HYDRO POWER PLANTS (2)

Plans	Items	Quantities	F.C. ¥ million	L.C. P 1,000	Total P 1,000	Remarks
Reconstruction of Ambuklao Power Plant intake	Construction road	500 m		25,782	25,782	Excavation:5,000m³, Crusher-run:26,000m³ Slope protection:500m² Concrete pavement :700m²
	Warking area	1 LS		5,316	5,316	Cutting:25,000m³
	Pneumatic caisson	1 LS	61.2	32,665	45,814	Excavation:5,000m³, Concrete:1,100m³ Temporary facility
	Shaft	88.7 m	141.7	74,926	103,924	Excavation:7,000m³, Concrete:3,100m³ Temporary facility
	Plugging work	12.0 m	9.6	7,336	9,303	
	Stop log	1 LS	45.8	4,439	13,821	
	Intake tower	1 LS	1,367.7	31,017	310,974	Intake tower, Sleeve gate, Hoisting winch, Bridge
	Sub total	—	1,626.0	181,481	514,304	
Replacement of Magat Power Plant excitation transformers	Excitation transformer	4 Units	24.8	320	5,422	1,400kVA, 13,800/940V, Molded type
Total		—	1,650.8	181,801	519,726	

Table 9-4-2 REHABILITATION SCHEDULE OF HYDRO POWER PLANTS

Plans	Items	First year	Second year	Third year	Fourth year	Fifth year
Reconstruction of Ambuklao Power Plant intake	Construction road Working area					
	Pneumatic caisson					
	Shaft					
	Plugging work Stop log					
	Intake tower					
Replacement of Magat Power Plant excitation transformer	Excitation trans.					

Table 9-4-3 ANNUAL DISBURSEMENT SCHEDULE FOR REHABILITATION OF HYDRO POWER PLANTS

Unit : US$ 1,000

Plans	Items		First year	Second year	Third year	Fourth year	Fifth year	Total
Reconstruction of Ambuklao Power Plant intake	Construction road	F.C.						
		L.C.	970					970
	Working area	F.C.						
		L.C.	200					200
	Pneumatic caisson	F.C.	471					471
		L.C.	529	700				1,229
	Shaft	F.C.		1,091				1,091
		L.C.		2,209	610			2,819
	Plugging work	F.C.			74			74
		L.C.			276			276
	Stop log	F.C.			353			353
		L.C.			167			167
	Intake tower	F.C.		5,241	3,052	2,240		10,533
		L.C.		396	231	540		1,167
	Sub total	F.C.	471	6,332	3,479	2,240		12,522
		L.C.	1,699	3,305	1,284	540		6,828
Replacement of Magat Power Plant excitation transformers	Excitation transformer	F.C.	192					192
		L.C.	12					12
Total		F.C.	663	6,332	3,479	2,240		12,714
		L.C.	1,711	3,305	1,284	540		6,840
		Total	2,374	9,637	4,763	2,780		19,554

9.5 Transmission Lines and Substations

9.5.1 Renovation Cost

The renovation cost of transmission lines and substations is as shown in Table 9-5-1 and is summarized as follows.

Unit: US$1,000

Plans	F.C.	L.C.	Total
Replacement of overhead ground wires	785	362	1,147
Replacement of circuit breakers lacking breaking capacity	1,663	52	1,715
Replacement of 230 kV circuit breakers	7,406	209	7,615
Adoption of steel towers for river or road crossings	603	393	996
Rerouting of T/L section difficult of restoration work	163	57	220
Provision of defective insulator detectors	85	0	85
Replacement of 115 kV and 69 kV circuit breakers	2,249	95	2,344
Replacement of disconnecting switches	2,346	172	2,518
Provision of spare circuit breakers	601	0	601
Total	15,901	1,340	17,241

9.5.2 Renovation Schedule

Table 9-5-2 shows the renovation schedule of transmission lines and substations.

9.5.3 Annual Disbursement Schedule

Table 9-5-3 shows the annual disbursement schedule for renovation of transmission lines and substations.

Table 9-5-1 RENOVATION COST OF TRANSMISSION LINES AND SUBSTATIONS (1)

Unit : US$ 1,000

Plans		Quantities	Renovation cost			Remarks
			F.C.	L.C.	Total	
Replacement of overhead ground wires		566 km	785	362	1,147	Aluminum-clad steel wire 55mm²
Replacement of circuit breakers lacking breaking capacity	230kV	6 Sets	1,201	34	1,235	GCB, 240kV, 2,000A, 40kA
	115kV	5 Sets	462	18	480	GCB, 120kV, 2,000A, 40kA
	Total	11 Sets	1,663	52	1,715	
Replacement of 230kV circuit breakers		37 Sets	7,406	209	7,615	GCB, 240kV, 2,000A, 40kA
Adoption of steel towers for river or road crossings	Ricer	20 Spans	441	290	731	69kV, 336.4 MCM 1cct 350m
	Road	9 Spans	162	103	265	69kV, 336.4 MCM 1cct 250m
	Total	29 Spans	603	393	996	
Rerouting of T/L section difficult of restoration work		10 km	163	57	220	69kV, Wooden pole 336.4 MCM 1cct
Provision of defective insulator detectors		22 sets	85	0	85	
Replacement of 115kV and 69kV circuit breakers	115kV	13 Sets	1,201	46	1,247	GCB, 120kV, 2,000A, 25kA
	69kV	20 Sets	1,048	49	1,097	GCB, 72kV, 2,000A, 20kA
	Total	33 Sets	2,249	95	2,344	
Replacement of disconnecting switches	230kV	86 Sets	1,656	108	1,764	D.S. 240kV, 2,000A
	115kV	36 Sets	444	33	477	D.S. 120kV, 2,000A
	69kV	40 Sets	246	31	277	D.S. 72kV, 2,000A
	Total	162 Sets	2,346	172	2,518	
Provision of spare circuit breakers		3 Sets	601	0	601	GCB, 240kV, 2,000A, 40kA
Total			15,901	1,340	17,241	

Table 9-5-1 RENOVATION COST OF TRANSMISSION LINES AND SUBSTATIONS (2)

Plans		Quantities	F.C. ¥ million	L.C. P 1,000	Total P 1,000	Remarks
Replacement of overhead ground wires		566 km	101.9	9,621	30,486	Aluminum-clad steel wire 55mm²
Replacement of circuit breakers lacking breaking capacity	230kV	6 Sets	156.0	904	32,825	GCB, 240kV, 2,000A, 40kA
	115kV	5 Sets	60.0	478	12,758	GCB, 120kV, 2,000A, 40kA
	Total	11 Sets	216.0	1,382	45,583	
Replacement of 230kV circuit breakers		37 Sets	961.7	5,555	202,400	GCB, 240kV, 2,000A, 40kA
Adoption of steel towers for river or road crossings	Ricer	20 Spans	57.3	7,708	19,429	69kV, 336.4 MCM 1cct 350m
	Road	9 Spans	21.0	2,738	7,044	69kV, 336.4 MCM 1cct 250m
	Total	29 Spans	78.3	10,446	26,473	
Rerouting of T/L section difficult of restoration work		10 km	21.2	1,515	5,847	69kV, Wooden pole 336.4 MCM 1cct
Provision of defective insulator detectors		22 sets	11.0	0	2,259	
Replacement of 115kV and 69kV circuit breakers	115kV	13 Sets	155.9	1,223	33,144	GCB, 120kV, 2,000A, 25kA
	69kV	20 Sets	136.1	1,302	29,157	GCB, 72kV, 2,000A, 20kA
	Total	33 Sets	292.0	2,525	62,301	
Replacement of disconnecting switches	230kV	86 Sets	215.0	2,871	46,886	D.S. 240kV, 2,000A
	115kV	36 Sets	57.7	877	12,678	D.S. 120kV, 2,000A
	69kV	40 Sets	31.9	824	7,362	D.S. 72kV, 2,000A
	Total	162 Sets	304.6	4,572	66,926	
Provision of spare circuit breakers		3 Sets	78.0	0	15,974	GCB, 240kV, 2,000A, 40kA
Total			2,064.7	35,616	458,249	

Table 9-5-2 RENOVATION SCHEDULE OF TRANSMISSION LINES AND SUBSTATIONS

Plans	First year	Second year	Third year	Fourth year	Fifth year
Replacement of overhead ground wires					
Replacement of circuit breakers lacking breaking capacity					
Replacement of 230kV circuit breakers					
Adoption of steel tower for river or road crossings					
Rerouting of T/L section difficult of restoration work					
Provision of defective insulator detectors					
Replacement of 115kV and 69kV circuit breakers					
Replacement of disconnecting switches					
Provision of spare circuit breakers					

Table 9-5-3 ANNUAL DISBURSEMENT SCHEDULE FOR RENOVATION OF TRANSMISSION LINES AND SUBSTATIONS

Unit : US$ 1,000

Plans		First year	Second year	Third year	Fourth year	Fifth year	Total
Replacement of overhead ground wires	F.C.	283	502				785
	L.C.	130	232				362
Replacement of circuit breakers lacking breaking capacity	F.C.	801	862				1,663
	L.C.	23	29				52
Replacement of 230kV circuit breakers	F.C.	1,601	1,201	2,402	1,401	801	7,406
	L.C.	45	34	68	39	23	209
Adoptiontion of steel towers for river or road crossings	F.C.			441	162		603
	L.C.			290	103		393
Rerouting of T/L section difficult of restoration works	F.C.			163			163
	L.C.			57			57
Provision of defective insulator detectors	F.C.				85		85
	L.C.				0		0
Replacement of 115kV and 69kV circuit breakers	F.C.				1,201	1,048	2,249
	L.C.				46	49	95
Replacement of disconnecting switches	F.C.	462	431	462	591	400	2,346
	L.C.	30	29	30	42	41	172
Provision of spare circuit breakers	F.C.					601	601
	L.C.					0	0
Total	F.C.	3,147	2,996	3,468	3,440	2,850	15,901
	L.C.	228	324	445	230	113	1,340
	Total	3,375	3,320	3,913	3,670	2,963	17,241

CHAPTER 10

ECONOMIC EVALUATION

CHAPTER 10 ECONOMIC EVALUATION

10.1 General

10.1.1 Method of Economic Evaluation

For the economic evaluation, the benefit/cost ratio method and the economic equalizing discount rate method are adopted.

Since Bataan Thermal Power Plant and Mak-Ban and Tiwi Geothermal Power Plants have more than 10 years of remaining life, it is not considered to be appropriate to compare the rehabilitation of these power plants with a new project, in view of the work items and scale of the project. Therefore, it is assumed, as alternative, that the rehabilitation of the objective power plant will not be implemented and the incremental output to be gained by the rehabilitation works would be supplied by the other power plants in the Luzon Grid, and the economic evaluation was made with the total expenses of this incremental power supply plus total cost of the operation of existing power plant, as it is, taken as the benefit. (WITH-WITHOUT Method)

The rate of fifteen percent (15%) given in the guideline of the National Economic Development Authority (NEDA) is adopted for the discount rate reflecting the opportunity cost in the Philippines.

10.2 Evaluation with Individual Power Facilities

10.2.1 Heavy Oil-fired Power Plants

As described in Chapter 6, Manila Power Plant and Bataan Power Plant are the power plants taken up in the present master plan.

1. Alternative Projects

The alternative projects for economic evaluation of the rehabilitation works of these power plants are as follows.

(1) Manila Thermal Power Plant

No. 1 Unit of this power plant will reach 30 years of operation, which is generally taken as the durable life of the thermal power plant, in 1995, and No. 2 Unit in 1996, and therefore, new construction of a heavy oil-fired combined cycle power plant was taken up as the alternative project.

(2) Bataan Thermal Power Plant

At Bataan thermal Power Plant, No. 1 Unit will reach the durable life of 30 years in 2002 and No. 2 Unit in 2007, and they have longer remaining lives than the units at Manila Power Plant. Therefore, the evaluation was made by the "WITH-WITHOUT Method" as described in Subsection 10.1.1.

2. Rehabilitation Cost

The following project costs do not include the interest during construction.

Manila Thermal Power Plant Rehabilitation Cost	:	US$115,500,000
Alternative Combined Cycle Power Plant Construction Cost	:	*US$155,000,000
Bataan Thermal Power Plant Rehabilitation Cost	:	US$ 79,400,000

* The construction cost for this combined cycle power plant has been adjusted in consideration of 15 years of life of Manila Power Plant after rehabilitation and 20 years of life of the new combined cycle power plant.

3. Operation, Maintenance and Administration Costs

The operation, maintenance and administration costs for the existing power plants were estimated based on the 1991 actual records in NAPOCOR, with the escalation taken into account. For the combined cycle power plant, the operation, maintenance and administration costs were estimated at 4% and 0.5% of the construction cost respectively. These costs are given in Table 10-1 (1).

4. Cost of Make-up Power from the Grid

As the cost of the make-up power supplied from the grid in the "WITHOUT" case, the generating cost of the coal-fired thermal power plant which mainly shoulders the reserve power is adopted. The generating cost is given in Table 10-1 (1).

5. Result of Analysis

The following benefit/cost ratios and economic equalizing discount rate, which is equal to Economic Internal Rate of Return (E.I.R.R.), were obtained and the rehabilitation projects are judged to be economically feasible.

	B/C ratio	E.I.R.R.
Manila Thermal Power Plant:	1.063	N.A.
Bataan thermal Power Plant:	1.022	15.63%

10.2.2 Geothermal Power Plants

Tiwi and Mak-Ban Geothermal Power Plants are taken up for the rehabilitation under the present master plan.

1. Alternative Project

As both Tiwi and Mak-Ban Power Plants have been in operation a little over 10 years and are relatively new, it is not considered adequate to adopt the new project for the alternative project as the benefit of the economic evaluation. Therefore, the evaluation was made by the "WITH-WITHOUT Method".

2. Rehabilitation Cost

The net rehabilitation costs for both the power plants are given in the following.

Tiwi Geothermal Power Plant
Rehabilitation Cost : US$49,630,000

Mak-Ban Geothermal Power Plant
Rehabilitation Cost : US$48,108,000

3. Operation, Maintenance and Administration Costs

The operation, maintenance and administration costs were estimated based on the 1991 actual records of Tiwi and Mak-Ban Power Plants, with escalation taken into account. The estimated costs are given in Table 10-1 (2).

4. Cost of Make-up Power from the Grid

The generating cost of the coal-fired thermal power plant which shoulders the reserve power is adopted as the cost of make-up power supplied from the Grid for the "WITHOUT" case. The generating cost is given in Table 10-1 (2).

5. Results of Analysis

The following benefit/cost ratios and E.I.R.R. were obtained and the rehabilitation projects are economically feasible.

	B/C ratio	E.I.R.R.
Tiwi Geothermal P.P. :	1.131	31.46%
Mak-Ban Geothermal P.P.:	1.071	29.23%

10.2.3 Hydro Power Plants

Ambuklao Hydro Power Plant is the only hydro power plant taken up in the present master plan.

1. Alternative Project

The construction of a new geothermal power plant which carries the base load and can be built in a short period (it is assumed that the geothermal wells have been developed.) similar to the hydro power plant is adopted as the alternative project, and the total cost is used as the benefit in the evaluation.

2. Rehabilitation Cost

The following rehabilitation cost and the construction cost are given in net costs.

Ambuklao Hydro Power Plant
Rehabilitation Cost (including Maget P.P.) : US$19,554,000

Alternative Geothermal
Power Plant Construction Cost : US$85,000,000

3. Operation, Maintenance and Administration Costs

The operation, maintenance and administration costs were estimated based on the 1991 actual records of Ambuklao Power Plant, with the escalation taken into account.
The estimated costs are given in Table 10-1 (3).

For the alternative geothermal power plant, the operation, maintenance and administration costs were estimated at 2% and 0.5% of the construction cost respectively.

4. Reserve for Supplementary Well Drilling (depletion cost) for Alternative Geothermal Power Plant

The depletion cost was estimated based on the actual records at the existing geothermal power plants in Luzon Island. The estimated depletion cost is given in Table 10-1 (3).

5. Result of Analysis

The following benefit/cost ratios and E.I.R.R. were obtained and this rehabilitation project is judged to be a very profitable project.

	B/C ratio	E.I.R.R.
Ambuklao Hydro Power Plant:	1.861	N.A.

10.2.4 Transmission Lines and Substations

The economic evaluation of the renovation project of the power system was not made for the following reasons.

(1) The transmission lines and substations are not the facilities for power generation, but are for transportation and distribution of the electric power. And they are indispensable for the stable supply of high quality electric power.

There is no other means to serve this purpose, and it is the duty of the electric power company to maintain the reliability of the transmission lines and substation facilities.

(2) The transmission lines and substation facilities taken up in the present study include some aged and deteriorated equipment, but as a whole they are to be used long into the future and there is no immediate need for a total replacement of the transmission lines and substation facilities.

Table 10-1 (1) Economic and Financial Evaluation Data Table

Thermal Power Plant

Item		Manila Thermal Power Plant Units 1&2		Bataan Thermal Power Plant Units 1&2			Remarks
			Alternative		Without Rehab.		
		Rehabilitation	Combined Cycle	Rehabilitation	Existing Conditions	Power supplied from Grid	
Rated Capacity	[MW]	200	189	225	225		1US$ = ¥130 1US$ = P 27 (1US$ = P 30
Plant Factor	[%]	70	70	70	65		in 1995 & 1996)
Annual Generation	[GWh]	1,226.4	1,159.3	1,379.7	1,281.1		
Station Use Power Ratio	[%]	6.7	1.3	6.0	6.0		
Transmission and Substations Loss	[%]	0.5	0.5	0.5	0.5		
Annual Salable Energy	[GWh]	-	-	-	-		
Power Rate	[P/kWh]	2.040	2.040	2.120	2.120		
Construction Cost	[1000 US$]	115,500	155,000	79,400	-		
Operation & Maintenance Cost	[P/kWh]	0.0516	4 % of construction cost	0.0475	0.0475		
Fuel		Bunker C	Bunker C	Bunker C	Bunker C		
Calorific Value	[MBTU/bbl]	6.23	6.23	6.23	6.23		Generating cost
Heat Rate	[BTU/kWh]	9,322.8	7,844.0	9,348.3	9,509.3	2.11 [P/kWh]	of coal-fired
(Thermal Efficiency)	[%]	(36.6)	(43.5)	(36.5)	(33.8)		thermal p.p. in
Unit Fuel Cost	International	16.39	16.39	17.05	17.05		Luzon Grid
[US$/bbl]	Domestic	22.50	22.50	23.40	23.40		
Administration Cost	[P/kWh]	0.075	0.5 % of construction cost	0.078	0.078		

Table 10-1 (2) Economic and Financial Evaluation Data Table

Geothermal Power Plant

Item		Mak-Ban Geothermal Power Plant Units 1 - 6		Tiwi Geothermal Power Plant Units 1 - 6		Power supplied from Grid	Remarks
		After Rehabilitation	Without Rehab. Existing Conditions	After Rehabilitation	Without Rehab. Existing Conditions		
Rated Capacity	[MW]	330 (55MW x 6units)	330 (55MW x 6units)	330 (55MW x 6units)	330 (55MW x 6units)		1US$ = ¥130 1US$ = P 27 (1US$ = P 30 in 1995 & 1996)
Plant Factor	[%]	91.7	79.2	87	63.2		
Annual Generation	[GWh]	2,650.0	2,288.6	2,390.3	1,827.2		
Station Use Power Ratio	[%]	5.6	5.6	6.2	6.2		
Transmission and Substations Loss	[%]	0.5	0.5	0.5	0.5		
Average Load	[MW]	52.25	50	50	43.6		
Annual Salable Energy	[GWh]	-	-	-	-		
Power Rate	[P/kWh]	2.040	2.040	2.120	2.120		
Rehabilitation Cost	[1000 US$]	48,108	-	49,630	-		
Operation & Maintenance Cost	[P/kWh]	0.1055	0.1055	0.1097	0.1097		
Steam Cost	[P/kWh]	0.505	0.505	0.525	0.525		
Reserve for Supplementary Well Drilling	[MP/Year]	262	262	313	313	2.11 [P/kWh]	Generating cost of coal-fired thermal P.P. in Luzon Grid
Transmission & Substation Facilities Overhead	[P/kWh]	0.0399	0.0399	0.0399	0.0399		
Administration Cost	[P/kWh]	0.1397	0.1397	0.1397	0.1397		

Table 10-1 (3) Economic and Financial Evaluation Data Table

Hydro Power Plant

Item		Ambuklao Hydro Power Plant Units 1,2 & 3 After Rehabilitation	Alternative Project (Geothermal Power Plant) Item		New Construction	Remarks
Rated Capacity	[MW]	75	Rated Capacity	[MW]	55	1US$ = ¥130 1US$ = P 27 (1US$ = P 30 in 1995 & 1996)
Plant Factor	[%]	-	Plant Factor	[%]	-	
Annual Generation	[GWh]	-	Annual Generation	[GWh]	-	
Station Use Power Ratio	[%]	0.5	Station Use Power Ratio	[%]	5.5	
Transmission and Substations Loss	[%]	1.7	Transmission and Substations Loss	[%]	0.5	
Annual Salable Energy	[GWh]	-	Annual Salable Energy	[GWh]	-	
Power Rate	[P/kWh]	2.205	Power Rate	[P/kWh]	2.205	
Rehabilitation Cost	[1000 US$]	19,554	Construction Cost	[1000 US$]	85,000	
			Operation & Maintenance Cost	[%]	2 % of construction cost	
Operation & Maintenance Cost	[P/kWh]	0.762	Steam Cost	[P/kWh]	0.546	
Administration Cost	[P/kWh]		Reserve for Supplementary Well Drilling	[MP/Year]	37.3	
			Transmission & Substation Facilities Overhead	[P/kWh]	0.1510	
			Administration Cost	[%]	0.5 % of construction cost	

CHAPTER 11

FINANCIAL EVALUATION

CHAPTER 11 FINANCIAL EVALUATION

11.1 Method of Financial Evaluation

The financial evaluation of each rehabilitation project is made by calculating the equalizing discount rate which makes the total rehabilitation cost converted to the present value equal to the present value of the increased revenue by increased generation after the rehabilitation, and by comparing it with the social discount rate (15%) reflecting the opportunity cost in the Philippines, the financial soundness of the project is examined.

11.2 Conditions for Financial Evaluation

(1) Price Escalation

The electric power rate which will make the basis of the operation and maintenance costs and the revenue from energy sales will be escalated year by year, but since the price escalation would effect both the revenue and the expenses equally, the price escalation after the completion of the rehabilitation is not taken into consideration.

(2) Costs

a. Rehabilitation cost and disbursement schedule

The rehabilitation costs and the disbursement schedule entered in Chapter 9 and chapter 10 are used.

b. Operation and maintenance cost and administration cost

The operation and maintenance cost and the administration cost are as given in Tables 10-1 (1) - 10-1 (3) in Chapter 10.

(3) Other Data Necessary for Financial Evaluation

Other data necessary for the financial evaluation are all given in Tables 10-1 (1) - 10-1 (3) in Chapter 10.

11.3 Results of Financial Evaluation

(1) The results of financial evaluation of individual rehabilitation projects are given in the following table.

Table 11-1 Results of Financial Evaluation

Project	Financial Internal Rate of Return (F.I.R.R.)(%)
1) Manila Thermal Power Plant Rehabilitation Project	23.77
2) Bataan Thermal Power Plant Rehabilitation Project	13.40
3) Tiwi Geothermal Power Plant Rehabilitation Project	43.88
4) Mak-Ban Geothermal Power Plant Rehabilitation Project	24.94
5) Ambuklao Hydro Power Plant Rehabilitation Project	44.46
6) Transmission Lines and Substation Facilities Renovation Project	27.04

(2) Conclusion

As seen in Table 11-1, the financial internal rates of return of the planned rehabilitation projects, excepting that for Bataan Thermal Power Plant, proved to be higher than the social discount rate (15%) in the Philippines and the rehabilitation projects are proved to be financially sound.

With Bataan Thermal Power Plant, the F.I.R.R. is 13.40% which means that the rehabilitation of this power plant is sufficiently feasible financially, if the fund can be borrowed at an interest rate lower than 13.40%.