THE REPUBLIC OF THE PHILIPPINES

MASTER PLAN STUDY ON REHABILITATION/RENOVATION AND OPERATION/MAINTENANCE IMPROVEMENT OF POWER FACILITIES IN LUZON GRID

FINAL REPORT

MAY, 1992

JAPAN INTERNATIONAL COOPERATION AGENCY

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PREFACE

In response to the request from the Government of the Republic of the Philippines, the Government of Japan decided to conduct a Master Plan Study on Rehabilitation/Renovation and Operation/Maintenance Improvement of Power Facilities in Luzon Grid and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to the Philippines a study team headed by Mr. Teruaki Ogawa of West Japan Engineering Consultants, Inc. three times during the period from July 1991 to April 1992.

The team held discussions on the project with officials concerned of the Government of the Republic of the Philippines, and conducted field surveys in the study area. After the team returned to Japan, further studies were made and the present report was prepared.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our countries.

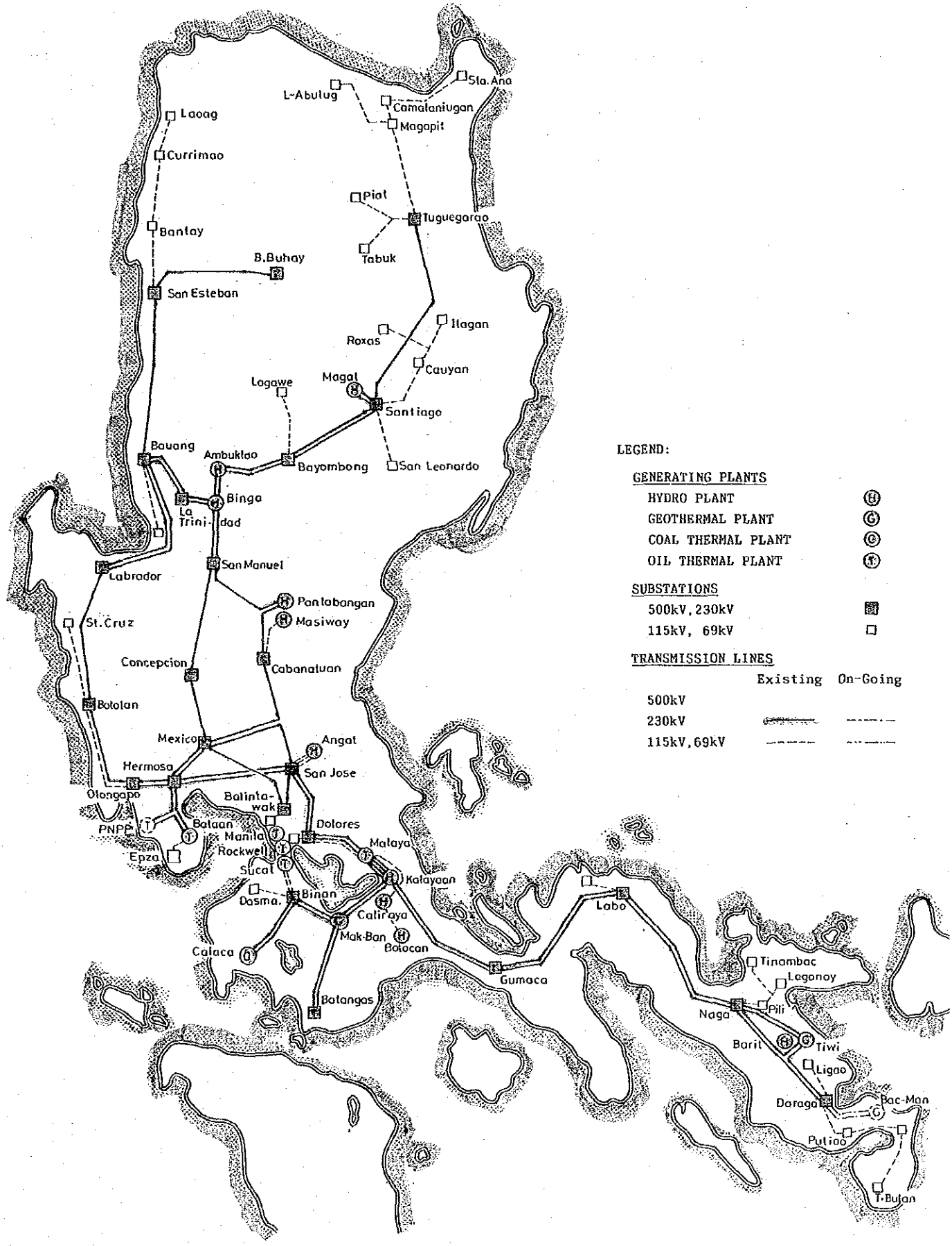
I wish to express my sincere appreciation to the officials concerned of the Government of the Republic of the Philippines for their close cooperation extended to the team.

May 1992

Kensuke Yanagiya

Kensuke Yanagiya
President
Japan International Cooperation Agency

LUZON GRID POWER SYSTEM DIAGRAM



LEGEND:

GENERATING PLANTS

HYDRO PLANT	Ⓗ
GEOTHERMAL PLANT	Ⓖ
COAL THERMAL PLANT	Ⓒ
OIL THERMAL PLANT	Ⓣ

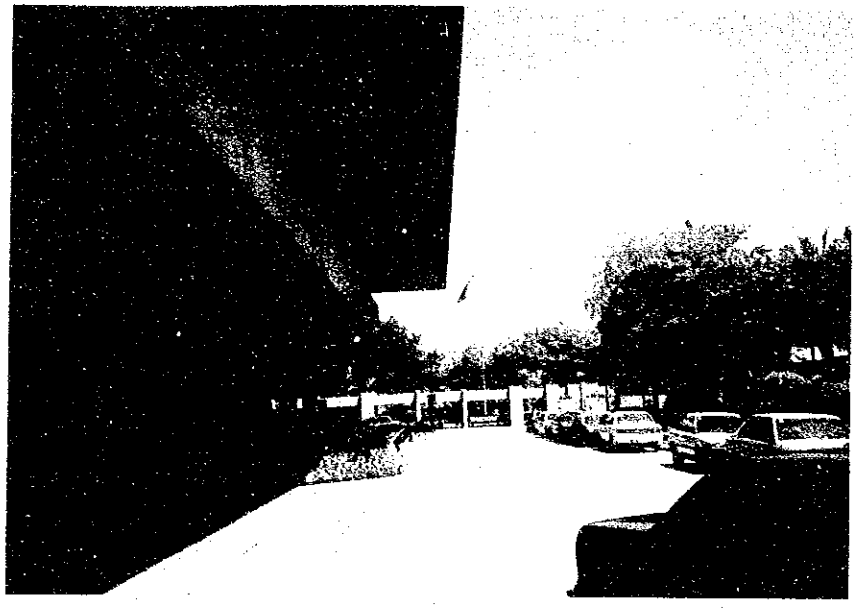
SUBSTATIONS

500kV, 230kV	▩
115kV, 69kV	□

TRANSMISSION LINES

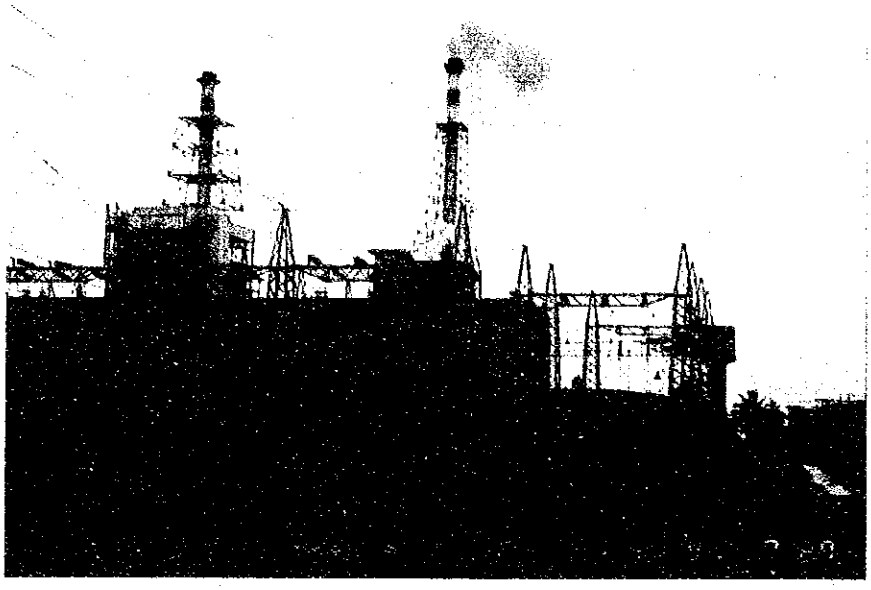
	Existing	On-Going
500kV		
230kV	———	- - - -
115kV, 69kV	– – – –	– · – · –

PHOTOGRAPHS

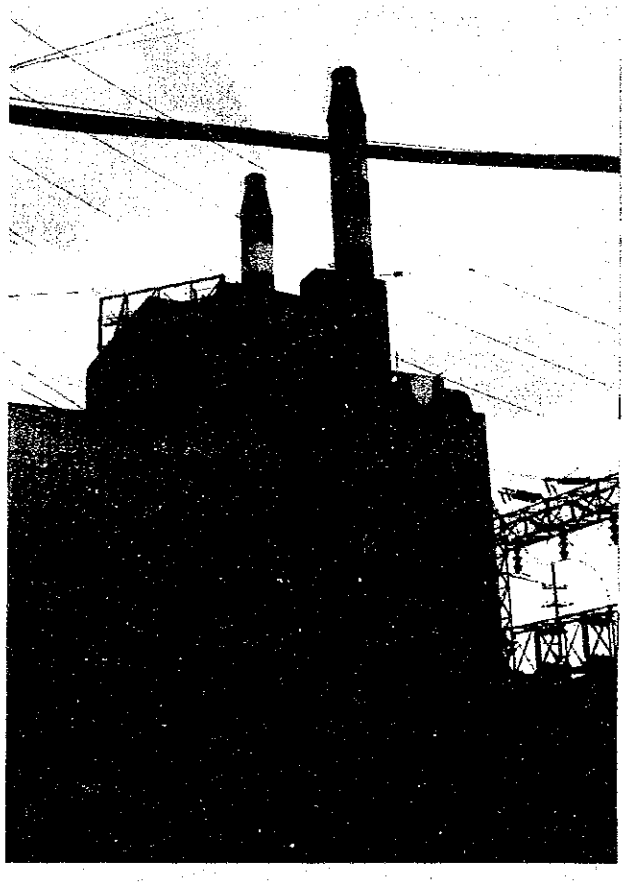


NAPOCOR Head Office

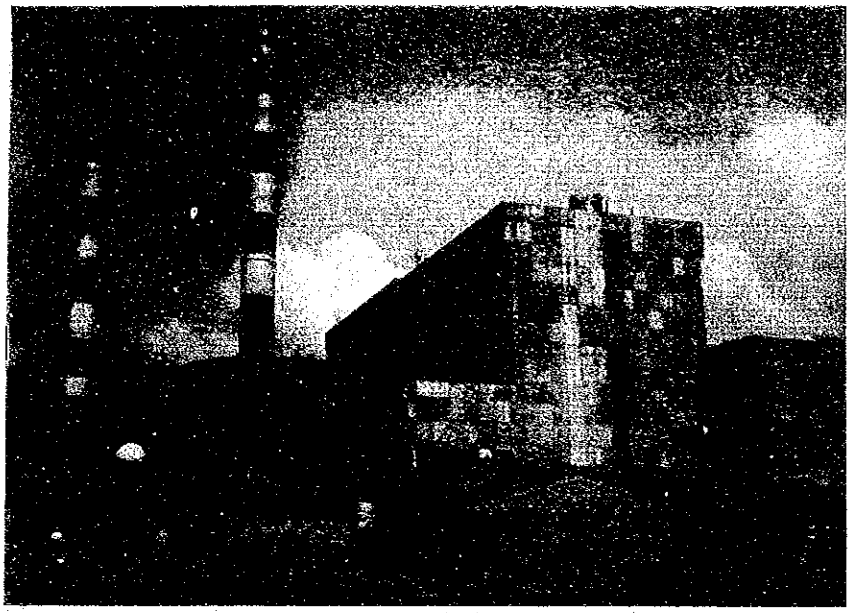
Southern Luzon Regional Center



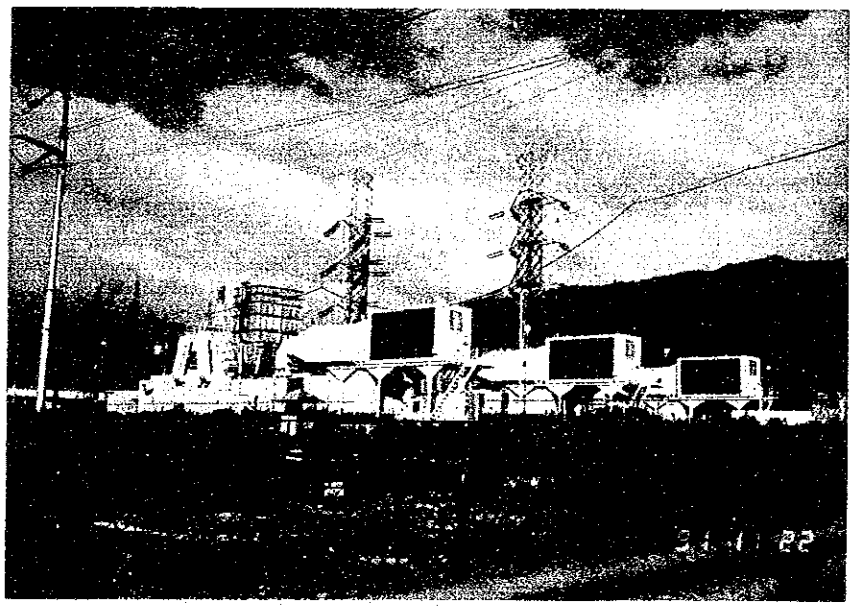
Bataan Thermal Power Plant



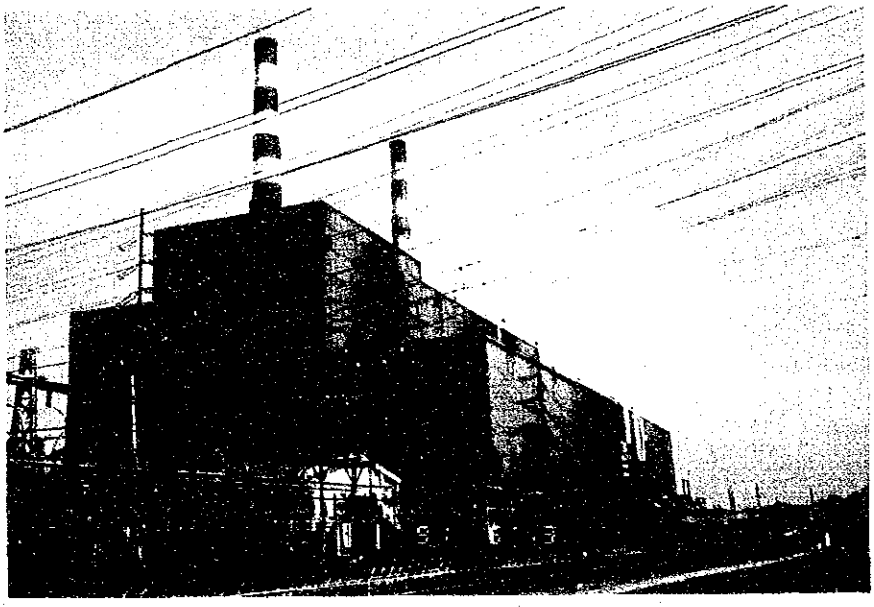
Manila Thermal Power Plant



Malaya Thermal Power Plant

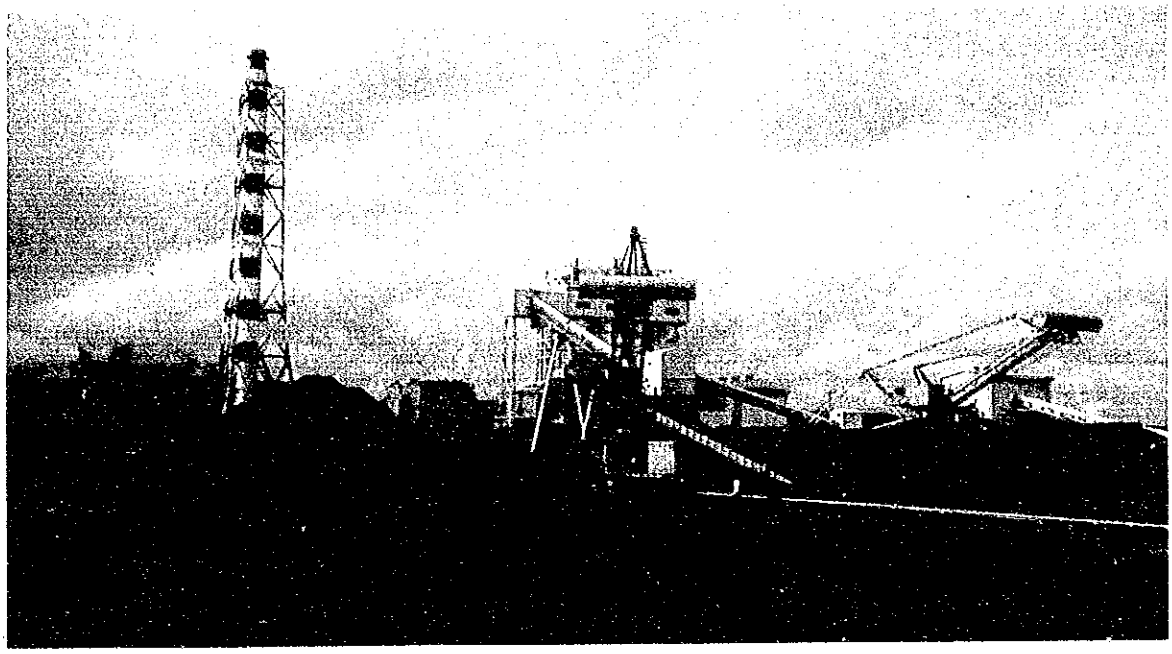


Malaya Gasturbine Power Plant



Sucat Thermal Power Plant

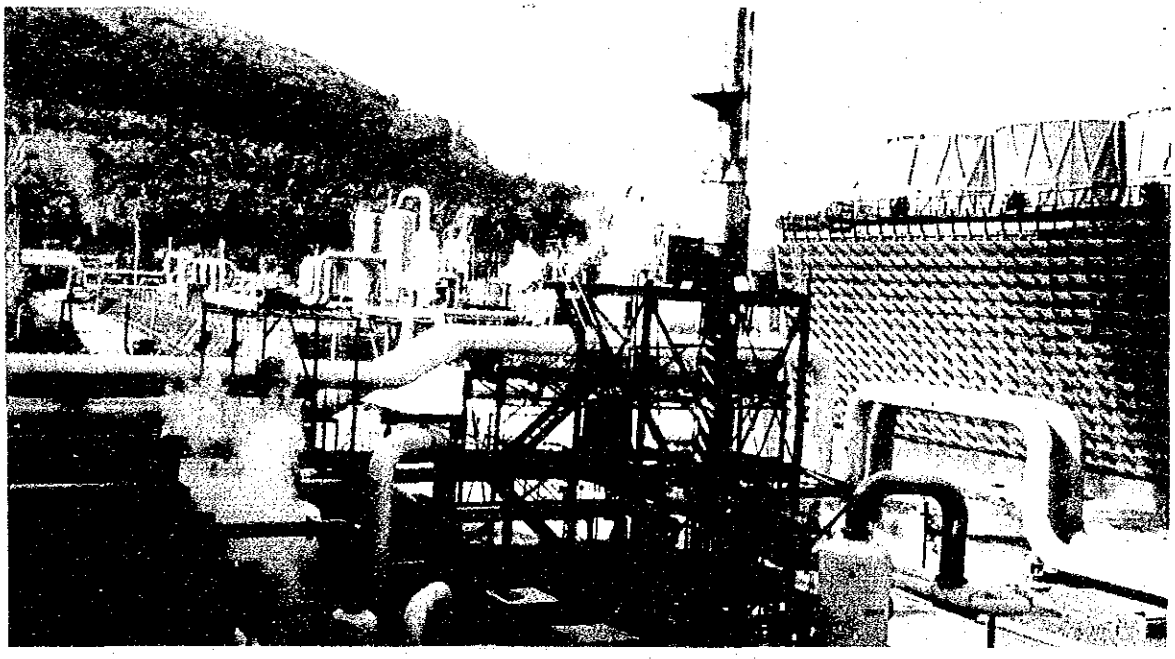
Maintenance Engineering Center



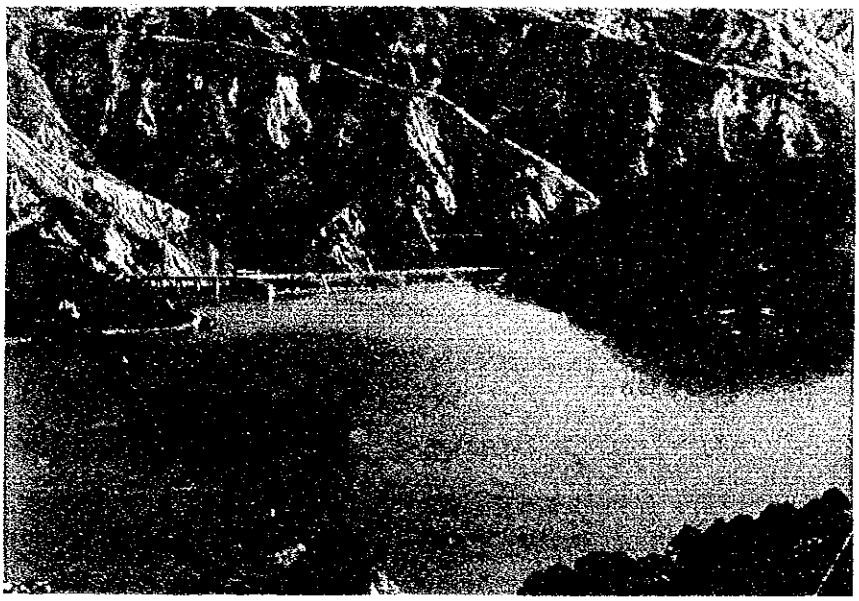
Batangas Coal-fired Thermal Power Plant

Batangas Coal-fired Thermal Power Plant

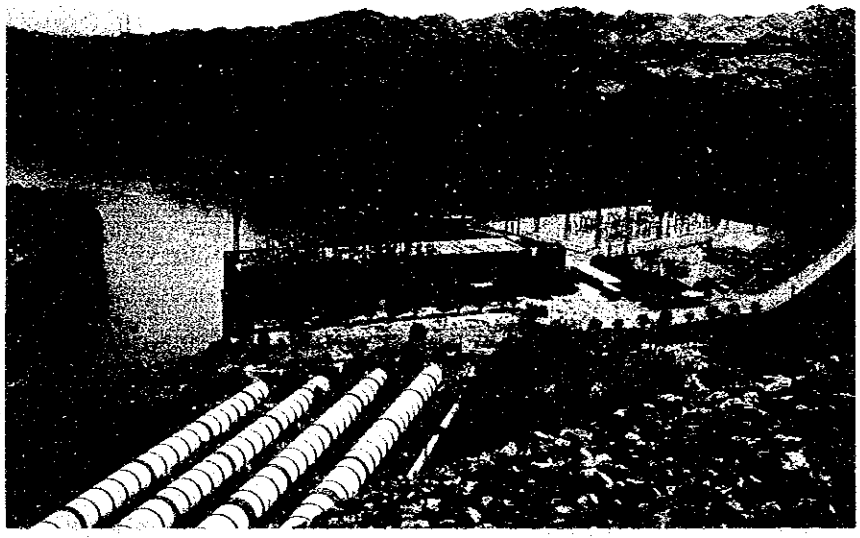
Tiwi Geothermal Power Plant



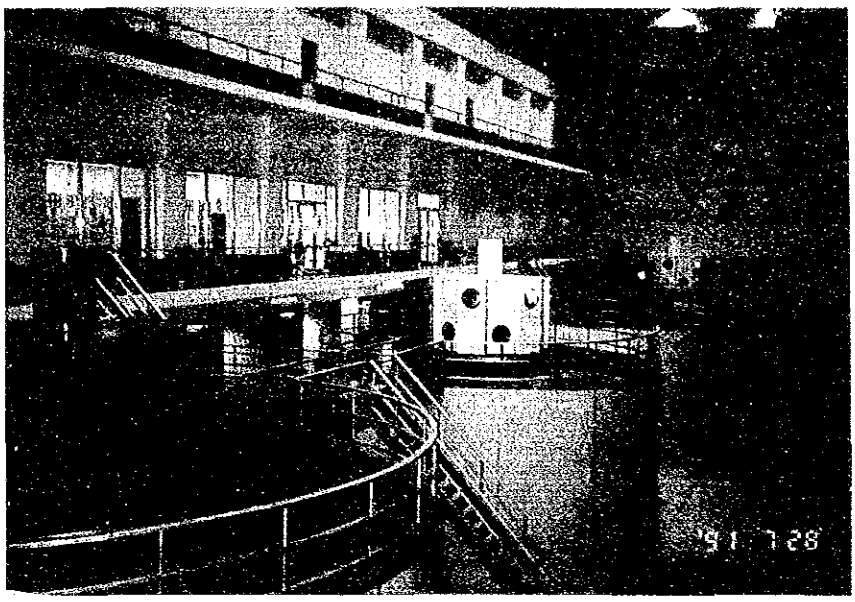
Mak-Ban Geothermal Power Plant



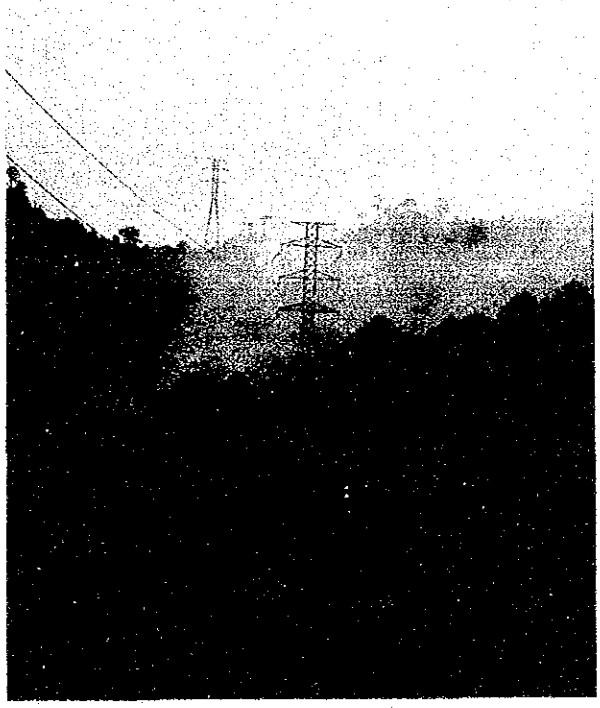
Binga Dam



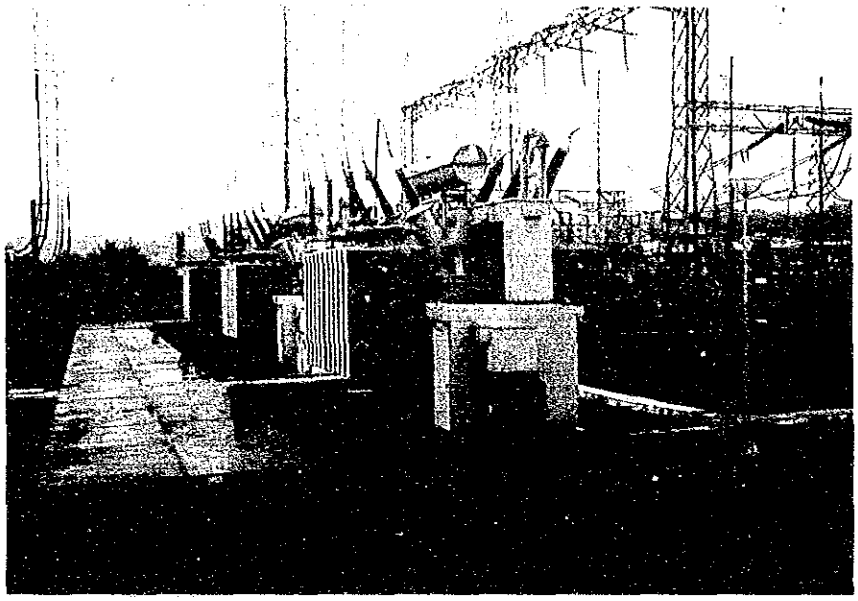
Magat Hydro Power Plant



Angat HEP Generators



230kV Binga - La Trinidad T/L



Dolores Substation

La Trinidad Substation

Seminar at the Head Office

Seminar at the Head Office

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CHAPTER 1

INTRODUCTION

CHAPTER 1 INTRODUCTION

1.1 Background and Progress of Study

The total installed capacity of the power generating facilities in the Luzon grid was 4,321 MW in 1990, which accounted for 71.6% of 6,037 MW of installed capacity in the whole Philippines. The peak demand in the Luzon grid was 2,973 MW and it appears from the above figures, that there is sufficient supply capability. However, supply interruptions and/or load sheddings have been frequently experienced in Luzon Grid, because of faults due to deterioration of facilities and degraded performances of power generation, transmission, and substation due to insufficient repair and maintenance, aggravated by the natural disasters. Therefore, steady electric power supply is given a high priority in the national policy. With the above background, the National Power Corporation (hereinafter referred to as "NAPOCOR") requested the study on the rehabilitation of power generating facilities, improvement of operation/maintenance of the power facilities, and renovation of transmission lines and substations.

In response to the request, Japan International Cooperation Agency (hereinafter referred to as "JICA") dispatched a preliminary study team in March 1991 and agreed upon and signed the "IMPLEMENTING ARRANGEMENT" for the Study with NAPOCOR.

JICA dispatched the survey team two times to Manila and other areas in the Republic of the Philippines, and carried out the field survey of thermal, geothermal and hydro power plants and transmission lines and substation facilities, held discussions with NAPOCOR, and collected necessary data and information.

This Final Report is the compilation of the results of analyses and studies made by the study team based on not only the materials collected by the surveys but discussion with NAPOCOR and in line with the purpose of this study after performing the presentation of the Draft Final Report to NAPOCOR.

In the meantime, the study team prepared the Interim Report compiling the results of the first stage field survey, and submitted it to NAPOCOR

during the period of the second stage field survey in November 1991.

1.2 Objectives of the Study

The objectives of this study are to formulate and compile in the report (1) 5-year rehabilitation plan for the power plant facilities, and 5-year renovation plan for transmission lines and substations, (2) operation and maintenance improvement plan for power facilities and (3) environmental countermeasures related to the operation of power facilities.

Technology transfer was made to NAPOCOR engineers during the study period.

1.3 Objective Areas and Power Facilities for the Study

Thermal, geothermal and hydro power plants and transmission lines and substations connected to the Luzon Grid in the Philippines.

1.4 Contents and Procedures of the Study

JICA dispatched to the Philippines the experts suited for the study to formulate the 5-year master plan of Rehabilitation/Renovation and operation and maintenance improvement plan of power facilities, and carried out the field survey of thermal, geothermal and hydro power plants, and transmission lines and substations. They collected necessary data and informations and held consultations with the NAPOCOR Task Force members.

The study was carried out in two years, from 1991 through 1992. The field survey was carried out in two times, 1st Stage and 2nd Stage, in 1991, and the studies in Table 1-1 were carried out in the process shown in the flow chart in Fig. 1-1. The schedule of the study is as shown in Table 1-2. On the occasion of the 2nd Stage during the field survey and reporting on the Draft Final Report, JICA held seminars for which JICA Headquarters dispatched additional experts.

The seminars were attended by many engineers of NAPOCOR Task Force and others, and discussions were made on the problems of the facilities and

the operation and maintenance based on the Interim Report, when the practices in the Japanese power companies were also explained. In the second seminar, explanation was made on the Implementation Program in Chapter 9.

(1) First Stage Survey

The first stage field survey was carried out in the period from July 16 to August 14, 1991. First the Inception Report prepared by the study team was discussed with the representatives of NAPOCOR and the Task Force of NAPOCOR as the counterpart to the study team was formed. The Task Force was composed of 7 groups, namely the groups for the thermal, geothermal, environmental, hydro, transmission and substations, load dispatching/communication/ efficiency/reliability, and economics. With the cooperation of the Task Force members, the study team carried out the overall study of the power facilities and their problems.

It is noted that the activities of the hydro and transmission/substation groups were restricted by the extremely bad road conditions due to the eruption of Volcano Pinatubo and continuous rain.

(2) Second Stage Survey

The second stage survey was carried out in the period from November 5 to December 4, 1991. During this period, the study team prepared the draft of the 5-year rehabilitation/renovation plan (master plan) and made the survey of problems in operation and maintenance management and study of the improvement plan in cooperation with NAPOCOR. A special aspect of this stage was to perform the seminar.

The presentation of the Draft Final Report to NAPOCOR was carried out during the third visit from April 21 to May 5, 1992.

As for the improvement of operation/maintenance, the Quality Assurance Department (QA) of NAPOCOR had pointed out the problems in the annual audit report of 1990, and added that the same

problems were repeated without improvement. As the improvement of operation/maintenance involves complicated problems difficult to solve, necessary follow-up should be continued further into future.

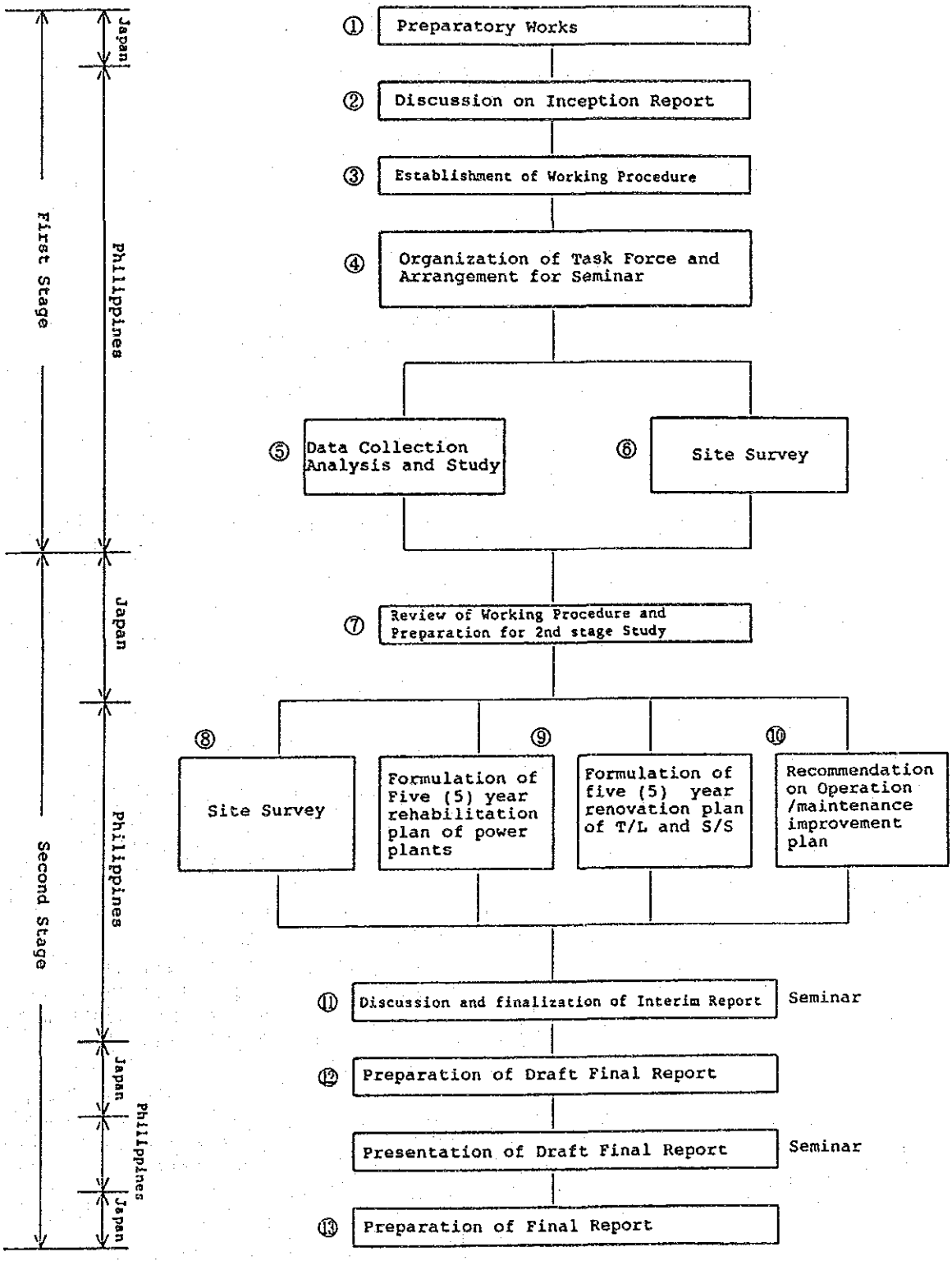
With the full cooperation of the Head Office, regional centers and power plants through the first and the second field survey periods, the study team was able to carry out studies and the collection of data and information.

Table 1-1 Contents of Study

Requirement	Service Items	1st Stage	2nd Stage
1. Preparatory Works	1) Preparation of Inception Report	o	-
	2) Consultation on IC/R and eatablishment of working procedure including organization of NAPOCOR Task Force and arrangement for seminar	o	-
	3) Review, consultation and finalization of working procedures	-	o
	4) Submittal of implementation plan of seminars	-	o
2. Formulation of 5-year Power Facilities Rehabilization/Renovation Plan (Master Plan)	1) Collection of data and information	o	o
	2) Analysis and study of collected data and information, and determination of power facilities rehabilitation/renovation work items	o	o
	3) Field survey of power facilities and collection and reconfirmation of data and information	o	o
	4) Study of causes of aged deterioration/defects and recommendation on rehabilitation/renovation measures	o	o
	5) Establishment of criteria for prioritization of rehabilitation/renovation work items	o	o
	6) Formulation of rehabilitation/renovation project schedule	o	o
	7) Study and recommendation on spare parts control	o	o
	8) Construction cost and disbursement plan	-	o
	9) Economic and financial evaluation	-	o

Requirement	Service Items	1st Stage	2nd Stage
3. Proposal of Operation and Maintenance Improvement Plan	1) Collection of data and information	o	o
	2) Analysis and study of collected data and information, identification of problems, and proposal of improvement plan	o	o
	3) Study of effective coordination of operation and maintenance systems on the power plant and area levels	o	o
	4) Proposal of administrative and technical procedures of operation and maintenance	o	o
	5) Standardization of maintenance manuals	-	o
	6) Establishment of information feedback system	-	o
	7) Standardization of test instruments, repair tools and facilities	-	o
4. Proposal of Environmental Countermeasures	1) Collection of data and information, and environmental laws and regulations in the Philippines	o	o
	2) Method of handling of equipment using PCB Proposal on control of equipment using PCB	o Field Survey	o
	3) Proposal on environmental monitoring system and cost estimate	o	o
5. Seminars	1) Thermal/geothermal/environmental groups	-	o
	2) Hydro/transmission and substation groups	-	o

Fig. 1-1 Flow Chart of the Study



1.5 Members of Study Team and Their Assignment

Name	Assignment	Service Items
Teruaki Ogawa	Team Leader	. Overall supervision
		. Coordination on the Study
Yoshiyuki Niihara	Hydro power plant facilities (civil)	. Survey and analysis of the present conditions of civil structures of hydro power plants.
		. Formulation of 5-year rehabilitation plan of civil structures of hydro power plants.
Toshinori Ishii	Hydro power plant facilities (Electrical)	. Survey and analysis of the present conditions and investigation of causes of decline of functions of electrical equipment of hydro power plants.
		. Formulation of 5-year rehabilitation plan of electrical equipment of hydro power plants.
Yukio Shimoda	Thermal power plant facilities	. Survey and analysis of the present conditions and investigation of causes of decline of functions of thermal power plant facilities.
		. Formulation of 5-year rehabilitation plan of thermal power plant facilities.
Kowashi Aosaki*	Geothermal power plant facilities	. Survey and analysis of the present conditions and investigation of causes of decline of functions of geothermal power plant facilities.
		. Formulation of 5-year rehabilitation plan of geothermal power plant facilities.

Name	Assignment	Service Items
Fuminori Sato	Transmission lines	. Survey and analysis of the present conditions of investigation of causes of decline of functions of transmission line facilities. . Formulation 5-year renovation plan of T/L facilities.
Hideo Yabusa	Substations	. Survey and analysis of the present conditions and investigation of causes of decline of functions of substations. . Formulation 5-year renovation plan of substations.
Toshikazu Simojo	Operation/Maintenance of hydro power plant, T/L and S/S.	. Survey and analysis of the present situation of operation/maintenance of hydro power plants, T/L and S/S. . Investigation and analysis of causes of defects in the operation/maintenance systems. . Formulation of the operation/maintenance management improvement plan.
Kazutoshi Ariyoshi	Operation/Maintenance of thermal power plant.	. Survey and analysis of the present situation of operation/maintenance of thermal power plants. . Investigation and analysis of causes of defects in the operation/maintenance systems. . Formulation of the operation/maintenance management improvement plan.

Name	Assignment	Service Items
Tadanori Aoki	Environment	. Survey and analysis of the environmental problems. . Recommendation on the environmental counter-measures.
Ginjiro Matsuo	Geothermal Power Plant Facilities, Economist	. Survey and analysis of the present conditions and investigation of causes of decline of functions of geothermal power plant facilities Economic survey and evaluation

* Joined in 1st Stage Field Survey only.

1.6 Survey Schedule

The period of field survey of each member of the study team was as tabulated in the following.

Name	1st Stage		2nd Stage	
	Departed from Japan	Returned to Japan	Departed from Japan	Returned to Japan
* Teruaki Ogawa	Jul. 16, 1991	Aug. 14, 1991	Nov. 5, 1991	Dec. 4, 1991
* Yoshiyuki Niihara	"	"	"	"
Toshinori Ishii	"	"	"	"
Yukio Shimoda	"	"	"	"
Kowashi Aosaki	"	Aug. 5, 1991	-	-
* Ginjiro Matsuo	"	Aug. 14, 1991	Nov. 5, 1991	Dec. 4, 1991
* Fuminori Sato	"	"	"	"
* Hideo Yabusa	"	"	"	"
* Toshikazu Shimojo	"	"	"	"
Kazutoshi Ariyoshi	"	"	"	"
* Tadanori Aoki	"	Aug. 5, 1991	"	Nov. 19, 1991

*-marked members visited the Philippines for explanation of the Draft Final Report in the 2nd Stage. Period: Departed from Japan on April 21, 1992 and returned to Japan on May 5, 1992.

1.7 Study Schedule

The Master Plan Study Schedule is on following Table 1-2.

Table 1-2 Study Schedule

Master Plan Study Schedule
Rehabilitation/Renovation and Operation/Maintenance Improvement
of Power Facilities in Luzon Grid.

Study Item \ Year & Month	1991 F.Y. 7	8	9	10	11	12	1	2	3	1992 F.Y. 4	5	6
1st Stage												
(1) Field survey, Data collection	7/16	8/14										
2st Stage												
(1) Study on Data, Preparation of Plans												
(2) Field Survey, Add'nl Data Collection					11/5	12/4						
(3)Reports	Inception Report				Interim Report 11/5	12/4				Final Report (Draft) 4/21	Final Report 5/5	
(1)Preparatory Work												
(2) Mobilization	11	2 9			9 (+1)	1 8 (+1)				6 (+1)	6 (+1)	▽ Fukuoka→Manila ▼ Manila→Fukuoka
(3) Courtesy Call to Authorities												
(4) Discussion on Inception Report												
(5) Field Survey, Discussion, Reporting												
(1) Preparation of Inception Report												
(2) Site Discussions, Survey, Data Collection (Discussion on basic concept of Seminar, Task Force)												
(3) Data Analysis and Study of Plans												
(4) Study of the priority of Plans												
(5) Study of Sched. and C/E of Plans												
(6) Economic Study												
(7) Field Survey & Data Collection												
(8) Study of Environm'tl Countermeasure												
(9) Study of technical problems of T/L												
(10) Study & Implementation of Seminar												

Legend : —— Preparatory Work ▬▬ Site Work ▭ Domestic Work △—△ Reporting ----- Others

1.8 Field Survey

. During the survey period the study team visited the Head Office, regional centers and power plants of NAPOCOR. At the commencement of the 1st Stage Survey, the team visited NEDA.

In these visits the study team saw the people listed in the following.

. The members of the NAPOCOR Task Force are as tabulated in Table 1-3.

. The people marked with an asterisk (*) are the coordinators in the 1st Stage Survey.

(1) NEDA (National Economic and Development Authority)

Mr. RUBEN REINOSO	- Asst. Director III
Mr. JOSE MONTERO	- Development Specialist, Chief, EDS
Mr. AUGUST PAGKALINAWAN	- Supervising Specialist
Mr. MARILES NAVARO	- Supervising Specialist

(2) NAPOCOR

Head Office

Mr. PABLO V. MALIXI	- President & CEO
Mr. MAMERTO S. BOCANEGRA	- Senior Vice President, Office of the Chairman
Mr. FRANCISCO T. DELGADO	- Senior Vice President, Engineering and Nuclear
Mr. JOSUE D. POLINTAN	- Senior Vice President
Mr. JOSE T. RAMAS	- Senior Vice President, Utility Operations
Mr. ARMANDO C. PLATA	- Former Senior Vice President, Operations
Mr. DEOGRACIAS S. PERALTA	- Vice President, Planning Services
Ms. PERLA A. SEGOVIA	- Vice President, Administration

	Mr. MACALINTAL	- Vice President, Human-Resources
*	Mr. HECTOR N. CAMPOS	- Vice President. Engineering & Nuclear
*	Mr. R. V. AREL	- Former Vice President, Operations
	Mr. HERRERA	- Vice President, Finance
	Mr. LEONARDO F. OSILLA	- Dept. Manager, Efficiency & Reliability Dept. [Overall Coordinator for Task Force]
	Mr. BESANA EDGAR A.	- Officer-in Charge, Quality Assurance
	Ms. Ma. RESURRECCION L. PETEL	- Officer-in-Charge Environmental Management Department
	Mr. FELINO BALCE	- Manager, Tech. Div. of Human-Resources
	Mr. J. C. GUADARRAMA	- Manager, Material Management Dept.
	Mr. CARLOS S. AQUINO	- Manager, Project Management for Spare Parts
	Mr. ORLANDO M. CRUZ	- Former Dept. Manager, Quality Assurance

MEC (Maintenance Engineering Center)

Mr. ANGELITO V. RAFLORES	- Manager, Head of MEC
Mr. LIGAYO EDUARDO D.	- Manager, Engineering Services
Mr. ARANZAMENDEZ ERNESTO R.	- Manager, Workshop Division
Mr. CHAMBERLAIN F. NAGMA	- Superintendent

Thermal Power Plants

- MMRC (Metro Manila Regional Center)

Mr. JAIME G. VILLANUEVA	- Vice President, Head of MMRC
Mr. SAMUEL A. PIEDAD	- Former Asst. to the V.P.
Mr. VIENCIO P. ESTACIO	- Former Manager, CM/TS Dept./Resident Manager
Mr. A. O. NERONA	- Manager, Operating Project Services
Mr. ANTONIO C. LAYSON	- Engineering Specialist

- Manila Power Plant

  a. Mr. ORLANDO P. MENDOZA - Plant Manager
  b. Mr. VICENTE V. DE GUZMAN - Acting Operations Manager

- Bataan Power Plant

  a. Mr. CRISANTO C. CANDELARIA - Plant Manager
  b. Mr. RICARDO A. ABAT, JR. - Former Manager, MMP (Managed Maintenance Program)/Acting Operations Manager

- Malaya Power Plant

  a. Mr. LOPE S. ACAPULCO - Plant Manager
  b. Mr. MARIO I. TAYLO - Acting Maintenance Manager
  c. Mr. JAIME T. ABELA - Acting Operations Manager

- Sucat Power Plant

  a. Mr. NESTOR M. PEDRON - Plant Manager
  b. Mr. ELIGIO G. FLORES - Acting Maintenance Manager
  c. Mr. SERBIO R. ABERIN - Acting Operations Manager

- Batangas (Calaca) Power Plant

  a. Mr. AMADO C. VICENCIO - Plant Manager
  b. Mr. ALVIN C. KINTANAR - Acting Operations Manager
  c. Mr. HENRY V. ALCALDE - Acting Maintenance Manager

<u>Geothermal Power Plants</u>

- Mak-Ban Power Plant

  Mr. VIRGILIO C. NAVARRO - Plant Manager
  Mr. MELCHOR A. BALLESTERO - Operations Manager

- Tiwi Power Plant

Mr. REYNALDO J. SANTIAGO	- Operations Manager
Mr. G. T. SILVA	- Maintenance Manager

Hydro Power Plants and Substations

- Head Office

a. Mr. REYNALDO I. EVANGELISTA	- Manager, Hydro Engineering Design Division

- NLRC (Northern Luzon Regional Center)

a. Mr. CORDELL U. DEL ROSARIO	- Vice President, NLRC
b. Mr. BENJAMIN L. CHAVEZ	- Asst. to the Vice President, NLRC
c. Mr. RENATO M. RARANG	- Engineering Specialist, NLRC
d. Mr. ENRICO P. JAJALLA	- Engineering Specialist, NLRC
e. Mr. DANILO P. MERCADO	- Manager, Technical Services-South, NLRC

- SLRC (Southern Luzon Regional Center)

a. Mr. DOMINGO L. BULATAO	- Vice President, SLRC
b. Mr. MAGNO O. CALMA	- Engineering Specialist, SLRC

- Hydro Power Plants (HEP)

a. Mr. FLORENCIO V. DE JESUS	- Manager, Angat HEP
b. Mr. JOSE C. RICO	- Manager, Binga HEP
c. Mr. MELVYN R. EUGENIO	- Superintendent, Magat HEP

Table 1-3 NAPOCOR Task Force Members

General Coordinator

Mr. L. F. OSILLA		- Manager. ERD, Head Office

Thermal Power Plant Group

Leader	Mr. S. A. PIEDAD	- Asst. to the SVP, Operations
Member	Mr. P. A. CABRERA	- Asst. Plant Manager, Batangas
Member	Mr. R. E. AGCAOILI	- Acting QA Specialist
Coordinator	Mr. A. C. LAYSON	- Eng'g Specialist, MMRC

Geothermal Power Plant Group

Leader	Mr. lR. J. SANTIAGO	- Dept. Manager, SLRC
Member	Mr. J. G. VICTA	- Operation Manager, Mak-Ban
Member	Mr. G. P. SILVA	- Acting Maint, Manager, Tiwi
Member	Mr. P. F. CANADA	- Prin. Engineer A, QA
Member	Mr. A. A. CADANO	- Prin. Engineer B. Mak-Ban (Replaced Mr. J. G. Victa)
Coordinator	Mr. M. N. MANUSON	- Prin. Engineer A, TPED

Environmental Group

Leader	Ms. M. R. L. PETEL	- Officer-in Charge, EMD
Member	Mr. J. J. TAMPO	- Eng'g. Specialist, SLRC
Member	Mr. N. B. ALFECHE	- Acting Prin. Engr. A, QA
Coordinator	Mr. P. L. MERRITT, JR	- Eng'g. Specialist, MMRC

Hydro Power Plant Group

Leader	Mr. B. L. CHAVEZ	- Asst. to the VP-NLRC
Member	Mr. R. F. LOMAGE	- Asst. Manager, CBK
Member	Mr. C. L. MONTECILLO	- QA Specialist, QAD
Member	Mr. O. E. LEGADOS	- Eng'g. Specialist, SLRC
Member	Mr. D. E. FABREGAS	- Principal Engr. II, HEDD
Coordinator	Mr. R. U. RARANG	- Acting Eng'g Specialist, NLRC

Transmission Line/Substation Group

Leader	Mr. E. P. JAJALLA	- Eng'g. Specialist, NLRC
Member	Mr. A. C. BALONZO	- Acting Chief Engr., QA
Member	Mr. M. C. DE. JESUS	- Prin. Engr. A, ERD
Member	Mr. D. L. GARCIA	- Prin. Engr. A, PDD
Coordinator	Mr. M. O. CALMA	- Eng'g. Specialist, SLRC

Load Dispatching, Communication, Efficiency/Reliability Group

Leader	Mr. D. C. DE LOS REYES	- Officer-in Charge, OCRSD
Member	Mr. F. J. PADILLA	- Prin. Engr. A, ERD
Member	Mr. A. C. GUANZON	- Prin. Engr. A, PRPD
Coordinator	Mr. P. R. MAGALONG	- Officer-in-Charge, TSD

Economic Group

Leader	Mr. P. P. HERNANDES	- Manager, MIFD
Member	Mrs. L. L. GARCIA	- Chief, Corplan

CHAPTER 2

CONCLUSIONS AND RECOMMENDATIONS

CHAPTER 2 CONCLUSIONS AND RECOMMENDATIONS

The conclusions of the present study for, and recommendations on the 5 year rehabilitation/renovation and operation/maintenance improvement plans of power facilities and the environmental management, are as described in the following.

2.1 5-year Rehabilitation/Renovation Plans of Power Facilities

With regard to the problems of respective facilities, the following rehabilitation/renovation plans which would be effective for improvement of supply reliability and rationalization of maintenance works have been formulated.

Since the facilities are suffering from frequent faults, it will be necessary to push forward strongly the fault reduction countermeasures separately from the above plans.

2.1.1 Rehabilitation/Renovation Plans

1. Thermal Power Plants

(1) Manila Thermal Power Plant Units No. 1 and No. 2 Rehabilitation

No. 1 Unit: 100 MW, No. 2 Unit: 100 MW

[Major Items]

a. Boiler and boiler auxiliary equipment

(a) Detailed inspection and replacement of major pressure parts of boiler

(b) Replacement/repair of major boiler auxiliaries

b. turbine and turbine auxiliary equipment

(a) Inspection of major parts of turbine proper
Replacement of HP and IP turbine inner casings and rotors/blades, replacement of LP turbine casing, and replacement of main stop valves

(b) Replacement/repair of major turbine auxiliaries

c. Electrical equipment

(a) Diagnosis of remaining life and replacement/repair of generator stators and rotors

(b) Replacement of major motors, switchgears, cables, etc.

d. Instruments and control

(a) Replacement/improvement of automatic boiler control system

(b) Provision of spare parts for instruments and control devices

(c) Replacement/improvement of local control systems

(2) Bataan Thermal Power Plant Units No. 1 and No. 2 Rehabilitation

No. 1 Unit: 75 MW No. 2 Unit: 150 MW

[Major Items]

a. Boiler and boiler auxiliary equipment

(a) Detailed inspection and replacement of major pressure parts of boiler

(b) Replacement/repair of major boiler auxiliaries

b. Turbine and turbine auxiliary equipment

(a) Inspection of major parts of turbine proper
Diagnosis of remaining life of HP, IP, and LP rotors

(b) Replacement/repair of major turbine auxiliaries
Replacement/repair of boiler feed pumps, etc.

c. Electrical equipment

(a) Replacement/repair of generator stators and rotors

(b) Replacement/repair of motors, power cables, and switchyard equipment

d. Instruments and control

(a) Replacement/repair of control board recorders and meters, and automatic boiler control system

(b) Provision of spare parts for instruments and control devices

(c) Replacement/repair of local control systems
(No. 1 Unit only)

Besides, Sucat Thermal Power Plant No. 2 and No. 3 Units rehabilitation project is in progress.

- Sucat No. 2 Unit (200 MW) rehabilitation

Rehabilitation works scheduled to be started from May 1993.

- Sucat No. 3 Unit (200 MW) rehabilitation

  Rehabilitation works scheduled to be started from July 1992.

2. Geothermal Power Plants

(1) Tiwi Geothermal Power Plant Units No. 1 - No. 6 Rehabilitation
No. 1 - No. 6 Units (55 MW x 6, 330 MW)

[Major Items]

a. Mechanical part

(a) Procurement of turbine spare rotor, nozzle, and diaphragm

(b) Installation of turbine water washing equipment

(c) Main cooling water pipe inner lining and addition of electrolytic protection system

(d) Installation of automatic tube cleaner for generator H_2 gas cooler

(e) Additional steam production well drilling

(f) Procurement of automobiles for transport of operators and maintenance works

b. Electrical part

(a) Inspection of generator stator windings and retaining rings

(b) Rewedging of generator stator windings

(c) Replacement of AVR

c. Instruments and control

(a) Replacement of recorders, indicating meters, transmitters, etc.

(b) Repair or replacement of air conditioners

(2) Mak-Ban Geothermal Power Plant Unit No. 1 - No. 6 Rehabilitation

No. 1 - No. 6 Units (55 MW x 6, 330 MW)

[Major Items]

a. Mechanical part

(a) Procurement of turbine spare rotor, nozzle, and diaphragm

(b) Installation of turbine water washing equipment

(c) Main cooling water pipe inner lining with stainless steel and addition of electrolytic protection system

(d) Installation of automatic tube cleaner for generator H_2 gas cooler

(e) Addition of after-condenser to steam air ejector and extension of gas exhaust line to outlet of cooling tower fans

(f) Procurement of automobiles for transport of operators and maintenance works

b. Electrical part

(a) Inspection of generator stator windings and retaining rings

(b) Rewedging of generator stator windings

(c) Replacement of AVR

c. Instruments and control

(a) Replacement of turbine supervisory instrument sensors

(b) Replacement of control board recorders, meters and transmitters

3. Hydro Power Plants

(1) Reconstruction of Ambuklao Power Plant intake

(2) Replacement of Magat Power Plant excitation transformer

4. Transmission Lines and Substations

(1) Replacement of overhead ground wires

(2) Replacement of circuit breakers

(3) Adoption of steel towers for river and road crossings

(4) Rerouting of transmission line section where restoration works are difficult

(5) Provision of defective insulator detectors

(6) Replacement of disconnecting switches

(7) Provision of spare circuit breakers

2.1.2 Rehabilitation/Renovation Cost

Unit: US$1,000

Facilities	F.C.	L.C.	Total
Thermal power plants	165,700	29,200	194,900
Geothermal power plants	94,908	2,830	97,738
Hydro power plants	12,714	6,840	19,554
Transmission lines and substations	15,901	1,340	17,241
Total	289,223	40,210	329,433

2.1.3 Annual disbursement Schedule

Unit: US$1,000

Facilities		Previous year	First year	Second year	Third year	Forth year	Fifth year
Thermal power plants	F.C.	26,365	36,644	44,228	50,673	7,790	-
	L.C.	2,089	3,884	8,108	11,776	3,343	-
	Total	28,454	40,528	52,336	62,450	11,133	-
Geothermal power plants	F.C.	-	7,016	17,046	30,342	26,202	14,302
	L.C.	-	201	504	903	790	432
	Total	-	7,217	17,550	31,245	26,992	14,734
Hydro power plants	F.C.	-	663	6,332	3,479	2,240	-
	L.C.	-	1,711	3,305	1,284	540	-
	Total	-	2,374	9,637	4,763	2,780	-
Transmission lines and substations	F.C.	-	3,147	2,996	3,468	3,440	2,850
	L.C.	-	228	324	445	230	113
	Total	-	3,375	3,320	3,913	3,670	2,963
Total	F.C.	26,365	47,470	70,601	87,962	39,672	17,152
	L.C.	2,089	6,024	12,241	14,408	4,903	545
	Total	28,454	53,494	82,842	102,370	44,575	17,697

2.2 Operation/Maintenance Improvement Plans

The study and implementation of the following improvement plans is recommended for solving the problems in operation and maintenance.

2.2.1 Head Office

1. Organization

   (1) Reinforcement of planning department

   (2) Establishment of maintenance department

2. Equipment and Materials Procurement System

   (1) Systematic advance arrangement for procurement of important proprietary equipment and materials (especially imported goods)

   (2) Enlargement of authority of local offices in procurement (including in emergency case)

   (3) Expediting of procurement processes

3. Personnel Plan

   (1) Formulation of short-term/long-term personnel plans

   (2) Systematic movement of personnel

4. Education and Training

   (1) Reinforcement of education and training system for new employees and middle-level employees
   (especially for operations and maintenance group)

5. Enhancement of Employees' Morale

(1) Continued appeal to authorities concerned for improvement of salary and fringe benefits.

(2) Increased and impartial opportunities for education and training (within country and overseas)

(3) Impartial opportunities for promotion

(4) Introduction of group proposal system on cost saving and improvement of working efficiency

(5) Improvement of environment/conditions of employees' work places

(6) Enforcement of safety measures for employees' works

(7) Adoption of other measures to incite personnel to work

2.2.2 Thermal Power Plants

1. Operation and Maintenance Management System

(1) Efficiency Control Group

a. Preparation of technical manual embodying the works

b. Coordination among divisions and sections in the power plant, such as periodical liaison and consultations

c. Handling of environmental works

(2) Maintenance Groups

a. Preparation of maintenance manual covering the works of newly formed planning and scheduling groups

b. Securing of necessary personnel and strategic assignment

(3) Periodical Overhaul Management

a. Clarification of responsible manager and scopes of responsibility of divisions and sections concerned for periodical overhaul

b. Study on the possibility of shifting from direct working system into contract working system

2. Performance of Operation and Maintenance

(1) Improvement of daily operation management

(2) Improvement of daily maintenance management

(3) Revision of operation and maintenance manuals

(4) Enhancement of MMP functions

3. Training and Safety Education

(1) Enlargement of scope of selection of trainees

(2) Reinforcement of basic education for new employees and education and training for middle-level employees, and introduction of job rotation system for operators to get versed in all operation positions and for maintenance/technical support personnel

(3) Early implementation of the training center and introduction of operation simulator

(4) Diffusion of TQC concept

(5) Opening of meetings for root-cause analysis and discussion of accidents and troubles, and training in countermeasures against troubles related

(6) Personnel rotations within a power plant and with other plants/organizations related

4. Procurement and Management of Equipment and Materials

(1) Improvement of procurement system for spare parts, parts and consumables

(2) Improvement of acceptance system

(3) Improvement of inventory management (including material handling/storing)

(4) Improvement of as-received coal quality

5. Other Recommended Items

(1) Earlier implementation of items pointed out by Quality Assurance Department of Head Office (All thermal power plants)

(2) Improvement and reinforcement of communication systems (All thermal power plants)

(3) Inspection and repair of bottom plates of oil storage tanks and water tanks (All thermal power plants and NAPOCOR depots)

(4) Installation and/or improvement and reinforcement of waste water treatment equipment and sedimentation ponds (All thermal power plants)

(5) Inspection and dredging of cooling water intake (All thermal power plants, especially Batangas Power Plant and Bataan

marine intake pipe replacement)

(6) Maintenance of analyzing equipment and tools in chemical laboratory (All thermal power plants)

6. Special Remarks

Investigation of countermeasures against avalanche of sand and stone into Malaya Power Plant/PPC common trend.

2.2.3 Geothermal Power Plants

1. Operation and Maintenance Organization

(1) Reinforcement of organization for periodical overhaul, and study on shifting from direct working system into contract working system

2. Performance of Operation and Maintenance

(1) Improvement of daily operation management

(2) Improvement of daily maintenance management

(3) Improvement of periodical overhaul management

(4) Revision of operation and maintenance manuals

3. Training and Safety Education

Same as for thermal power plant

4. Improvement of Procurement and Management of Equipment and Materials

Same as for thermal power plant

2.2.4 Hydro Power Plants, Transmission Lines and Substations

1. Operation and Maintenance System

   (1) Division of NLRC into two regional centers, and relocation of office

   (2) Establishment of organizational units in charge of maintenance in the regional centers

2. Operation and Maintenance Procedure

   (1) Review of the frequency of preventive maintenance and test items by Technical Services (TS)

   (2) Review of recording frequency of operation logs at hydro power plants and substations

   (3) Review of the frequency of patrol checks at hydro power plants and substations

   (4) Carrying out of periodic inspection of civil structures

      a. Measurement of deposits in the reservoirs

      b. Measurement of wall thickness of penstocks

      c. Inspection of races

   (5) Review of patrol check procedure for transmission lines

   (6) Contracting out of simple works

   (7) Promotion of fault reduction countermeasures

3. Operation and Maintenance Manuals

(1) Review of hydro power plant preventive maintenance guide, substation patrol checklist guideline and transmission line patrol checklist guideline

(2) Preparation of civil structure inspection manual

4. Operation and Maintenance Records, Reports, and Reporting System

(1) Review of forced outage report

a. Standardization of the classification of causes on the Corporation-wide level

b. Review of the forms of monthly and annual reports

(2) Preparation of maintenance work reports

(3) Preparation of civil structure inspection report

(4) Submission of the above reports to the regional centers and the Head Office

5. Spare Parts Inventory Level and Management System

(1) Arrangement of basic data, and study of procurement procedure, management system, etc.

- Arrangement of statistics of parts used in the past
- Arrangement of equipment fault statistics
- Investigation of the availability of parts
- Review of the standard inventory level of spare parts
- Standardization of specifications
- Adequate lead time and ordering time
- Simplification of procurement procedure
- Strengthening of the spare parts management system in the Head Office and regional centers

(2) Storing of spare equipment for substation equipment

6. Custody of Technical Documents and Drawings

(1) Establishment of the rule for retaining the specifications, drawings, design calculations, etc. at the time of construction, and arrangement of the above documents and drawings for the existing facilities

(2) Standardization of single line diagrams, and establishment of the rule for periodic updating

7 Test Instruments, Workshop Facilities, and Repair Tools

(1) Provision of the devices for measuring deposits in the reservoirs and wall thickness of the penstocks

(2) Utilization of Maintenance Engineering Center (MEC) for the repairing of parts at the hydro power plants and for the overhaul of GCBs.

8. Training of Operation and Maintenance Staff

(1) To increase the staff of Technical Training Division to improve the training quality, enrich the curriculum, and increase the frequency of training courses.

(2) To promote the early implementation of the Training Center Project to enrich and improve the quality of training.

2.3 Environmental Management

1. Complete Storage Control and Management of PCB

(1) Dissemination of knowledge of method of storing and handling of PCB

(2) Selection of person in charge of storing and control of PCB

2. Monitoring of Air Pollution

(1) Observation of meteorological data at power plants and measurement of SO_2, NOx and dust at emission source (stack inlet)

(2) Measurement of ground level concentration (Installation of monitoring station or purchase of observation buses)

3. Measures for Reduction of Hydrogen Sulfide from Geothermal Power Plants

(1) Introduction of ejector exhaust gas to cooling towers

4. Reinforcement of Environmental Management System

(1) Assignment of persons in charge of environmental problems to regional centers and thermal power plants

(2) Fostering of affiliate company specializing in environmental investigation

CHAPTER 3

GENERAL SITUATION OF THE REPUBLIC OF THE PHILIPPINES

CHAPTER 3 GENERAL SITUATION OF THE REPUBLIC OF THE PHILIPPINES

3.1 Outline of the Philippines

The Republic of the Philippines consists of approximately 7,100 islands of various sizes, spread over an area extending 1,855 km from north to south and 1,108 km from east to west, and has a total land area of 299,765 square kilometers. The largest island is Luzon (104,686 km^2) lying in the north, followed by Mindanao (94,630 km^2) situated in the southernmost. Between the two islands, there are nine relatively large islands, including Samar (13,079 km^2), with a total land area of 85,451 km^2.

The population, which was 48,098,000 in the 1980 census, is estimated at 61,980,000 in 1990 as shown in Table 3-1, with an annual growth rate of 2.57 percent. The population of Luzon was 26,081,000 (54 percent of total population) in 1980 and is estimated at 33,746,000 (growth rate of 2.64%) in 1990.

Table 3-1 Population of Philippines, Luzon Grid

(10^3)

Region	1980	1988	1990	1995
All Philippines	48,098	58,721	61.980	68,424
Metro Manila	5,926	7,561	7,974	8,971
Region 1	3,541	4,134	4,292	4,690
Region 2	2,215	2,713	2,845	3,182
Region 3	4,803	5,863	6,142	6,844
Region 4	6,119	7,692	8,105	9.152
Region 5	3,477	4,198	4,388	4,873
Luzon Total	26,081	32,161	33,746	37,712

The island of Luzon is politically divided into one special district and 71 provinces, which are placed under administrative control of 12 Regions and Metro Manila Area. The island of Luzon together with the island of Masbate, is generally called "Luzon", while the island of Mindanao is referred to as "Mindanao" and all other islands between "Luzon" and "Mindanao" are called "Visayas". (excluding Mindoro and Palawan)

3.2 Politics and Economy

3.2.1 Politics

(1) General

Since the turnover of the administration from Mr. Marcos to Mrs. Aquino by the revolution in February 1986, the new administration has exerted its best efforts to normalize the domestic situations and to reconstruct the economy under the new Constitution promulgated on February 2, 1987. As for the diplomatic policy, the Republic of the Philippines is now seeking for and positively proceeding to the new direction of peaceful international relationship with independence not covered by any umbrella of particular international powers.

(2) Energy Policy

As to the energy policy in the Philippines, the Medium Term Development Plan (1987-1992) was started by the New Regime, and severe reconsideration of the energy plans was undertaken. According to the Plan, the dependence upon oil should be lessened for the purpose of stabilizing the energy supply, for which the comprehensive energy policy was set up such as; the diversification of the oil supply sources and oil products; the adjustment of infrastructures for effective utilization of energy; diffusion of energy saving technology and furthering of energy storage. Moreover, in 1987, the participation of private sectors into the electric power enterprises was permitted for promotion of the economic development. (Executive Order 215).

(3) Electric Power Policy

As to the electric enterprises in the Philippines, the state owned NAPOCOR, since its establishment has been in charge of the development of the electric power sources, and Manila Electric Company (MERALCO), a private power distribution company, has been engaged in the supply of electricity mainly to Metro Manila area.

In 1969, the National Electrification Administration (NEA) was established to supply electricity through the electrification cooperatives organized all over the Philippines, except for Metro Manila.

NAPOCOR has been directly controlled by the Office of the President instead of the former Ministry of Energy, since the New Regime started, and has been under the administration of the Energy Regulatory Board (ERB) as well as the National Power Board (NPB).

Consequently, NAPOCOR is in the similar position as NEDA which controls the development plans of the country.

On the other hand, the National Electrification Administration (NEA), taking charge of rural electrifications is under the control of the Department of Environmental and Natural Resources (DENR).

3.2.2 Philippine Economy

(1) General

The economic system of the Philippines is that of private system modeled after the United States economic system. However, the role of the government in the national economy has become increasingly important in recent years through successive implementation of powerful infrastructure improvement programs.

To characterize the economic environment of the Philippines, the "economy based on excess labor" is often pointed out.

In the Philippines, the unemployment ratio is constantly at high levels, which was 4.6 percent in 1982, 5.5 percent in 1987, and 4.2 percent in 1988, making a major source of social unrest.

(2) Economic Indicators

a. General

The Philippines came through a difficult economic struggle in the past; the economic instability as a result of the oil crisis, inflationary and recessive pressures, and the deterioration of world market prices for the country's export products.

Until 1984, the country's economy was in a decline. Prices of basic goods and services almost doubled from the 1980 prices. Inflation rate was recorded at 50.3 percent, and the consumer price index was 306.20 against the previous year's 137.10. The Peso-Dollar exchange rate increased to ₱16.70 from ₱11.10 in 1983.

In 1986, the government under the new leadership managed to improve the economy and provided more job opportunities for its people. As a result, the country's Gross National Product (GNP) at constant 1972 prices improved by 15.4 percent. During the year, gross value added of the agriculture, fishery and forestry sector and services sector increased by 3.74 percent and 2.32 percent, respectively, while the industrial sector registered a negative growth of 2.74 percent. Prices continued to increase but at a much lesser rate of 0.8 percent.

The country's economic performance was more encouraging in 1987. The increase in GNP was 5.05 percent and gross value added of all three sectors likewise increased 0.72 percent for agriculture, fishery and forestry sector, 7.90 percent for the industrial sector, and 4.85 percent for the services sector.

Foreign trade is another important factor in the development of economy. The country's export of products is increasing the dollar reserve available for the purchase of equipment and other goods from other countries.

Through the years, the Philippines' premier trading partners are the United States and Japan. Total trade of both countries increased from 1985 to 1986; the United States from 2.89 to 2.90 billion U.S. Dollars and Japan from 1.61 to 1.72 billion U.S. Dollars. Hong Kong, the Federal Republic of Germany and Taiwan complete the list of top five countries which have trade relations with the Philippines. Although all five countries recorded increases in their total trade, it was only with the United States and the Federal Republic of Germany that the Philippines registered a favorable balance of trade.

b. Bases of demand forecast

Various economic and demographic variables were used in projecting of energy sales to different customers.

NEDA's latest official medium-term forecast was adopted for economic indicators for the period 1990-1992. For 1993-2010, three Gross Domestic Product (GDP) scenarios (low, medium, and high) were considered in obtaining the upper and lower limits of demand growth. The resulting absolute GDP levels were then allocated to the different sectoral components of GDP based on their historical percentage shares to total GDP.

The following Table 3-2 summarizes these economic variables.

Table 3-2 Luzon Grid Economic Indicators

Item	Average Annual Growth Rate (%)			
	1989-1992	1993-2000	2001-2010	1989-2010
Low Scenario				
Gross Domestic Product (NAT.)	6.4	6.1	4.8	5.6
GDP MFG. (NAT.)	7.8	7.1	4.4	6.0
GDP Services (NAT.)	6.0	6.3	4.8	5.6
PCE (Metro Manila)	4.5	5.4	4.4	4.8
Medium Scenario				
Gross Domestic Product (NAT.)	6.4	6.5	6.5	6.5
GDP MFG. (NAT.)	7.8	7.5	6.1	7.0
GDP Services (NAT.)	6.0	6.7	6.6	6.5
PCE (Metro Manila)	4.5	5.8	6.1	5.7
High Scenario				
Gross Domestic Product (NAT.)	6.4	6.0	9.0	8.5
GDP MFG. (NAT.)	7.8	10.1	8.6	9.0
GDP Services (NAT.)	6.0	9.2	9.1	8.6
PCE (Metro Manila)	4.5	8.2	8.6	7.7

Note : PCE = Personal Consumption Expenditure

CHAPTER 4

CURRENT POWER SITUATION IN LUZON GRID

CHAPTER 4 CURRENT POWER SITUATION IN LUZON GRID

4.1 Forecast of Power Demand and Peak Load

(1) Capacity and Annual Generation of Generating Facilities

The total installed capacity of the entire Philippines as of the end of 1990 was 6,037 MW, out of which 4,321 MW (corresponding to 72%) beloved to the Luzon Grid, whereas the Visayas Grid had 663 MW, and the Mindanao Grid 1,053 MW. The power generation in 1990 totaled 24,800 GWH, out of which the Luzon Grid had 18,800 GWH (corresponding to 76%). The energy sold in 1990 was 22,900 GWH in the entire grids, and 17,400 GWH (76%) in the Luzon Grid.

The population serviced in 1988 was 53,850,000 in the total grids, and 29,690,000 (corresponding to its 55%) in the Luzon Grid. The electric energy consumption per person was 542 KWH in the Luzon Grid against 393 KWH in the entire grids. The energy sold in 1988 was 21,200 GWH in the entire grids, and 16,100 GWH in the Luzon Grid. (Refer to Table 4-1 - 4-3)

(2) Composition of Generating Facilities

The power sources are composed of 2,612 MW of the oil-fired thermal power plants (corresponding 43% of the total), and 405 MW of the coal-fired power plants (7%), thus the thermal power plants accounting for 50% of the total.

The Hydro power generating capacity is 2,132 MW corresponding to 35% of the total, including 300 MW of Kalayaan Pumped-storage Power Plant, and the remaining 15% is 888 MW by the geothermal power plants.

The Luzon Grid has the generating capacity of 4,321 MW, corresponding to 72% of the total capacity, which is broken down to 2,135 MW (50%) of the oil-fired thermal power plants, 300 MW (7%) of the coal-fired thermal power plant, 1,226 MW (28%), of the hydro power plants and 660 MW (15%) of the geothermal power plants. It is a peculiarity of the structure of power sources of the Philippines that the share of the geothermal power generation is large as compared with those in the other countries. (Refer to Table 4-1)

(3) Power Demand Forecast

As for the power demand forecast, NAPOCOR made its own demand forecast based on the forecast in the power development study report prepared by Bechtel Corporation in March 1988, and formulated the electric power development program for the entire systems in the Philippines for 15 years from 1991 through 2005.

According to this program, the maximum power demand in 2005 is estimated at 11,428 MW, approximately 2.8 times 4,075 MW estimated for 1991 (demand in 1990 was recorded at 3,974 MW). In the Luzon Grid, the maximum power demand in 2005 is estimated at 8,647 MW or 2.9 times 3,013 MW estimated for 1991 (demand in 1990 was recorded at 2,973 MW).

These values are a little lower than the estimate based on the high economic growth of 9% by Bechtel Corporation, and is fairly higher than the standard forecast based on 6% of the economic growth, which is judged to be a forecast with some margin.
(Refer to Table 4-1-3)

Note: The values of installed capacity, GWH, etc. of the power sources in the text were taken from 1990 Annual Report.

Table 4-1. SUMMARY OF INSTALLED CAPACITY
1991 POWER DEVELOPMENT PROGRAM

GRID/ PLANT TYPE	CAPACITY (MW)					AVE. YEARLY INCREASE (MW)			GROWTH RATE (PERCENT)		
	1990	1990 AR	1995	2000	2005	1991-1995	1996-2000	2001-2005	1991-1995	1996-2000	2001-2005
PHILIPPINES	6108	6037	8539	10675	15543	486	427	974	6.9	4.6	7.8
OIL-BASED	2683	2612	3644	3682	3698	192	8	3	6.3	0.2	0.1
HYDRO	2132	2132	2217	2485	3437	17	54	190	0.8	2.3	6.7
GEO	888	888	1323	1603	1803	87	56	40	8.3	3.9	2.4
COAL	405	405	1355	2905	6605	190	310	740	27.3	16.5	17.9
LUZON	4391	4321	6236	8114	12014	369	376	780	7.3	5.4	8.2
OIL-BASED 1/	2205	2135	2805	2805	2805	120	0	0	4.9	0.0	0.0
HYDRO	1226	1226	1226	1494	1794	0	54	60	0.0	4.0	3.7
GEO	660	660	955	1015	1015	59	12	0	7.7	1.2	0.0
COAL 1/	300	300	1250	2800	6400	190	310	720	33.0	17.5	18.0
VISAYAS	664	663	778	856	1172	23	16	63	3.2	1.9	6.5
OIL-BASED	329	328	358	396	412	6	8	3	1.7	2.0	0.8
HYDRO	2	2	7	7	7	1	0	0	28.5	0.0	0.0
GEO	228	228	308	348	548	16	8	40	6.2	2.5	9.5
COAL	105	105	105	105	205	0	0	20	0.0	0.0	14.3
CEBU	334		289	289	389	-9	0	20	-2.9	0.0	6.1
OIL-BASED	229		184	184	184	-9	0	0	-4.3	0.0	0.0
COAL	105		105	105	205	0	0	20	0.0	0.0	14.3
NEGROS	116		196	268	308	16	14	8	11.1	6.5	2.8
OIL-BASED				32	32	0	6	0	-	-	0.0
HYDRO	1		1	1	1	0	0	0	0.0	0.0	0.0
GEO	115		195	235	275	16	8	8	11.1	3.8	3.2
PANAY	80		80	80	80	0	0	0	0.0	0.0	0.0
OIL-BASED	80		80	80	80	0	0	0	0.0	0.0	0.0
HYDRO	0		0	0	0	0	0	0	-	-	-
LEYTE-SAMAR	113		176	176	336	13	0	32	9.3	0.0	13.9
OIL-BASED			63	63	63	13	0	0	-	0.0	0.0
GEO	113		113	113	273	0	0	32	0.0	0.0	19.4
BOHOL	21		37	43	59	3	1	3	12.0	3.1	6.5
OIL-BASED	20		31	37	53	2	1	3	9.2	3.6	7.5
HYDRO 1/	1		6	6	6	1	0	0	43.1	0.0	0.0
MINDANAO	1053	1053	1525	1705	2357	94	36	130	7.7	2.3	6.7
OIL-BASED	149	149	481	481	481	66	0	0	26.4	0.0	0.0
HYDRO	904	904	984	984	1636	16	0	130	1.7	0.0	10.7
GEO			60	240	240	12	36	0	-	32.0	0.0

1/ Includes non-NPC plants.

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Table 4-2 SYSTEM ENERGY GENERATION MIX
1991 POWER DEVELOPMENT PROGRAM

GRID/FUEL TYPE	ACTUAL 1990		PROJECTED							
			1991		1995		2000		2005	
	GWH	%	GWH	%	GWH	%	GWH	%	GWH	%
PHILIPPINES	24800	100	26270	100	36633	100	53404	100	75992	100
OIL-BASED	11541	47	12342	47	13582	37	9988	19	6854	9
HYDRO	6047	24	5806	22	6600	18	7643	14	10084	13
GEO	5470	22	5916	23	9282	25	17060	32	18537	24
COAL	1742	7	2206	8	7169	20	18713	35	40517	53
LUZON	18823	100	20035	100	27192	100	40257	100	57860	100
OIL-BASED	10328	55	11061	55	11450	42	6405	16	3962	7
HYDRO	2370	13	2369	12	2369	9	3412	8	3412	6
GEO	4495	24	4650	23	6826	25	12347	31	10446	18
COAL	1630	9	1955	10	6547	24	18093	45	40040	69
VISAYAS	2051	100	2371	100	3675	100	5184	100	7633	100
OIL-BASED	955	47	841	35	1006	27	1638	32	1463	19
HYDRO	9	0	13	1	34	1	34	1	34	0
GEO	975	48	1266	53	2013	55	2892	56	5659	74
COAL	112	5	251	11	622	17	620	12	477	6
MINDANAO	3926	100	3864	100	5766	100	7963	100	10499	100
OIL-BASED	258	7	440	11	1126	20	1945	24	1429	14
HYDRO	3668	93	3424	89	4197	73	4197	53	6638	63
GEO	0	0	0	0	443	8	1821	23	2432	23

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Table 4-3

ENERGY SALES AND DEMAND FORECAST SUMMARY
1991 POWER DEVELOPMENT PROGRAM

YEAR	ENERGY SALES (GWH) LUZ	VIS	MIN	PHIL	DEMAND (MW) 1/ LUZ	VIS	MIN	PHIL
ACTUAL								
1986	13535	1355	2948	17838	2311	283	484	3078
1990	17601	1926	3756	23283	2888	356	621	3865
1990 AR	17368	1818	3729	22915	2973	380	621	3974
GROWTH RATE (%)	-							
(1987-1990)	6.8	9.2	6.2	6.9	5.7	5.9	6.4	5.9
FORECAST								
1991	18402	2120	3941	24463	3013	407	655	4075
1995	24868	3300	5456	33624	4072	592	907	5571
GROWTH RATE (%)								
(1991-1995)	7.2	11.4	7.8	7.6	7.1	10.7	7.9	7.6
1996	26898	3529	5811	36238	4405	633	966	6004
2000	36815	4631	7475	48921	6029	812	1243	8084
GROWTH RATE (%)								
(1996-2000)	8.2	7.0	6.5	7.8	8.2	6.5	6.5	7.7
2001	39569	4959	7793	52321	6480	860	1296	8636
2005	52807	6537	9904	69248	8647	1134	1647	11428
GROWTH RATE (%)								
(2001-2005)	7.5	7.1	5.8	7.2	7.5	6.9	5.8	7.2
(1991-2000)	7.7	9.2	7.1	7.7	7.6	8.6	7.2	7.7
(1991-2005)	7.6	8.5	6.7	7.5	7.6	8.0	6.7	7.5

1/ Net of Station use and non-coincident demand for Visayas and Philippines.

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4.2 Power Development Plan

(1) Composition of Future Generating Facilities

The power development program up to 2005 by NAPOCOR is made on the basis of 11,428 MW (8,647 MW in the Luzon Grid) of the peak power demand forecast for 2005.

This program follows the plan by Bechtel Corporation in which the installed capacity in 2005 of the entire systems in the Philippines will reach 15,543 MW with a reserve rate of 36%. The power sources will be composed of 3,698 MW (24%) of oil-fired thermal power, 3,437 MW (22%) of hydro power, 1,803 MW (12%) of geothermal power, and 6,605 MW (42%) of coal-fired thermal power, and it is characterized by a drastic increase of coal-fired thermal power generation.

With regard to the Luzon Grid, the total installed capacity will be 12,014 MW with 39% reserve in 2005, composed of 2,805 MW (23%) of oil-fired thermal power, 1,794 MW (15%) of hydro power, 1,015 MW (9%) of geothermal power, and 6,400 MW (53%) of coal-fired thermal power.

This power source configuration is characterized by the higher share of coal-fired thermal power and lower share of hydro power, and less flexibility of system regulation is feared. (Refer to Table 4-1)

(2) Outline of Power Development Program

The power development program by NAPOCOR for the Luzon Grid is based on the Bechtel concept that the new hydro power development is not economical, and the development of geothermal and coal-fired thermal power plants are emphasized.

Especially, since an extreme shortage of power is foreseen in 1994, new construction of gas turbine generators of 210 MW in 1989 and 436 MW in 1991 is planned.

Interconnection of the Luzon Grid with the Leyte Grid is planned to introduce the geothermal power of 880 MW from Tongonan, Leyte to Luzon from 1997 through 1999, which will necessitate the construction of interconnecting lines of Leyte - Samar - Luzon in 1997.
The Calaca II Power Plant is planned to be commissioned in 1994, and the bidding documents are now under review. There may be 2 to 3 years delay in its implementation.

The coal-fired thermal power plant III scheduled to be commissioned in 1995 is already decided, together with the BOT scheme of construction.

The coal-fired thermal power plant (Masinloc) scheduled for 1995 is projected in Zambales. For coal-fired thermal power plant B, the feasibility study is expected to be made soon including the selection of an appropriate site. (Refer to Table 4-4 - 4-5, Fig.4-1 - 4-3)

(3) Review of the Components of Future Generating Facilities

In view of the tendency of too much dependence upon the imported coal, reconsideration for the use of indigenous energy sources has been pointed out. In connection with the commencement of the study of hydro power plants for the regulating power sources, the restudy of the utilization of hydro power potential of 5,000 MW in Luzon is undertaken as well as the expansion of Kalayaan Pumped-storage Power Plant.

The Rockwell Thermal Power Plant in Makati has become an urgent issue for its aged deterioration and environmental pollution, and its earlier rehabilitation or removal out of the city is a pending problem.

An agreement was signed in September 1989 on USAID grant for the feasibility study of the above. The power plant has 3 units of 60 MW and 5 units of 25 MW, totaling 305 MW, but only 2 units of 60 MW are in operation after 25 to 38 years after commissioning.

(4) Promotion of Power Sources Development Program

The electric power demand and supply balance in the Luzon Grid is in a very tight condition caused by the abortage of supply power, and the planned supply curtailment (or brown-out) is made as a matter of daily routine.

The main reason of the above situation lies in the fact that the capabilities of the existing power plants have declined largely, and the reserve power which appears to be 30% or more is actually nearly zero or on the minus side.

The decrease of the reserve power is due to;

* Decrease of output of hydro power plants due to drought,
* Output limitation and unit shutdown due to aged deterioration of equipment and troubles,
* Unit shutdown for maintenance,

Where the former two reasons are largely responsible. Consequently, the new power sources development projects do not proceed as planned initially, and the delays add again to the supply power shortage.

Therefore, as the countermeasure for the power shortage, it would be essential (1) to see that there would be no further delay of the power sources development program, and (2) to carry out the rehabilitation, repair and maintenance of existing power generating facilities regularly in defiance of inevitable unit shutdowns.