No. 5

JAPAN INTERNATIONAL COOPERATION AGENCY(JICA)

NATIONAL POWER CORPORATION
THE REPUBLIC OF THE PHILIPPINES

FEASIBILITY STUDY
ON
MALAYA POWER PLANT
RELIABILITY IMPROVEMENT PROJECT

FINAL REPORT
(SUMMARY)

MARCH 1995

West Japan Engineering Consultants, Inc.

MPN
JR
95-087

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GENERAL

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1.1 Background of the Study

At present in the year of 1994, the power supply situation in the Luzon Grid is being greatly improved by consistent effort exerted by National Power Corporation (referred to as NPC hereinafter) and the Philippine government. But, back in the year of 1991 to 1993, the Luzon Grid suffered from chronic power supply shortage and daily brownouts. There are two (2) major reasons for this power situation, namely the delay of the power development program and the deterioration of existing power generating facilities. The delay of the power development program, one (1) of the major reasons for the power shortage, has been made up for by the implementation of the fast track projects. But, the other reason, namely, the problems residing in the present operation and maintenance practices (software) of the generating facilities are still to be solved.

Malaya Thermal Power Plant (referred to as Malaya TPP hereinafter) was rehabilitated in 1986 and 1987, but serious troubles were consecutively encountered in 1991 and 1992 for both units, 4 years after the rehabilitation. Repair works for the damages by these troubles have already been carried out, however, new problems might be being generated within the power plant equipment/materials (hardware) due to the annual deterioration.

In order to formulate the Improvement Plans for both hardware and software problems mentioned above, the Philippine government made request to the Japanese government on the technical cooperation for the study of the rehabilitation of Malaya TPP (Phase II) and improvement plan for operation and maintenance.

In response to this request, the Japan International Cooperation Agency (referred to as JICA hereinafter) dispatched the Preparatory Study Team in February 1994 and signed the Implementing Arrangement on March 1, 1994.

On the basis of this Implementation Arrangement, JICA has dispatched the Main Study Team (referred to as Team hereinafter), three (3) times, in September 1994, December 1994 and February 1995.

1.2 Objective of the Study

The objective of this study is to formulate the following improvement plans in order to upgrade the reliability of the Malaya TPP.

- Formulation of the rehabilitation project of the existing power plant facilities optimum in view of technical, economical and financial aspects.

- Formulation of improvement plan for operation and maintenance and good technology transfer to NPC counterpart.

1.3 Objective Area and Facilities

This study shall cover such areas and offices/facilities as Malaya TPP, Metro Manila Regional Center (MMRC), NPC Head Office, Maintenance and Department of Energy (DOE).

1.4 Scope of the Study and Study Methodology

JICA dispatched experts to the Luzon island of the Republic of the Philippines, conducted the detailed survey and collected relevant data and information with close cooperation of NPC. On the basis of the detailed analysis of the data and information, recommendations are presented to NPC as for the formulation of the rehabilitation program of the power plant (hardware) and the improvement plan of operation & maintenance (software).

1.4.1. Scope of the Study

Scope of the Study is as described in the following;

1) Power Plant Facilities (Hardware)

The detailed study on previous plant operations shown in various records such as troubles/fault records, inspection/maintenance records, performance test records, etc. is carried out. The power plant facilities are also inspected with the overhauled condition, and from the point of view of the preventive maintenance, the conditions of power plant facilities are evaluated to identify the following items:

a. Repair or replacement of the equipment/parts including major equipment, which are deemed essential for the restoration of plant output.

b. Repair or replacement of the equipment/parts which have severely deteriorated or which are difficult to repair or replace during normal maintenance, and which are essential for the restoration of reliability.

After the detailed review of the above, an optimum rehabilitation program of the power plant facilities is formulated in the five (5) year overhaul plan followed by the economic and financial evaluation.

2) Operation & Maintenance (Software)

The study on such software matters as listed in the following is carried out to propose the measures that would keep the facilities from unexpected forced outage as well as the points to be improved for good operation & maintenance:

a. Operation & maintenance procedures

b. Daily patrol & check methods

c. Planning & budgeting methods for periodic and preventive maintenance

d. Periodic maintenance procedures and organization structure

e. Management procedure for drawings and data

f. Management and storage methods for spare parts

g. Organization of the power plant personnel
Manpower and skilled personnel for operation and maintenance including technical/engineering functions for preparation of technical specifications for procurement

h. Establishment of procurement concept for proprietary items of power plant equipment or parts for maintenance or overhaul

i. System for authority and responsibility

j. Sub-contracting method for periodic and other maintenance

k. Operation & maintenance management system at head office and MMRC

l. Hiring and education/training of employees

Problems found through the above study are analyzed, relevant root causes are identified and concrete software improvement plans are formulated.

3) Technology Transfer

Technology transfer to NPC counterpart of task force members is made by means of the joint surveys during the first site survey in the Philippines and seminars are held at the time of the second and the third Study in the Philippines.

1.4.2 Process of the Study

1) Study Flow Chart

Figure 1-2 "Study Flow Chart" shows the process of the Study mentioned above.

2) NPC Task Force

The improvement plans formulated through the Study are to meet the actual conditions in the Philippines and must be realized. From this point of view, one of the most important factors for the success of this Study is that NPC staffs study the root causes of problems and to formulate the improvement plans by themselves. The Team assists, making best use of the experience in Japan, NPC in taking the initiative to formulate the improvement plans through the mutual discussions. In order to materialize the scheme, NPC has organized the Task Force throughout the Study period, to establish a project group as a firm organization directly connected to the vice president, MMRC for materialization of the Improvement Plans of operation and maintenance even after completion of the JICA Study.

Figure 1-1 Luzon Grid Power System Diagram

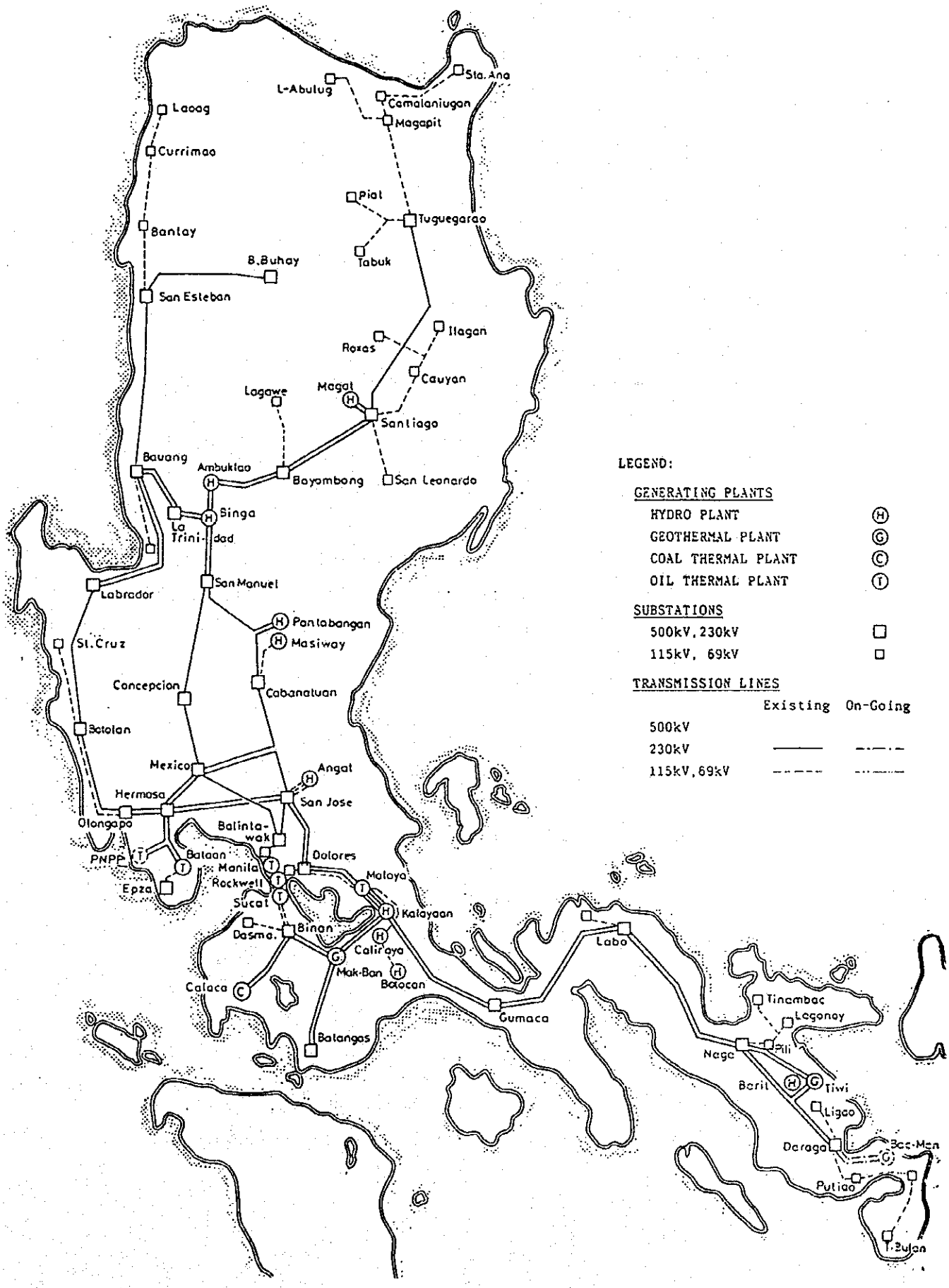
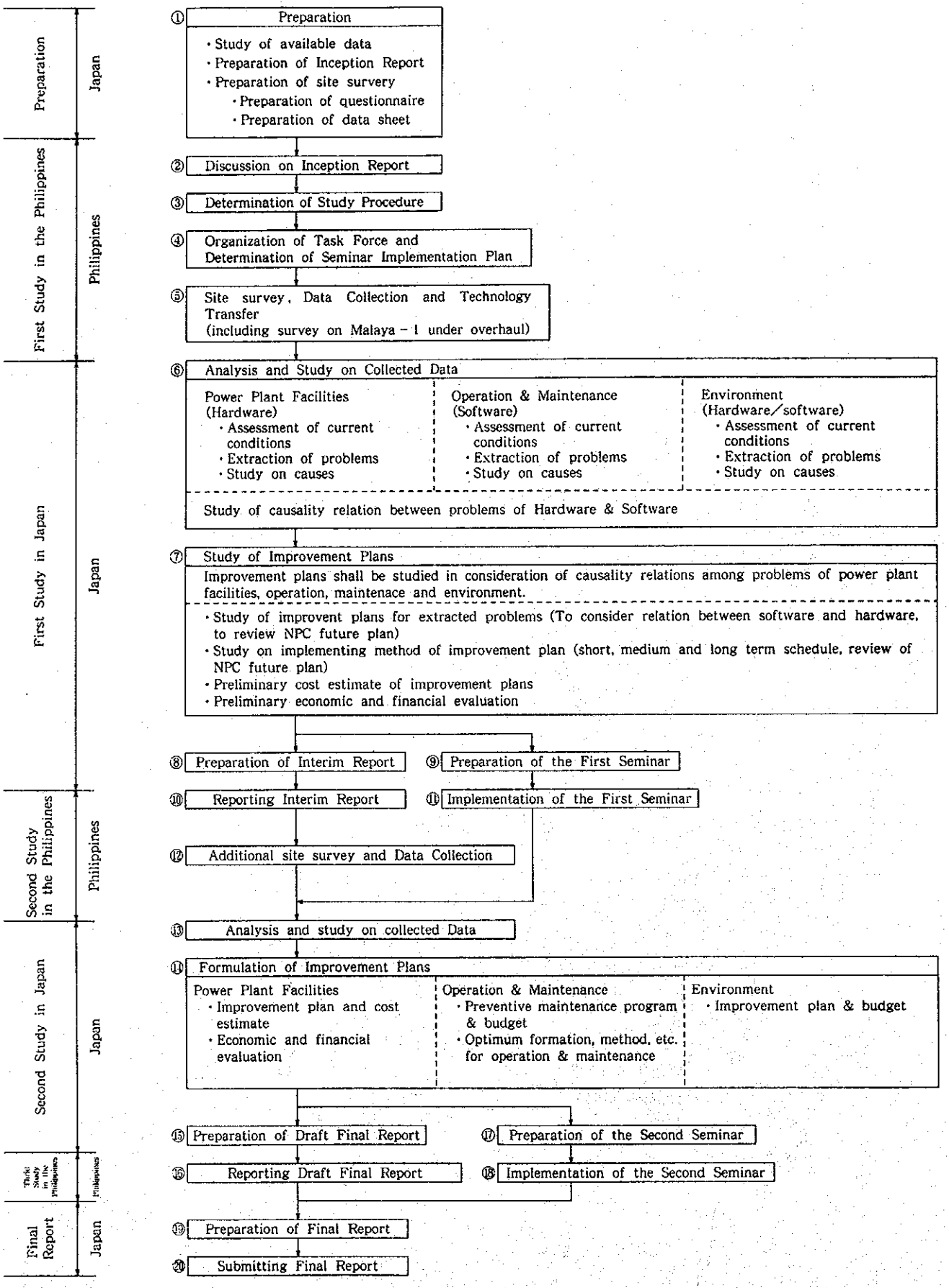


Figure 1-2 Study Flow Chart



1.5 Study Team Members

Name	Assignment	Service Items
Teruaki OGAWA	Team Leader	- General management - Engineering supervision
Kenji TOMOKIYO	Organization & Management	- Study on the organization and management - Formulation of Improvement Plan
Yoshimi FUNAKOSHI	Power Plant Facilities (Mechanical)	- Site survey on mechanical equipment - Study on the data and analysis - Formulation of Improvement Plan
Ginjiro MATSUO	Power Plant Facilities (Electrical)	- Site survey on electric and control equipment - Study on the data and analysis - Formulation of Improvement Plan
Yukio SHIMODA	Operation	- Site survey on plant operation - Study on the data and analysis - Formulation of Improvement Plan
Hirofumi GOTO	Maintenance	- Site survey on maintenance management and spare parts control - Study on the data and analysis - Formulation of Improvement Plan
Yoshihiro EGUCHI	Maintenance	- Site survey on maintenance management and spare parts control - Formulation of Improvement Plan
Nobuhiro HARAGUCHI	Environment	- Site survey on environment and power plant chemical facilities - Study on the data and analysis - Formulation of Improvement Plan

Kenji FUJII	Economic Evaluation	-	Economic and Financial Evaluation
Katsumi OTANI	Assistant	-	Assistance and arrangement for efficient work

1.6 NPC Task Force of Counterpart

NPC organized Task Force of Counterpart to facilitate the effective transfer of technology and know-how during the Study, and also to execute continuously the realization of the Improvement Plan after the Study. Refer to Figure 1-3 and Table 1-1.

1.7 Study Schedule

The study is conducted for seven (7) months started with the first work in the Philippines from August 31, 1994, and completed with the submission of the Final Report in March 1995. Refer to Figure 1-4.

Figure 1-3 Organization of NPC Task Force of Counterpart

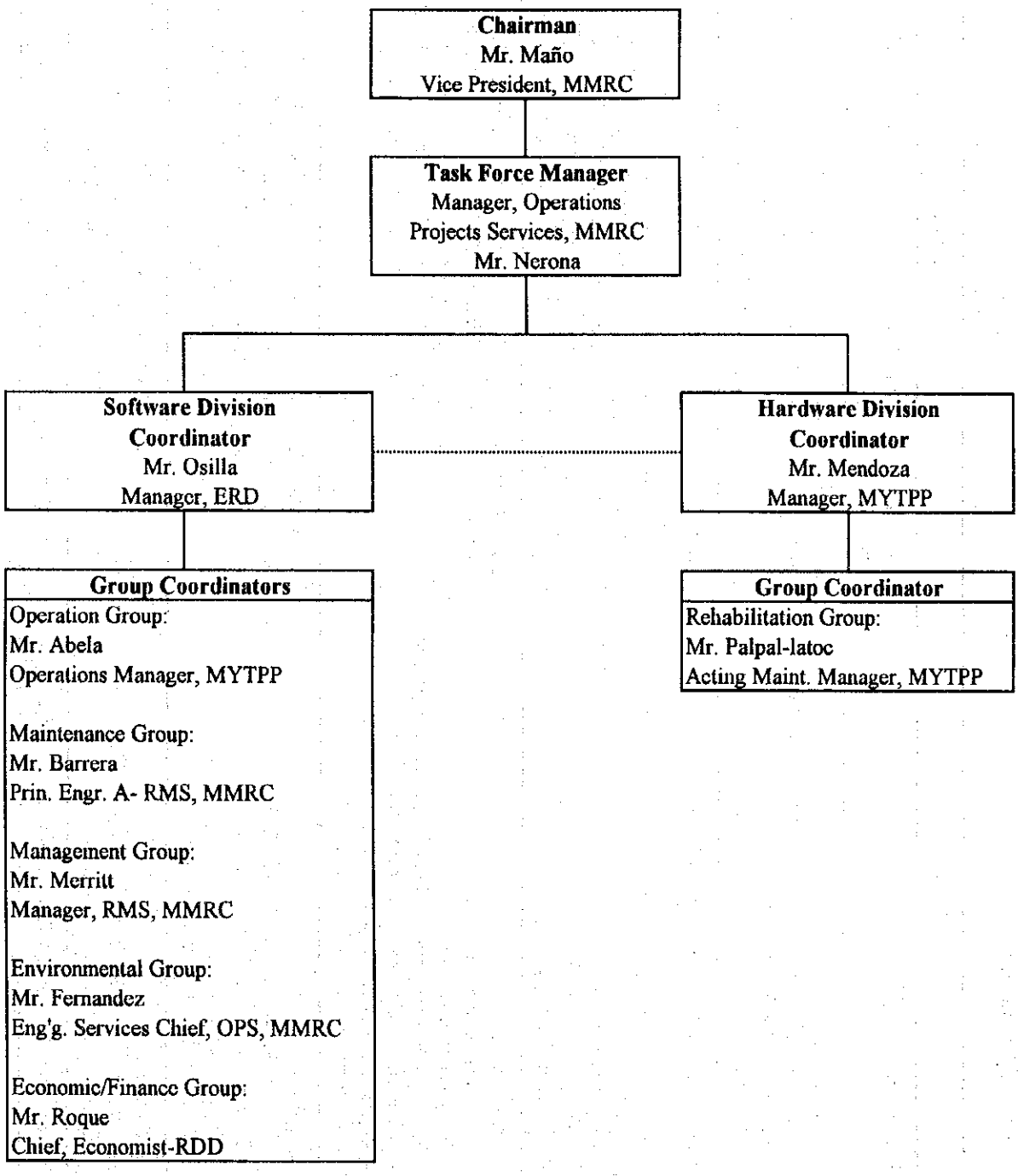
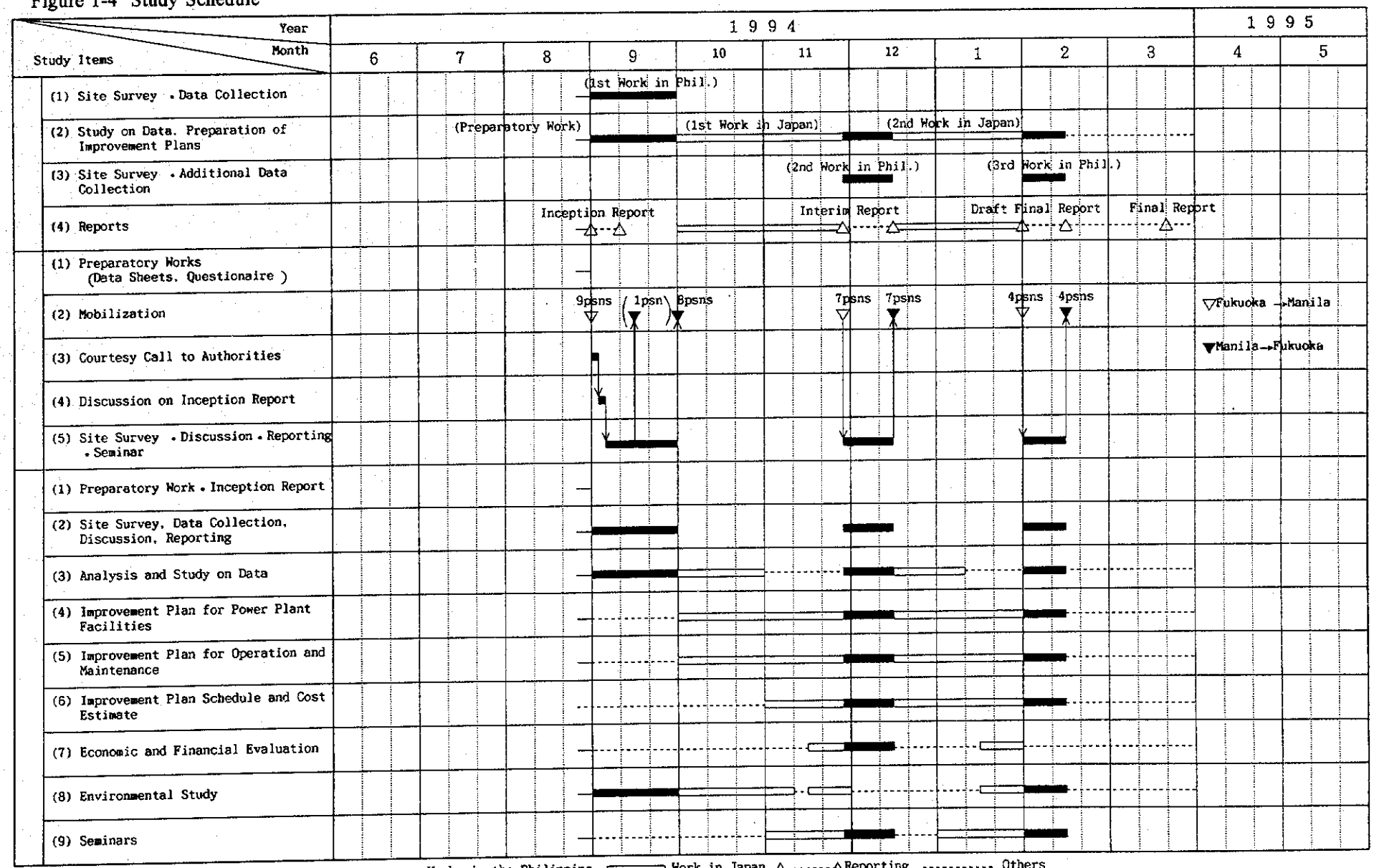


Table 1-1 Member of NPC Task Force of Counterpart

Field	Group	Member	
1. Hardware Division	Rehabilitation Plan	Division Coordinator	Mr. Mendoza (Group Manager, MYTPP)
a) Power Plant Facilities	Rehabilitation Plan - Study of present conditions of power plant facilities - Study of overhaul activities - Rehabilitation plan	Group Coordinator Members	Mr. Palpal-latoc (Acting Maint Manager, MYTPP) Mr. Marte (Mech. Maint. Supt., MYTPP) Mr. Galingan (I & C Maint. Supt., MYTPP) Mr. Flores (Chemical Supt., MYTPP)
2. Software Division	Improvement Plan for Operation & Maintenance	Division Coordinator	Mr. Osilla (Manager, ERD)
b) Operation/Maintenance	[I] Operation - Operation procedure - Daily patrol & check - Education / training of operator	Group Coordinator Members	Mr. Abela (Operations Manager, MYTPP) Mr. Lumawag (Eng'g Services Chief, OPS, MMRC) Mr. Labadan (Operations Supt., MYTPP) Mr. Flores (Chemical Supt., MYTPP)
	[II] Maintenance - Daily maintenance procedure - Daily patrol & check - Plan, procedure & organization of periodic maintenance - Management of drawings & spare parts - Organization of power station personnel - Procurement of goods / materials	Group Coordinator Members	Mr. Barrera (Prin. Engr. A-RMS, MMRC) Mr. Fajardo (Eff. Control Supt., MYTPP) Mr. Dela Cruz (Maint. Supt., Sucat TPP) Mr. Villona (Sched/Planning Supt., MYTPP) Mr. Ortañez (MSD Supt., MMRC)
	[III] Management - Organization of Head Office & MMRC - Responsibility and competence - Hiring of employees - Education / training of employees	Group Coordinator Members	Mr. Merritt (Manager, RMS, MMRC) Mr. Guarin (Manager, ECD-ERD, NPC H.O.) Mr. Ramos (Prin. Engr. A-QA/Operation,) Ms. Delos Reyes (Admin. Manager, MMRC)
c) Environment	[IV] Environment Group - Study of present conditions of Malaya TPP - Formulation of improvement plan	Group Coordinator Members	Mr. Fernandez (Eng'g Services Chief, OPS, MMRC) Mr. Dannang (RMS, MMRC) Mr. Flores (Chemical Supt., MYTPP)
d) Economy / Finance	[V] Economic & Financial Evaluation (Rehabilitation)	Group Coordinator	Mr. Roque (Chief Economist - RDD)

Figure 1-4 Study Schedule



CHAPTER 2

CONCLUSIONS AND RECOMMENDATIONS

CHAPTER 2. CONCLUSIONS AND RECOMMENDATIONS

The following sections describe the conclusions of the survey and our recommendations concerning the reliability improvement plan for the existing power plant facilities (hardware) and the improvement plan for operation and maintenance management (software).

2.1 Outline

1) It is no exaggeration to say that reliability of power plant facilities depends on implementation of complete periodic overhaul. It bears repeating: implementation of periodic overhaul, complete in every aspect, is critically important and absolutely required. This is the first of our conclusions.

   Like all of us, power plant facilities incur some problems naturally as they age. As we require periodic health examinations followed by treatment, so do power plant facilities. Getting aged requires special inspections and treatment that is "rehabilitation".

   How the power plant has handled facility (hardware) problems and how it will cope with facility problems in the future determine reliability of the power plant. "What is the complete periodic overhaul maintenance ?" is a theme which not only the NPC task force, but everyone concerned are expected to consider.

   The periodic overhaul discussed here is the general term for the standardized annual overhaul work accompanied by regular inspections.

2) In order to assure complete overhaul, establishment of overhaul regulations and overhaul planning/preparation system and reinforcement of Maintenance Services Department (MSD) are considered essential.

   Support systems of MSD such as those for spare parts supply, supply of construction machines and overhaul tools, transportation, communications, lodging facilities, etc. are also indispensable. Above items are basically regarded as the software issues, however, hardware such as spare parts, construction machines, tools, transportation, etc. relevant to the above software items are also discussed. As well as the solution of the software issues mentioned above improvement of such personnel related matter as the education/training of power plant operators as well as systems for job rotation and personnel promotion/pay hike are also the matters of significance in view of the brush-up of skills and morale enhancement.

3) Most of the software problems are not so simple as those of hardware which can be solved by replacement or repair of defective parts. Software problems are difficult, require time and effort to solve, and related to not only Malaya TPP but also all thermal power plants. Therefore, from the beginning, a campaign appealing to all concerned to make efforts to realize the improvement should be launched.

Our proposal for the goal and slogan of the campaign is "No Forced Outages and No Accidents."

4) After all, the hardware and software improvement must be carried out concurrently so that the plant reliability could be attained. Taking into the lead time for implementation of the hardware improvement, the implementation will be the 3rd or 4th year after this study. Accordingly, the implementation plan of the reliability improvement program, or Overall Schedule, is set as follows:

a. Implementation year : From 1995 to 1999

b. Duration : 5 years

c. Hardware Improvement

a) Program-I

- Rehabilitation Project : 10 months for Unit No. 1 from 1979 to 1998
  3 months for Unit No. 2 in 1997

b) Periodic Overhaul : Once a year from 1995 to 1999
  In the year when the rehabilitation is carried out, the periodic overhaul shall be carried out at the same time.

d. Software Improvement

a) Program-II

- Improvement of procedure and organization for planning of periodic overhaul
- Improvement of procedure and organization for implementation of periodic overhaul
- Measures for safe and reliable operation

b) Program-III

- Improvement related to education and training of employee
- Morale enhancement

e. "No Forced Outage and No Accident" Movement

- Through 5 years

2.2 Improvement Plan

2.2.1 Reliability Improvement of Power Plant Facilities (Hardware)

We provide a improvement plan which is a combination of rehabilitation; Program-I and periodic overhauls.

1) Effects of Project

a. Recovery of Rated Output

The unit output will be recovered to 300 MW for Unit No. 1 and 350 MW for Unit No. 2.

b. Recovery of Plant Efficiency

The efficiency will be recovered to a 1988 value after the previous rehabilitation project.

c. Improvement of Reliability

The reliability will be improved, and the units can be operated with a higher capacity factor in 1988 after the previous rehabilitation project.

d. Service Life

Both the units will be operated until the originally scheduled retirement year, 2005 for Unit No. 1 and 2009 for Unit No. 2.

2) Major Work Items

In order to obtain the project effects mentioned above, the following major works should be carried out in addition to the comprehensive overhaul work of the power plant facilities.

a. Malaya Unit No. 1

Plant Facilities	Major Work Items
Boiler	- Replacement of whole water wall tubes. - Boiler chemical cleaning - Examination of secondary superheater - Complete repair of boiler casing and gas duct - Replacement of heating elements of air pre-heater - Improvement of dust collector and ash handling system - Rehabilitation of smoke stack inner lining - Study on fuel additive injection - Installation of additional sootblower at secondary superheater section
Turbine	- Life expectancy analysis (HP-, IP- & LP-turbines, Major Valves, Main steam pipe, Reheat steam pipe) - Comprehensive overhaul of HP-turbine or replacement with higher efficiency HP turbine - Comprehensive overhaul of IP-turbine - Replacement of IP-turbine rotor - Comprehensive overhaul of LP-turbine and replacement of cut blades - Eddy current test of condenser tubes - Replacement of tube handle of LP feedwater heater or replacement of complete assembly - Replacement of condensate distributor of deaerator or replacement with spray type deaerator - Replacement of circulating water pump - Installation of additional plate type heat exchanger
Electrical Facilities	- Repair of generator stator core end - Installation of spare 4160V switchgear cubicle - Installation of spare 480 control center
Instrument & Control Facilities	- Replacement of boiler metal temperature recorder, etc. - Replacement of control valves and instruments - Improvement of minimum flow control of boiler feed pumps

a. Malaya Unit No. 1 (cont'd)

Plant Facilities	Major Work Items
Chemical Facilities	- Recovery of automatic operation of condensate polishing plant and comprehensive overhaul - Installation of magnetic filter - Establishment of steady raw water supply system to demineralizing plant - Replenishment of chemical apparatus for laboratory

b. Malaya Unit No. 2

Plant Facilities	Major Work Items
Boiler	- Replacement of boiler hopper tubes - Replacement of superheater spray nozzles - Replacement of feedwater stop valve at economizer inlet - Complete repair of boiler casing and gas duct - Replacement of GRF rotor - Replacement of heating elements of air pre-heater - Replacement of defective sections of steam coil air heater - Improvement of dust collector and ash handling system - Rehabilitation of smoke stack inner lining - Study on fuel additive injection - Life expectancy analysis of main steam pipe and reheat steam pipe
Turbine	- Comprehensive overhaul of HP-, IP- & LP-turbines and life expectancy analysis - Eddy current test of condenser tubes - Replacement of raw water pump for heat exchanger
Electrical Facilities	- Replacement of whole 480V motor control center and others
Instruments and Control Facilities	- Replacement of GRF damper controller - Replacement of automatic boiler control (ABC) and others
Chemical Facilities	- Replacement of whole sampling rack

b. Malaya Unit No. 2 (cont'd)

Plant Facilities	Major Work Items
Common Facilities	- Replacement of auxiliary boiler tubes and countermeasure for corrosion - Installation of concrete sheet pile at intake channel - Additional installation and repair of lighting fixtures of powerhouse and boiler house.

3) Implementation Plan (See Figure 2-1)

a. First Year

- A Major Overhaul will be carried out for both the Units No. 1 and No. 2
- Remaining service life of boilers, turbines, and generators will be diagnosed.

Based on the results of the above work, implementation plans for overhauls and rehabilitation work for the 2nd and subsequent years will be drawn up.

b. Second Year

- An annual overhaul will be carried out for both the Units No. 1 and No. 2. Work periods will be relatively short.
- Sections left uninspected during the Major Overhaul in the first year will be inspected to determine the degree of deterioration. The results will be reflected in the plans for rehabilitation.

c. Third Year

- Rehabilitation and overhaul will be executed.
- For rehabilitation work items, refer to the foregoing clause 2) and Chapter 4, Clause 4.3 in detail.

d. Fourth Year

- One year after completion of rehabilitation, a simplified annual overhaul will be conducted to check the sections repaired, replaced or improved during the

rehabilitation. Items left uncorrected during the 3rd overhaul (Rehabilitation), if any, will be properly rectified.

- All defective sections will be completely rectified by the rehabilitation and four periodic overhauls.

c. Fifth Year

- In the second year after completion of rehabilitation, a Major Overhaul will be carried out.
- In accordance with the inspection results, standards for future overhauls and deterioration surveys will be formulated.
- If this 5th Major Overhaul does not fit within the planned time-frame of 5 years, the 4th annual overhaul will be conducted as this Major Overhaul.

4) Implementation Method

a. Rehabilitation

- Rehabilitation of major equipment will be subcontracted to individual contractors including the original manufacturers. Their responsibilities will be made clear by a 'turnkey' contract.
- Supervision over the entire job will be conducted with assistance of a consultant.

b. Overhauls

- Overhauls will be executed by the NPC.
- Planning and supervision of the remaining life and deterioration surveys will be conducted with assistance of a consultant. Actual surveys and work will be subcontracted.

c. Costs

- Funds for rehabilitation and post-rehabilitation overhauls (construction costs) will be procured through a loan.

5) Costs of Work

[UNIT: x 1,000 US$]

Items	UNIT NO. 1			UNIT NO.2			UNIT NOS. 1 & 2		
	F. C.	L. C.	TOTAL	F. C.	L. C.	TOTAL	F. C.	L. C.	TOTAL
1. Rehabilitation cost	96,134	5,161	101,295	36,817	1,977	38,794	132,951	7,138	140,089
2. Consultant fee	3,580	188	3,768	1,170	62	1,232	4,750	250	5,000
3. Total project cost	99,714	5,349	105,063	37,987	2,039	40,026	137,701	7,388	145,089

6) Projected Disbursement Schedule

Unit: Thousand US $

	No. 1 Unit	No. 2 Unit	Total
1995	1,815	1,586	3,401
1996	15,746	5,862	21,608
1997	55,316	30,464	85,779
1998	30,373	1,057	31,430
1999	1,814	1,057	2,870
Total	105,063	40,026	145,089

2.2.2 Improvement Plan for Operations and Maintenance Management (Software)

In order to solve the various problems concerning operations and maintenance, we recommend that the following improvement plan be studied and implemented.

PRIORITY ITEMS OF IMPLEMENTATION:

Program-II

I. Formulation of complete periodic overhaul plan
II. Implementation of complete periodic overhaul
III. Safe and reliable operations

Program-III

IV. Hiring, education and training of personnel
V. Improvement of morale

The essential points of the improvement plan for the respective priority items are given below. For Program-II, further detailed survey (F/S) is deemed necessary. For other recommendations not included in the improvement plan, refer to Chapter 5.2.

1) Formulation of Complete Periodic Overhaul Plan (Priority Item I)

a. Preparation and Establishment of Periodic Overhaul Standards

a) Establishment of the standards for periodic inspection categories and intervals
Annual implementation plan should be strictly observed.
Particularly, work schedule and period should never be arbitrarily changed without satisfactory or proper justification.

b) Standardization of the items and scope of inspection and repair work to be repeated with overhauls.

b. Establishment of Days for Standard Periodic Overhaul for Each Power Plant Unit.

c. Reinforcement of Periodic Overhaul Plan Formulating Function

a) Clarification of departments or sections, in power plant and MSD, in charge of periodic overhaul planning and the scope of their responsibilities

b) Plan for diagnosis of the life-span of important equipment and deterioration survey.

2) Complete Implementation of Periodic Overhaul (Priority Item II)

a. Mandatory Implementation of Periodic Overhaul in Conformity to the Periodic Overhaul Standards

a) Establishment of company guidelines stipulating mandatory implementation of periodic inspections

b) Study of legal measures applicable in support of these company guidelines

b. Capability Improvement Plan for MSD's Work Implementation

a) Required Staff Size and Supplementing Measures
- Estimate of required number of MSD staff
- Recruitment from both in-house and outside sources
- Measures for in-house recruitment

b) Arrangement of Support System for Overhaul Works
- Supply of spare parts for overhaul
- Procurement of machines and tools for overhaul works (lacking and short items)
- Procurement of vehicles for transportation of personnel and equipment/materials
- Construction of lodging facilities for overhaul workers at site, MSD site offices at power plants, equipment/material center, training center, etc.
- Preparation of communication systems

c) Nurturing and Training of Subcontractors

- Supplementing of staff from outside sources will be made through subcontracting.

c. Establishment of Organized Work Implementation System and Lines of Responsibility for Periodic Overhauls

a) Promotion of work schedule and quality control

b) Expediting (following-up) of ordered items

c) Implementation of diagnosis of the life-span of important equipment as well as deterioration survey

3) Safe and Reliable Operations (Priority Item III)

Points

1. Prevention of operational error, early detection of abnormal symptoms or such section during operation
2. Establishment of operating system being cognizant that some operations will be conducted by young inexperienced operators

a. Complete Preparation of Operational Procedures and Manuals
Manuals should be prepared to meet the purpose of OMP project.

b. Daily patrol and inspections, and routine work should be strictly carried out.

a) Daily patrol inspections

b) Periodic routine operations including spare equipment switching tests

- Preparation of routine operation check sheet, etc. for prevention of operational error and for recording

c. Review of Shift Operations System

a) Operation staff, and rotation staff structure

- Since the present full strength staff size needs to be examined for its adequateness for all power plants and MSD, the full strength of rotation staff will also be examined.

b) Increase of Shuttle Bus Operations

- Increase of shuttle bus service

4) Hiring, Education and Training of Personnel (Priority Item IV)

Points

1. Since people solve problems, the reliability improvement for the Malaya TPP cannot be expected without addressing those issues relating to human resources.
2. In recognition of the importance of this issue, the NPC has been studying the improvement measures including the educational and training programs prepared for new employees.
3. Improvement measures to complement and reinforce NPC's own efforts need to be put into practice as soon as possible.
4. Improvement of morale

a. Hiring of Personnel

a) Review of Full Strength

- In order to promote efficient job operation based on the management policy of the company, without increasing the total staff size, the present staff size allocated for each power station, MSD, etc. should be re-examined.
- Estimates should be made for changes in staff size accompanying the projected construction/addition or abolition of power plants.

b) Drawing Up a Long-term Staff Plan

- In reference to the results of above-mentioned review and estimation, long-term staff plan should be drawn up, and based on the plan, the annual number of new employees should be stabilized.

c) Review of Hiring System

- Current system of hiring irregularly only when vacancies need to be filled should be replaced by annual hiring of all new employees together at a time based on the long-term hiring plan.

b. Education and Training

a) Education of New Employees

- Newly employed power plant staff and newly employed MMRC engineers will be educated collectively.

  Linked with periodic once-a-year employment, this will be implemented at the NPC training center.
- After collective education at the training center, the new members allocated to each station will be given orientation and training.

b) Education of Staff Members with Some Years of Experience

- Operation training by simulator for operators

  Operation training by simulator shall be implemented systematically every year for all operators after their 1st year of employment including the younger employees and seasoned staff and leaders.
- Position training for operators

  Position training shall be implemented systematically, irrelevant to the necessity of transfer to fill retired operator's or other vacancies.

  All shall undergo training to acquire skill and knowledge for multiple positions.

c) Personnel Transfer, Job Rotation and Position Training

- Multiple position training facilitates job rotation.
- By giving higher priority for promotion to those who have acquired skill and knowledge for multiple positions, the opportunities of transfer of personnel and promotion will increase.

d) Overseas Training for Seasoned Operators and Maintenance/Repair Engineers

e) Retaining Operations and Maintenance/Repair Consultants

Schedule	Duration and number of consultants	
	First phase	Second phase
Before rehabilitation	2 years, 2 people	-
After rehabilitation	-	2 years, 2 people

5) Improvement of Morale (Priority Item V)

a. Feasibility Study of Qualification System

- Qualification system to evaluate the knowledge and skill of the individual achieved through education, training or voluntary self enhancing efforts (OJT) will be adopted.
- For seasoned technical personnel, periodic examinations on academic subjects and practical job performance (or practical skill) will be conducted, for which a minimum number of years in a certain position will be a requirement.
  Those who have passed the examination will be rated and given a certain qualification and will be given priority for promotion.
  (Qualification for operators is currently under study at the NPC.)

b. Implementation of Education and Training for Morale Improvement
  All personnel in every power plant shall take the course by turns.

c. Study of Adoption of Periodic Personnel Transfer System
  Rotation of personnel between different sections within the power plant, and where possible, between different power plants and/or MMRC, will be systematized to prevent employee burnout.

d. Implementation of an Incentive System
  The system seems to exist, therefore the applicable range should be expanded.
  - Activities of quality control and/or other similar groups to make voluntary proposals should be encouraged. In combination with an incentive system, support shall be provided to these activities to encourage and motivate all members to exercise their originality and ingenuity in the workplace.

2.2.3 Implementation Method

Reliability improvement plan for the Malaya TPP, as explained previously, has to be executed in parallel with rehabilitation of power plant facilities and improvement of operations and maintenance procedures. The following are recommended in coordination with this principle:

1) Classification of Implementation Plan

For actual implementation, the above-stated priority items shall be categorized into the following 3 programs.

Program-I	:	Power plant facility rehabilitation project
Program-II	:	a. Improvement of periodic overhaul plan methods and system
		b. Reinforcement of periodic overhaul implementation methods and system
		c. Measures for safe and reliable operation
Program-III	:	a. Hiring, education and training of personnel
		b. Morale enhancement

2) Project Implementation

a. Implementation Methods

a) Program-I

Like other conventional rehabilitation projects for the power plant facilities, this program shall be executed by contracted work to contractors.

b) Program-II

Task forces will be organized with the operations and maintenance staff members from NPC Head Office, MMRC, power plants, MSD and MEC. The program shall be carried out in cooperation with OMP and MMP groups.

Like the study for MSD reinforcement versatile review in detail of hardware and software is required for this program.

Therefore, along with the review of the software for the other two important items, 'Complete Periodic Overhaul Plan' and 'Safe and Reliable Operation,' one study project shall be formed and an immediate Feasibility Study (F/S) shall be conducted.

However, there are items in Program-II, which need to be implemented at once and can also be implemented as soon as the NPC system has been ready, such as those related to 'Safe and Reliable Operation.' They include:

- Preparation of operations manuals and procedures
- Review of daily patrol and inspections, and routine work
- Review of operational shift system, etc.

We recommend that these be categorized under Program-II/Phase-I, and to be carried out in parallel with the aforementioned F/S led by the NPC task forces and supported by consultants.

c) Program-III

Task forces shall be organized, involving power plant staff, led mainly by NPC Head Office Human Resources and MMRC Human Resources Section. Then the concrete improvement plan shall be studied and executed by referring to the advice given in this study report.

b. Implementation Schedule

The implementation schedule for these three types of programs are as shown in Figure 2-1 Malaya TPP Reliability Improvement Plan, Implementation Schedule.

Figure 2-1 Improvement Plan Overall Schedule

	1st year 1995	2nd year 1996	3rd year 1997	4th year 1998	5th year 1999
1. Program-I					
Rehabilitation (Hardware) Unit No.1	Major Overhaul	Annual Overhaul		Major Overhaul REHABILITATION	Major Overhaul
Unit No.2	Major Overhaul	Annual Overhaul	Major Overhaul REHABILITATION	Annual Overhaul	Major Overhaul
2. Program-II					
1) Feasibility Study on Program-II					
2) Implementation of Program-II		Phase-I	Phase-II		
a. Improvement of Planning system of Overhaul		Detailed Study Taskforce	Implementation		
b. Reinforcement of Implementation System of Overhaul					
a) Regulations of Overhaul, etc.		Detailed Study Taskforce	Implementation		
b) Reinforcement of MSD					
• Personnel&System		Detailed Study Taskforce Peparation	Addition of Personnel & training		
• Procurement of tools, machines, vehicles, etc. for overhaul		Peparation	Procurement		
• Construction of Facilities.		Peparation	Construction		
・Site offices at P/S.					
・Material Centre					
・Training Centre, etc.					
c) Preparation of various Manuals	Preparation		Implementation		
c. Countermeasures for Safe and Reliable operation		Detailed Study Taskforce	Implementation		
3. Program-III					
1) Improvement of Hiring, Education and Training System	Detailed study Taskforce		Implementation		
2) Improvement of Morale	Detailed study Taskforce		Implementation		

2.2.4 Economic and Financial Evaluation

1) Economic Evaluation

The study team concluded through technical study that there are merits of the rehabilitation project; output recovery, reliability improvement, etc. Based on these merits, the economic evaluation will be done to check if the Project would economically benefit to the society as compared with the alternatives that can provide with the same services by Malaya TPP after rehabilitation (With Project). The economic internal rate of return, EIRR, will be calculated and compared with the discount rate set forth for this type of Project in the Philippines. The study team applied the alternative for the economic evaluation this time; namely the cost of the With project is taken as *Cost* (project cost plus fuel cost) and the cost of Without as *Benefit* (fuel cost plus expenses for supplementary power supply/purchase). The operation and maintenance cost, interest expenses, other overhead costs are disregarded because these costs will be necessary for both With and Without cases.

It is recommended that the rehabilitation items, cost estimate of the equipment, and these assumed operating conditions be reviewed in collation with the actual operating conditions whenever the management will be required decision making concerning this rehabilitation project.

2) Result of Economic Evaluation

a. Energy Generated and Unit Generating Cost

The following table shows comparisons of energy generated and average generating cost per kWh between With and Without cases. The generating cost of the With cases considers the levelized investment for rehabilitation works with a discount rate of 15% and both the generating costs are average values for the respective operating years.

	M-1		M-2	
	With	Without	With	Without
Energy Production in GWh	12,877	8,032	25,754	18,172
Unit Gen. Cost in P/kWh*	1.3108	1.2249	1.0224	1.0383

Concerning the comparison of energy generated, the capacity factor decline greatly influence on the energy production of the Without case as a matter of course. The energy production of the Without cases will be about 62% for M-1 and 70% for M-2 as against the With case. Since the insufficiency in energy production should rely on purchase of the energy, the economic impact of the With case in this point of view is significant.

In the other hand, the unit generating cost of the With case become higher than that of the Without case because of a large amount of investment to the rehabilitation works. The generating cost of the With case, however, is still lower than the average power rate in Luzon Grid at 1.8505 peso per kWh and that of other Non-NPC power supply sources.

b. EIRR of Base Case

Each EIRR value depending on the supplementary power sources at the base case (the capacity factor at 70% at With case and fuel oil cost at US$15/bbl) is calculated. Also EIRRs of M-1 only, M-2 only and combination thereof are calculated as summarized below.

EIRR of the Project

Supplementary Power Source	M-1 Only	M-2 Only	M-1 & M-2 Combined
LUZON GRID Average	2.27%	26.65%	12.32%
Oil based	1.34%	25.47%	11.35%
Coal	3.74%	28.52%	13.86%
Geothermal	1.39%	25.53%	11.40%
Gas turbine	25.46%	58.77%	37.40%
NON NPC PLANTS Average	21.57%	52.97%	33.06%
Oil based	17.60%	47.23%	28.69%
Coal	15.29%	43.97%	26.17%

Gas Turbine	32.65%	69.94%	45.59%

c. Conclusion

Shorter economic benefit recovery period compared with the investment to M-1, seven years only, greatly gave the adverse effect to the overall economic evaluation while M-2 rehabilitation with smaller investment and the longer recovery period became competitive with most of the alternative cases except only NPC's geothermal power supply. In consideration of the fact that the republic is now concentrating the development of large scale coal-fired thermal power plant comparable to these objective units in term of output capacity, the competition with the coal-fired power units, probably combination of NPC's own source and non-NPC source, is the most probable case. In this case, the project EIRR became 13.86%, which is below NEDA's 15% but exceeds current discount rate of the Philippines at 12%. So, the report concludes that the project is economically feasible from the stand point of NPC.

As a result of sensitivity analysis, too, the sensitivity to the capacity factor is very high and a few drops of the capacity factor may jeopardize the project economy even the coal-fired thermal is selected as an alternative. From the economic view point, maintenance of the plant dependability and availability is crucial if this project should be pursued. As to the project total cost, the estimated cost still have a few margins if the first contender is considered as the coal-thermal. Should the supplementary energy in the case of Without be supplied through purchase of Non-NPC plants, this project is highly worth to pursue economically. Namely, the implementation of this rehabilitation project is much better for NPC rather than that NPC increases the purchase from Non-NPC power sources.

3) Financial Evaluation

Financial soundness of Malaya thermal power station after rehabilitation, or operation of these units by NPC, will be analyzed by an internal rate of return method, and then FIRR will be compared with the opportunity cost of capital for the project. The benefit of the project will be the balance of energy production and sales between With and Without cases. In addition, the financial statements; cash flow balance, income statement and repayment schedule, will be prepared.

4) Result of Financial Evaluation

Financial internal rates of return of the project stand at 16.06% for M-1, 46.67% for M-2 and 29.74% for the combined. As these figures well cleared the opportunity cost of capital at 5.8% and even the rate base of NPC at 8%, the project is concluded financially feasible. Those financial evaluations this time compared the balance of energy production between the With and Without cases, the financial evaluation with the actual cases taking the benefit as power sale by With case only may result in similar FIRR values since the depreciation and interest portions in the power rate were deducted in the With/Without FIRR calculations.

Should the technical and physical restoration of the equipment and facilities be attained as engineered, the project is concluded financially feasible.

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Table 2-1 Economic Internal Rate of Return

No. 1 & No. 2 Combined EIRR =	12.32%	11.35%	13.86%	11.40%	37.40%	33.06%	28.69%	26.17%	45.59%
EIRR =	2.27%	1.34%	3.73%	1.39%	26.46%	21.57%	17.80%	15.29%	32.65%

No. 1 Unit

Year		WITH REHABILITATION								WITHOUT REHABILITATION							Supply by Other Power Sources (PAVVh)									
		Project Cost	M-1 WITH Capability	Capacity Factor	Annual Energy	Effici-ency	Fuel Consump.	Fuel Cost	With Total Cost	M-1 W/O Capability	Capacity Factor	Annual Energy	Effici-ency	Fuel Consump.	Fuel Cost	Supple-mental Energy	Luzon Grid Average	Oil Based	Coal	Geo-thermal	Gas Turbine	Non NPC Average	Non NPC Oil	Non NPC Coal	Non NPC Gas T.	
		Thous $	MW	%	GWh	%	Mil. lit.	Thous $	Thous $	MW	%	GWh	%	Mil. lit.	Thous $	GWh	1.0797	1.051	1.1264	1.0525	2.088	1.878	1.6809	1.5742	2.5209	pkWh
0	1994	0							0								0	0	0	0	0	0	0	0	0	
1	1995	1,815							1,815								-1,815	-1,815	-1,815	-1,815	-1,815	-1,815	-1,815	-1,815	-1,815	
2	1996	15,746							15,746								-15,746	-15,746	-15,746	-15,746	-15,746	-15,746	-15,746	-15,746	-15,746	
3	1997	55,315							55,315								-55,315	-55,315	-55,315	-55,315	-55,315	-55,315	-55,315	-55,315	-55,315	
4	1998	30,373							30,373								-30,373	-30,373	-30,373	-30,373	-30,373	-30,373	-30,373	-30,373	-30,373	
5	1999	1,814	300	70%	1,839.60	33.27%	488.30	48,216	50,030	300	47.50%	1,246.30	29.69%	371.30	36,663	591.30	11,188	10,535	12,250	10,569	34,119	29,343	24,861	22,434	43,964	
6	2000	0	300	70%	1,839.60	33.19%	489.48	48,332	48,332	300	46.16%	1,213.08	28.85%	371.33	36,666	626.52	14,351	13,660	15,477	13,696	38,648	33,586	28,839	26,267	49,080	
7	2001	0	300	70%	1,839.60	33.11%	490.66	48,449	48,449	300	44.86%	1,178.92	28.04%	371.30	36,663	660.68	15,650	14,921	16,837	14,959	41,272	35,935	30,927	28,216	52,272	
8	2002	0	300	70%	1,839.60	33.03%	491.85	48,566	48,566	300	43.59%	1,145.55	27.25%	371.25	36,658	694.05	16,914	16,148	18,160	16,188	43,830	38,224	32,982	30,114	55,385	
9	2003	0	300	70%	1,839.60	32.95%	493.04	48,684	48,684	300	42.36%	1,113.22	26.48%	371.26	36,659	726.38	18,139	17,338	19,444	17,379	46,309	40,442	34,935	31,955	58,403	
10	2004	0	300	70%	1,839.60	32.87%	494.24	48,802	48,802	300	41.17%	1,081.95	25.73%	371.35	36,668	757.65	19,329	18,493	20,690	18,536	48,711	42,592	36,848	33,739	61,326	
11	2005	0	300	70%	1,839.60	32.79%	495.45	48,922	48,922	300	40.01%	1,051.46	25.00%	371.42	36,675	788.14	20,482	19,612	21,898	19,658	51,047	44,661	38,706	35,472	64,169	
12	2006	0																								
13	2007	0																								
14	2008	0																								
15	2009	0																								
Total		105,063			12,877.20		3,443	339,971	445,034			8032.48		2599.21	256,652	4,844.72	12,804	7,458	21,507	7,736	200,687	161,556	124,829	104,948	281,350	

EIRR =	26.65%	25.47%	26.52%	25.53%	58.77%	52.97%	47.23%	43.97%	69.94%

No. 2 Unit

Year		WITH REHABILITATION								WITHOUT REHABILITATION							Supply by Other Power Sources (PAVVh)									
		Project Cost	M-2 WITH Capability	Capacity Factor	Annual Energy	Effici-ency	Fuel Consump.	Fuel Cost	With Total Cost	M-2 W/O Capability	Capacity Factor	Annual Energy	Effici-ency	Fuel Consump.	Fuel Cost	Supple-mental Energy	Luzon Grid Average	Oil Based	Coal	Geo-thermal	Gas Turbine	Non NPC Average	Non NPC Oil	Non NPC Coal	Non NPC Gas T.	
		Thous $	MW	%	GWh	%	Mil. lit.	Thous $	Thous $	MW	%	GWh	%	Mil. lit.	Thous $	GWh	1.0797	1.051	1.1264	1.0525	2.088	1.878	1.6809	1.5742	2.5209	pkWh
0	1994	0							0								0	0	0	0	0	0	0	0	0	
1	1995	1,586							1586								-1,586	-1,586	-1,586	-1,586	-1,586	-1,586	-1,586	-1,586	-1,586	
2	1996	5,862							5862								-5,862	-5,862	-5,862	-5,862	-5,862	-5,862	-5,862	-5,862	-5,862	
3	1997	30,464							30464								-30,464	-30,464	-30,464	-30,464	-30,464	-30,464	-30,464	-30,464	-30,464	
4	1998	1,057	350	70%	2,146.20	34.90%	543.08	53,625	54,682	350	60.00%	1,839.60	32.33%	502.50	49,618	306.60	7,668	7,330	8,219	7,347	19,556	17,082	14,758	13,499	24,663	
5	1999	1,057	350	70%	2,146.20	34.82%	544.33	53,748	54,805	350	57.83%	1,773.07	32.11%	487.64	48,151	373.13	8,841	8,429	9,511	8,451	23,311	20,297	17,469	15,938	29,524	
6	2000	0	350	70%	2,146.20	34.74%	545.58	53,872	53,872	350	55.74%	1,708.99	31.89%	473.26	46,731	437.21	11,015	10,532	11,800	10,558	27,970	24,439	21,125	19,330	35,250	
7	2001	0	350	70%	2,146.20	34.66%	546.84	53,996	53,996	350	53.72%	1,647.06	31.67%	459.28	45,350	499.14	12,082	11,531	12,978	11,560	31,439	27,407	23,623	21,575	39,749	
8	2002	0	350	70%	2,146.20	34.58%	548.10	54,121	54,121	350	51.78%	1,587.57	31.45%	445.79	44,018	558.63	13,095	12,479	14,099	12,511	34,759	30,247	26,012	23,720	44,060	
9	2003	0	350	70%	2,146.20	34.50%	549.38	54,247	54,247	350	49.91%	1,530.24	31.24%	432.58	42,714	615.96	14,048	13,366	15,152	13,402	37,933	32,958	28,289	25,761	48,189	
10	2004	0	350	70%	2,146.20	34.42%	550.65	54,372	54,372	350	48.10%	1,474.75	31.03%	419.72	41,444	671.45	14,955	14,214	16,161	14,253	40,995	35,571	30,481	27,726	52,174	
11	2005	0	350	70%	2,146.20	34.34%	551.93	54,499	54,499	350	46.36%	1,421.40	30.82%	407.29	40,217	724.80	15,817	15,017	17,119	15,056	43,925	38,071	32,576	29,602	55,993	
12	2006	0	350	70%	2,146.20	34.26%	553.22	54,626	54,626	350	44.66%	1,369.89	30.61%	395.22	39,025	776.31	16,637	15,760	18,031	15,825	46,743	40,472	34,587	31,402	59,668	
13	2007	0	350	70%	2,146.20	34.18%	554.52	54,754	54,754	350	43.06%	1,320.22	30.40%	383.52	37,870	825.98	17,416	16,505	18,900	16,552	49,449	42,777	36,516	33,126	63,201	
14	2008	0	350	70%	2,146.20	34.10%	555.82	54,883	54,883	350	41.50%	1,272.39	30.19%	372.20	36,752	873.81	18,156	17,191	19,725	17,242	52,043	44,985	38,361	34,775	66,592	
15	2009	0	350	70%	2,146.20	34.02%	557.13	55,012	55,012	350	40.00%	1,226.40	29.98%	361.26	35,672	919.80	18,856	17,841	20,509	17,894	54,527	47,096	40,125	36,350	69,842	
Total		40,026			25,754.40		6,600.58	651,755	691,781			18,171.58		5140.26	507,562	7,583	130,672	122,303	144,292	122,741	424,740	363,492	306,010	274,892	550,993	

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Table 2-2 FIRR Calculations

M-1 & M-2 Combined FIRR = 29.74%

No. 1 Unit

FIRR = 16.06%

		WITH REHABILITATION								WITHOUT REHABILITATION										
	Year	Project Cost	M-1 WITH Capability	Capacity Factor	Annual Energy	Effici-ency	Fuel Consump	Fuel Cost	With Total Cost	M-1 W/O Capability	Capacity Factor	Annual Energy	Effici-ency	Fuel Consump	Fuel Cost	Benefit Energy With	Balance of Fuel Cost	Energy Sale Benefit	Cost Balance
		Thous $	MW	%	GWh	%	Mil. lit.	Thous $	Thous $	MW	%	GWh	%	Mil. lit.	Thous $	GWh	Thous $	Thous $	Thous $
0	1994																		
1	1995	1,815							1,815										-1,815
2	1996	15,746							15,746										-15,746
3	1997	55,315							55,315										-55,315
4	1998	30,373							30,373										-30,373
5	1999	1,814	300	70%	1,839.60	33.27%	488.30	44,346	46,160	300	47.50%	1248.3	29.69%	371.30	33,721	591.30	-10,625	35,765	23,326
6	2000		300	70%	1,839.60	33.19%	489.48	44,453	44,453	300	46.16%	1213.08	28.85%	371.33	33,723	626.52	-10,730	37,895	27,165
7	2001		300	70%	1,839.60	33.11%	490.66	44,561	44,561	300	44.86%	1178.92	28.04%	371.30	33,721	660.68	-10,840	39,961	29,121
8	2002		300	70%	1,839.60	33.03%	491.85	44,669	44,669	300	43.59%	1145.55	27.25%	371.25	33,716	694.05	-10,953	41,979	31,026
9	2003		300	70%	1,839.60	32.95%	493.04	44,777	44,777	300	42.36%	1113.22	26.48%	371.26	33,717	726.38	-11,060	43,935	32,875
10	2004		300	70%	1,839.60	32.87%	494.24	44,886	44,886	300	41.17%	1081.95	25.73%	371.35	33,725	757.65	-11,161	45,826	34,665
11	2005		300	70%	1,839.60	32.79%	495.45	44,996	44,996	300	40.01%	1051.46	25.00%	371.42	33,731	788.14	-11,265	47,670	36,405
12	2006																		
13	2007																		
14	2008																		
15	2009																		
Total		105,063			12,877.20		3,443	312,688	417,751			8032.48		2599.21	236,054	4844.72	-76,634	293,031	111,334

No. 2 Unit

FIRR = 46.67%

		WITH REHABILITATION								WITHOUT REHABILITATION										
	Year	Project Cost	M-2 WITH Capability	Capacity Factor	Annual Energy	Effici-ency	Fuel Consump	Fuel Cost	With Total Cost	M-2 W/O Capability	Capacity Factor	Annual Energy	Effici-ency	Fuel Consump	Fuel Cost	Benefit Energy With	Balance of Fuel Cost	Energy Sale Benefit	Cost Balance
		Thous $	MW	%	GWh	%	Mil. lit.	Thous $	Thous $	MW	%	GWh	%	Mil. lit.	Thous $	GWh	Thous $	Thous $	Thous $
0	1994																		
1	1995	1,586							1,586										-1586
2	1996	5,862							5,862										-5862
3	1997	30,464							30,464										-30,464
4	1998	1,057	350	70%	2,146.20	34.90%	543.08	49,321	50,378	350	60.00%	1,839.60	32.33%	502.50	45,636	306.6	-3,685	18,545	13,803
5	1999	1,057	350	70%	2,146.20	34.82%	544.33	49,435	50,492	350	57.83%	1,773.07	32.11%	487.64	44,286	373.13	-5,149	22,569	16,363
6	2000		350	70%	2,146.20	34.74%	545.58	49,548	49,548	350	55.74%	1,708.99	31.89%	473.26	42,960	437.21	-6,568	26,444	19,876
7	2001		350	70%	2,146.20	34.66%	546.84	49,663	49,663	350	53.72%	1,647.06	31.67%	459.28	41,711	499.14	-7,952	30,190	22,238
8	2002		350	70%	2,146.20	34.58%	548.10	49,777	49,777	350	51.78%	1,587.57	31.45%	445.79	40,486	558.63	-9,291	33,789	24,498
9	2003		350	70%	2,146.20	34.50%	549.38	49,893	49,893	350	49.91%	1,530.24	31.24%	432.58	39,286	615.96	-10,607	37,256	26,649
10	2004		350	70%	2,146.20	34.42%	550.65	50,009	50,009	350	48.10%	1,474.75	31.03%	419.72	38,118	671.45	-11,891	40,612	28,721
11	2005		350	70%	2,146.20	34.34%	551.93	50,125	50,125	350	46.36%	1,421.40	30.82%	407.29	36,989	724.80	-13,136	43,839	30,703
12	2006		350	70%	2,146.20	34.26%	553.22	50,242	50,242	350	44.68%	1,369.89	30.61%	395.22	35,893	776.31	-14,349	46,955	32,606
13	2007		350	70%	2,146.20	34.18%	554.52	50,360	50,360	350	43.06%	1,320.22	30.40%	383.52	34,830	825.98	-15,530	49,959	34,429
14	2008		350	70%	2,146.20	34.10%	555.82	50,478	50,478	350	41.50%	1,272.39	30.19%	372.20	33,802	873.81	-16,676	52,852	36,176
15	2009		350	70%	2,146.20	34.02%	557.13	50,597	50,597	350	40.00%	1,226.40	29.98%	361.26	32,809	919.80	-17,788	55,634	37,846
Total		40,026			25,754.40		6,601	599,448	639,474			18,172		5140.26	466,826	7582.82	-132,622	458,644	285,996

2.2.5 Recommendation on Environmental Improvement

1) Air Pollution

a. Procurement of Fuel Oil Sulfur Meter

The sulfur content in fuel which is restricted by national regulations can be controlled and the SO_2 content in stack gas can be calculated.

b. Measurement of NO_x Content in Flue Gas

NO_x in the power plant stack gas is not measured. Since a standard value for NO_x emission has been established by national regulations, measurement should be implemented by all means.

c. Procurement of Anemometer with Continuous Recorder

In the Environmental Impact Assessment for existing courses and new sources, the Philippine government requires an atmospheric diffusion forecast calculation. However, forecast calculation is not possible due to the unavailability of meteorological data (wind direction and velocity data, in particular) for the area. It is necessary for the NPC to purchase one or two sets of anemometers and consecutively take meteorological data for one year for each existing thermal power plant as well as for the planned sites for new thermal power plants.

2) Water Contamination

a. Relocation of the Waste Water Neutralization Tank, and Installation of Neutralization Vessel

Current neutralization method of adding caustic soda cannot ensure satisfactory neutralization. It is necessary to install a neutralization vessel in a position immediately before the waste water outlet so that the waste water will be completely neutralized at this point before being discharged.

b. Installation of Waste Water Clarifier

Highly-concentrated unburnt carbon ash is in the waste water discharged into Laguna Lake. A waste water clarifier should be installed to prevent contamination.

c. Prevention of Oil Spill from the API Oil-water Separator

Oil detectors should be installed and patrol frequency should be increased as measures to prevent oil spillage due to accidents, floods and/or other natural/man made disasters or incidents.

3) Noise

Noise at the north boundary and in the surrounding area of the power plant should be measured.

4) Unburnt Carbon Ash

Due to use of inferior quality heavy oil for fuel, a large volume of unburnt carbon ash is generated at the Malaya TPP. The following measures should be considered.

- The unburnt carbon must be reduced by improving the combustion method.
- Use of superior fuel oil of lower viscosity, use of additives or agents and other measures need to be studied.
- Detail study on the causes of high unburnt carbon content in the ash must be made to prepare appropriate countermeasures.

CHAPTER 3

OUTLINE OF NATIONAL POWER CORPORATION

CHAPTER 3 OUTLINE OF NATIONAL POWER CORPORATION

3.1 History of NPC

National Power Corporation (NPC) was established in 1936 as a public corporation fully owned by the Philippine Government. NPC is in charge of the construction and operation of power generation, transmission and substation facilities, and wholesales electric power to Manila Electric Company (MERALCO), other power distribution companies and electric cooperatives, and also sells power directly to some large customers.

NPC was originally organized to develop hydroelectric power and electric power from other natural resources. NPC expanded the scope of operation in 1972, and purchased thermal power plants from MERALCO in 1978, and ever since, has been carrying out the operation of power generation, transmission and substation facilities.

Development of the scale of NPC's operation is as shown in the Table 3-1 and Figure 3-1.

Table 3-1 Development of the Scale of NPC's Operation

		1966	1976	1980	1985	1990	1993
Gross Energy Generation	GWh	1,425	3,140	15,086	18,757	24,799	23,654*1 2,808*2
Gross Energy Sales	GWh	1,310	2,966	14,033	17,140	22,915	24,805
System Peak Demand	MW	674	1,787	2,414	(2,311) 3,037	(2,973) 3,974	(3,473) 4,824
Generating Capacity	MW	270	663	3,821	5,549	6,037	7,100*1 874*2
Transmission Line, Circuit	Km	2,398	3,682	7,152	11,832	14,060	14,951
Substation Capacity	MVA	916	2,180	7,598	13,307	14,381	14,788

( ) : Luzon Grid Peak Demand

Note: *1 NPC

*2 Non-NPC

3.2 Organization of NPC

The government of President Ramos, which was set up in June 1992, established the Department of Energy (DOE) and repealed the Office of Energy Affairs (OEA) of the Office of the President in December 1992. Since then, NPC has been supervised by the DOE.

The Electric Power Crisis Act, RA7648 (passed through the both houses in April 1993) was purposed not only to support NPC to resolve effectively the brownout problems, but also to give the National Power Board the right to rationalize and activate the organization and the operation of NPC.

1) Reorganization

Following to the reorganization in November 1991, on the basis of the Electric Power Crisis Act, and under the administration of the new president, reorganizations and rationalizations are being done or being studied for NPC.
Figures 3-2 shows the present organizations.

3.3 Changes of the Number of Employees

1) Total Number of Employees

As of 1993, the total number of NPC employees was 14,560.

Table 3-2 and Figure 3-1 show changes of the number of NPC employees for 7 years from 1987.

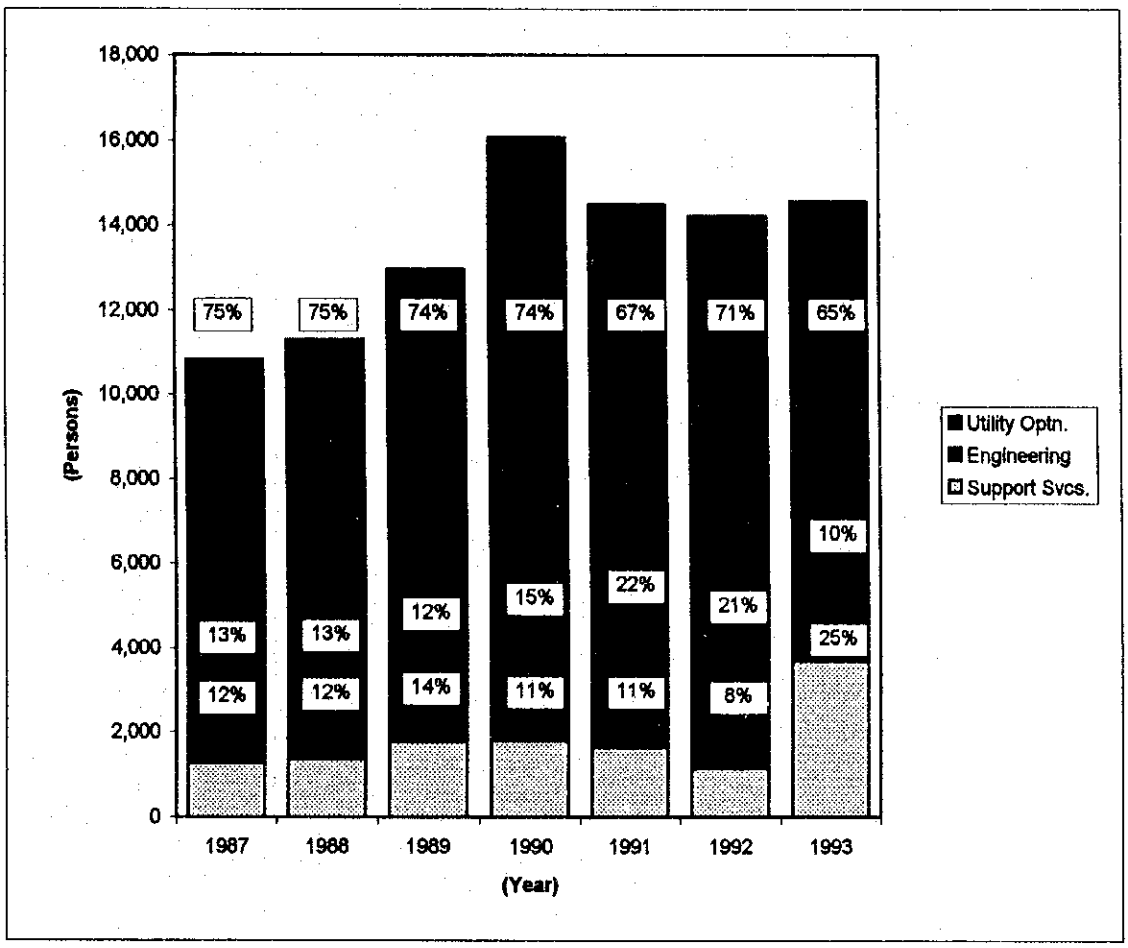
2) Personnel Allocation

The allocation of manpower in 1993 was 65% for utility operation, 10% for engineering, and 25% for supporting services, which indicates that a large portion of the manpower is allocated for the operation and maintenance works.

Table 3-2 Manpower Statistics

Year	1987	1988	1989	1990	1991	1992	1993
Utility Optn.	8,126	8,432	9,657	11,860	9,752	10,040	9,450
Engineering	1,423	1,494	1,541	2,402	3,095	3,023	1,418
Support Svcs.	1,270	1,368	1,756	1,794	1,643	1,145	3,692
Total	10,819	11,294	12,954	16,056	14,490	14,208	14,560

Figure 3-1 Manpower Statistics



3) Table 3-3 Manning by Position Level as of 1993

Executive	19	1.6%
Managerial	467	3.86%
Supervisory	1,011	8.36%
Professional/Technical (High Level)	6,015	49.75%
Professional/Technical (Entry Level)	2,614	21.62%
Rank & File	1,965	16.25%
Total *	12,091	100%

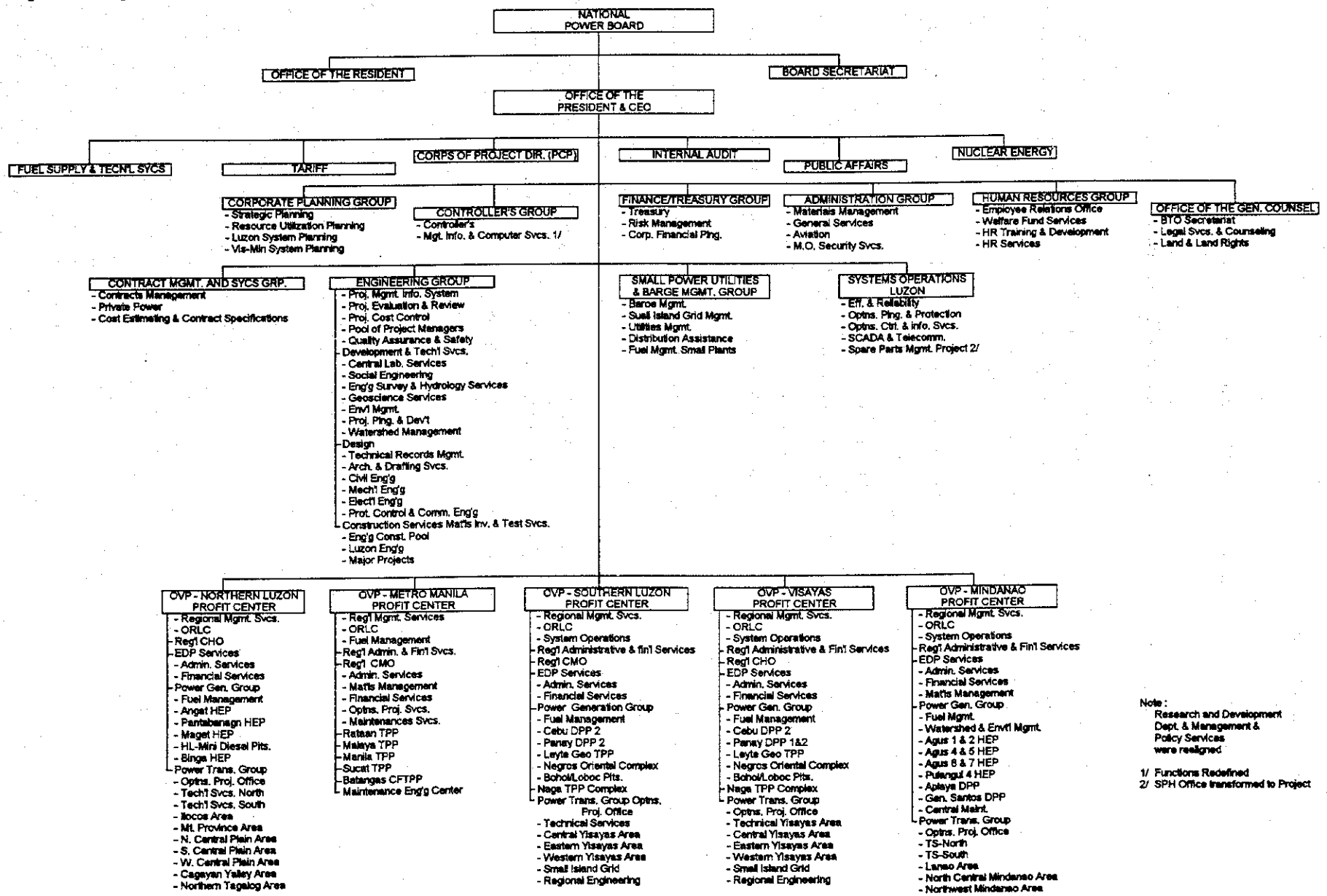
*Regular employees only

4) Table 3-4 Regional Manning as of 1993

Head Office	5,366	36.8%
MMRC (Metro Manila Regional Center)	1,786	12.3%
NLRC (Northern Luzon Regional Center)	1,648	11.3%
SLRC (Southern Luzon Regional Center)	1,426	9.8%
VRC (Visayas Regional Center)	1,792	12.3%
MRC (Mindanao Regional Center)	2,542	17.5%
Total *	14,560	100%

*Regular and casual employees

Figure 3-2 Organization of National Power Corporation (As of May 16, 1994)



3.4 Financial Situation

Outline of financial performance in 1993 is shown in Table 3-5.

The energy sales were 24,805 GWh, an increase of 3.5% over the previous year.

The operating revenue amounted to 40,490 million pesos, a 7.6% growth from the 1992 figure. This increase was mainly a result of an about 3.5% increase in energy sales and of an increase by 0.06 P/kWh in the average power rate.

The operating expenses totaled 33,825 million pesos, an 11% growth from the 1992 expenses. This increase is attributable to the following:

1) A 136% increase in the purchased power
2) Higher depreciation costs largely brought about by the capitalized loan restatement and by new plants that went into operation.
3) Higher other operating expenses mainly due to increased operating and maintenance cost, plus increase in taxes.
4) Higher steam and coal cost. A much higher expense figure was off set by lower fuel cost.

Net operating income, after all, decreased by 5.8% to 6,665 million pesos, and from this net operating income NPC realized a net income of 1,365 million pesos, down by 66.9%, compared to the 1992 net income of 4,118 million pesos.

Table 3-5 Financial Performance in 1993

Items			Unit	1992	1993	Inc. (Dec) %
Energy Sales			GWh	23,958	24,805	3.5
Average Power Rate			P/kWh	1.57668	1.6385	3.9
Net Operating Revenue			P Million	37,644	40,490	7.6
Operating Expenses			P Million	30,567	33,825	10.7
	Generation		P Million	21,166	21,414	
	Transmission and Distribution		P Million	579	671	
	Administrative and General		P Million	878	937	
	Depreciation		P Million	6,258	8,501	
	Depletion		P Million	823	916	
	Provision		P Million	53	32	
	Other Operating Expenses		P Million	806	1,350	
Net Operating Income			P Million	7,078	6,665	(5.8)
Net Income			P Million	4,118	1,365	(66.9)
Rate Base			P Million	99,596	112,778	13.2
Return on Rate Base (Net O.I./Rate Base) x 100			%	7.11	5.91	(1.20)
Cost of Service			P/kWh	1.4746	1.5833	7.4
	Fuel Cost		P/kWh	0.5840	0.4807	
	Steam Cost		P/kWh	0.1404	0.1409	
	Coal Cost		P/kWh	0.0494	0.0512	
	Depreciation and Depletion		P/kWh	0.2966	0.3811	
	Manpower Related Expenses		P/kWh	0.0598	0.0632	
	Other Operating Expenses *1		P/kWh	0.1501	0.2517	
	Non-Other Operating Expenses *2		P/kWh	0.1943	0.2145	
Net Income (Average power rate - cost)			P/kWh	0.1022	0.0552	(46)
Assets	Total		P Million	203,154	245,375	20.9
	Utility Plant	Under Construction	P Million	21,478	27,559	28.3
		Operating (Net)	P Million	104,725	135,160	29.1
Proprietary Capital (equity)			P Million	67,760	72,191	6.5
Long Term Debt (Net current portion)			P Million	67,306	96,004	42.6
Capital Expenditures			P Million	15,242	29,431	93.1
Funding Sources	Foreign Loans		P Million	10,156	19,815	95.1
	Net Internal Cash Generation		P Million	1,643	2,209	34.4
	Equity Advance from the National		P Million	410	4,678	1041.0
	Others (Grant + others)		P Million	3,033	2,729	(10)

Notes: *1 includes purchased power cost

*2 includes interest expenses

3.5 Power Rates

On April 2, 1993, NPC increased power rates by 18 centavos per kWh as follows; 5.57 centavos per kWh adjustment in basic rate and 12.42 centavos per kWh through the Retroactive Component Adjustment (RCA). The RCA is a mechanism to recover unrealized revenue due to the non-implementation of the 17 centavos per kWh increase in 1991 and the supposed rate adjustment in 1992 to attain a 10% return-on-rate base.

Table 3-6 Average Power Rates

(Unit : P/kWh)

Year	Luzon	Visayas	Mindanao	Philippines	Annual Increase Rate (%)
1980	0.3641	0.4078	0.1644	0.3423	
1981	0.4480	0.4982	0.1800	0.4166	21.7
1982	0.4670	0.5444	0.1859	0.4299	3.2
1983	0.6152	0.7244	0.2966	0.5790	34.7
1984	0.9740	0.9980	0.3740	0.8754	51.2
1985	1.2082	1.0401	0.5205	1.0835	23.8
1986	1.0552	0.9063	0.5086	0.9548	-11.9
1987	0.9793	0.8671	0.5657	0.9038	-5.3
1988	1.0031	0.9252	0.6252	0.9354	3.5
1989	0.9877	1.0385	0.6669	0.9381	0.3
1990	1.2049	1.2424	0.7043	1.1263	20.1
1991	1.4728	1.5293	0.9028	1.3953	23.9
1992	1.6576	1.6922	0.9644	1.5768	13.0
1993	1.7194	1.7343	1.1596	1.6385	3.9

3.6 Privatization

The Aquino Administration set about a five-year temporary legislation to promote the privatization of 122 government owned firms out of 301. In 1991, the term of this legislation was extended for two years. At present, many items are still being examined at the Congress.

In NPC, several measures are being studied: dividing of the organization into Luzon, Visayas and Mindanao; optimal financial system; method of dividing; disposal of assets and others.

3.7 ROM Scheme

1) NPC is trying to transfer the operation and maintenance works to private sector. So called Rehabilitate-Operate-Maintain (ROM) were adopted in the Naga Thermal Power Plant Complex and the Binga Hydro Power Plant.

The Malaya Thermal Power Plant will also adopt the ROM and NPC invited candidates for bidding who passed pre-qualification by NPC. Bid closing date, i.e. opening date of proposals, was scheduled December 28, 1994.

2) ROM Contractual Agreement for Malaya TPP

The ROM contractual agreement is outlined for Malaya TPP as following Table 3-7:

Table 3-7 ROM Contractual Agreement

Item	Contractor	NPC
1. Equipment		
[1] 300 MW Malaya 1 350 MW Malaya 2 including Auxiliaries	Peaceful possession of all generating facilities involved in [1], except [2]	NPC retains ownership of the all generating facilities of Malaya TPP complex.
[2] 3 x 3- MW Gas Turbines Meralco Switchyard NPC Switchyard NPC Vehicles	(For Item 1. [2]) Out of Scope in ROM	(For Item 1. [2]) NPC takes care of these equipment [2]
2. Scope of Agreement	1) General Rehabilitation of the Item 1. [1] (Please refer; Minimum Rehabilitation Requirement)	
3. Duration of the Cooperation Period	1) Fifteen (15) years including: - first 4 years for Assessment & Rehabilitation for the Item 1. [1] 2) Commercial Operation starts - on 5th year or - After satisfactory completion of the rehabilitation works whichever comes first	

Item	Contractor	NPC
4. Rights & obligations	To be given peaceful possession of the Item 1. [1].	Retains ownership of the Malaya TPP complex, visitorial rights and use of the laboratory facilities
[1] Fuel	To convert NPC's fuel oil into quality electric power.	To supply all fuel requirements at its own cost
[2] Electric power generated	To supply electric power exclusively to NPC and guarantee volume of energy that it will deliver	To guarantee a minimum purchase of energy on take or pay basis
[3] General Rehabilitation	To do the works with the objective of bringing each the units to their designed condition and prolonging the economic life of the units by at least 15 years	-
[4] Operation	To guarantee capacity and efficiency of the units	-
[5] Employment	- To take at least 90% of its manpower requirements from the existing manpower of Malaya TPP. - The size of organization of the contractor shall follow the local industry standards in terms of Kilowatt per person	-