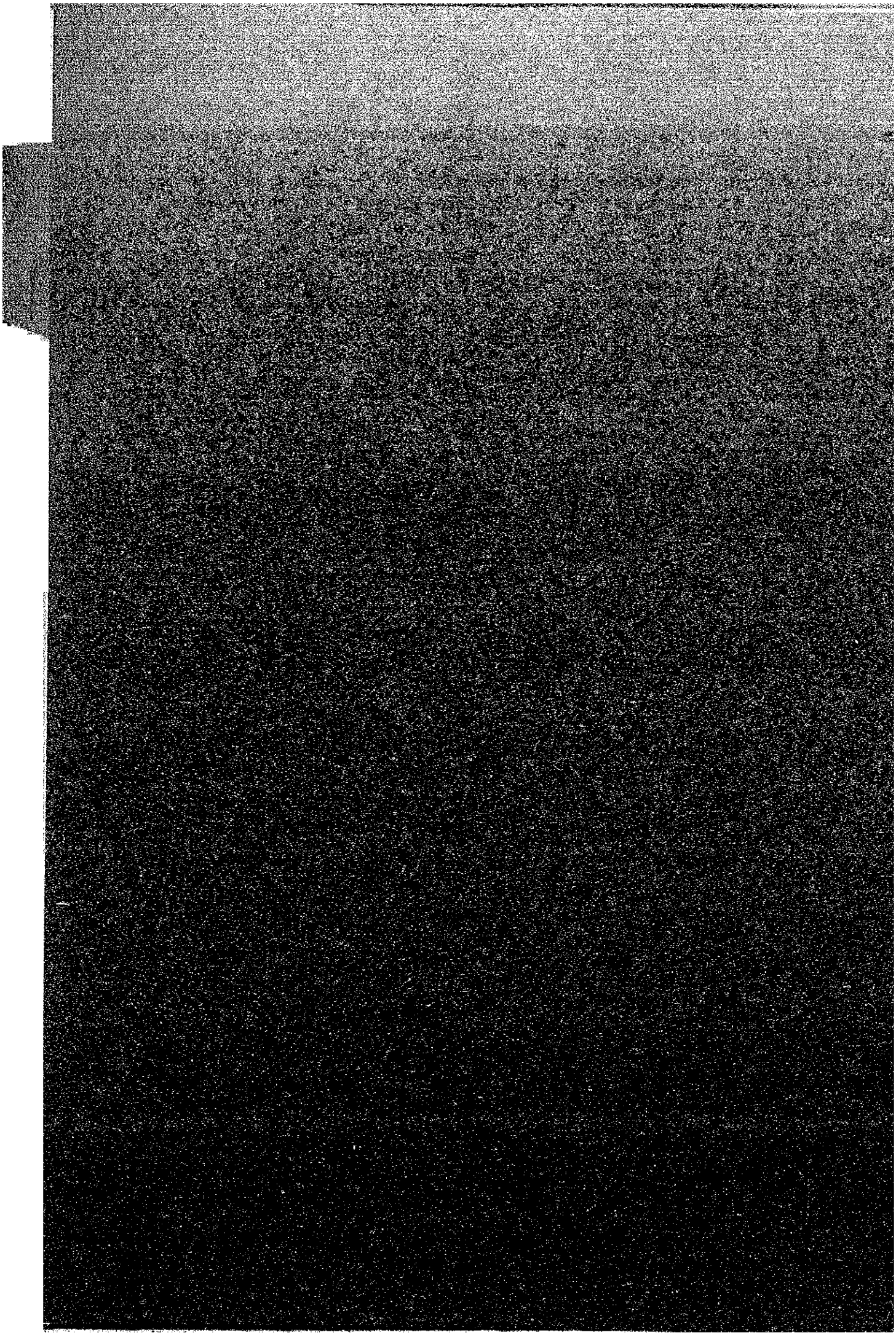
1. INTRODUCTION



1. INTRODUCTION

1.1 BACKGROUND

The electricity service in the Luzon Grid has been suffering serious interruptions since January 1, 1982 causing much difficulty in the social and industrial activities.

The service interruptions were mainly due to the unreliability of four (4) thermal power plants in Metro Manila area and suburbs. These power plants are Tegen in Manila, Gardner/Snyder* in Sucat (Paranaque), and Malaya in Pililla (Rizal). The unit capacities are T-1, T-2: 100 MW each; G-1: 150 MW; G-2: 200 MW; S-1: 200 MW; S-2: 300 MW; M-1: 300 MW; M-2: 350 MW and total rating is 1,700 MW, and sub-critical once-through boilers are applied to G-2, S-1, S-2 and M-1.

Note: Gardner/Snyder power station is now named Sucat and each unit of this power station is called as follows:

Old Name	New Name
Gardner - 1	Sucat - 1
Gardner - 2	Sucat - 2
Snyder - 1	Sucat - 3
Snyder - 2	Sucat - 4

However, to keep consistency with the preliminary survey, old names are used in this report.

After assessing the poor conditions of these plants, National Power Corporation (hereinafter referred to as NAPOCOR) launched as rehabilitation program in August 1979. Under these circumstances, NAPOCOR decided to request the Japanese government to dispatch a group of experts in power plant operation, design

and maintenance for the assistance in solving the problems of these power plants.

The government of Japan, in response to the request of NAPOCOR through the government of the Republic of the Philippines (hereinafter referred to as the Philippines) decided to undertake the study on this matter through Japan International Cooperation Agency (hereinafter referred to as JICA) and dispatched the preliminary survey team headed by Mr. Keiji Iimura from May 10 to May 29, 1982 to find out the fundamental problems involved in the plants and find out the items to be surveyed in detail by the detail survey team.

According to the result of the preliminary survey, JICA decided to dispatch a survey team to the Philippines to proceed the detailed investigation.

In this connection, JICA dispatched a team comprising of four (4) members headed by Mr. K. Iimura to the Philippines for the purpose of discussing the Implementation Arrangement (hereinafter referred to as I.A.) and to agree upon the Scope of Work of the Study from July 26 to August 7, 1982. As a result of a series of discussions, I.A. was mutually agreed and signed on July 30, 1982 in Manila between JICA and NAPOCOR.

Immediately after the signing of I.A., JICA dispatched the survey team consisting of 14 experts (3 of them were already staying in Manila from July 26, 1982, for the discussion of I.A.) of thermal power plant design, operation and maintenance to carry out the various surveys covered by the Scope of Work, starting from August 1 to September 30, 1982.

1.2 OBJECTIVE AND SCOPE OF THE STUDY

1.2.1 Objective of the Study

The objective of this study is to make the rehabilitation program for improvement of operations of four (4) power plants with once-through boilers, in order to restore reliable electricity supply in Metro Manila.

1.2.2 Scope of Study

Respective items of the study carried out this time in line with the objective are classified into the following major items:

- Improvement of Plant Operation
- Improvement of Plant and Plant Systems
- Improvement of Preventive Maintenance and Corrective Maintenance
- Assessment of Availability
- Planning and Management of Scheduled Plant Outage
- Comparison and advices of Operating Practices and Experience in Japanese and Other Electric Utilities

1.3 SURVEY IN THE PHILIPPINES

1.3.1 General

The site survey in the Philippines was carried out from August 1 to September 30, 1982 in accordance with the attached schedule with close and warm cooperation of NAPOCOR counterparts and Manila Electric Company (hereinafter referred to as MERALCO).

The survey team was divided into four (4) groups, such as General group, Gardner/Snyder group, Malaya group and Chemical group, in order to carry out the efficient survey:

MEMBERS OF NAPOCOR AND MERALCO CONCERNED, AND SURVEY TEAM

The NAPOCOR and MERALCO Concerned	JICA Team
NAPOCOR:	
- Mr. G. Y. Itchon President	- Mr. K. Iimura Head of Natural Resources Survey Division, JICA
- Gen. M. S. Bocanegra Sr. Vice President	- Mr. E. Hiraoka Thermal Power Division Public Utilities Dept. MITI
- Mr. J. U. Jovellanos Special Assistant to the Chairman	- Mr. T. Oga (E.E.) Team Leader
- Mr. H. C. Gaerlan Vice President Human Resources & General Services	- Mr. K. Ariyoshi (M.E.) Gardner/Snyder Group
- Mr. T. H. Calasanz Vice President Utility Operations	- Mr. H. Maeda (M.E.) Gardner/Snyder Group
- Mr. M. E. Mañó Officer-in-Charge MMRC	- Mr. J. Fujimoto (E.E.) Gardner/Snyder Group
- Mr. M. B. Villafuerte Manager, Finance MMRC	- Mr. Y. Yuasa (C.E.) Chemical Group
	- Mr. M. Tajima (M.E.) General Group

- Mr. L. F. Osilla
  Manager
  Quality Assurance Group

- Mr. A. P. Estiandan
  Plant Manager

- Mr. S. A. Piedad
  Manager
  Technical Services Div.

- Mr. E. A. Besana
  Superintendent B
  Mechanical Section
  Technical Service Division

- Mr. C. S. Estrellado
  Superintendent B
  Chemical Section
  Technical Services Div.

- Mrs. P. SJ. Madic
  Executive Assistant

- Mrs. E. L. Jimenes
  Chief, Administrative
  Service

- Mr. R. E. Agcaoile
  Chief Engineer

- Mr. G. Merced
  Sr. Control Engineer

- Mr. I. Gutierrez
  Principal Tech. Analyst B
  Technical Services Div.

- Mr. L. Roy
  Sr. Tech. Analyst B

- Mr. R. de Jesus
  Sr. Relay Engineer
  Tech. Services Div.

- Mr. C. Viscarra
  Sr. Maintenance Foreman

- Mr. A. Balonzo
  Principal Engineer A
  Quality Assurance Div.

- Mr. N. N. Gensoli
  Technical Assistant B

- Mr. J. Galingan
  Technical Services
  Superintendent A

- Mr. T. Hashizume
  (E.E.) Malaya Group

- Mr. T. Fukazawa
  (M.E.) Malaya Group

- Mr. G. Matsuo
  (E.E.) General Group

- Mr. M. Kotani
  (E.E.) Gardner/Snyder Group

- Mr. K. Hataya
  (C.E.) Chemical Group

- Mr. M. Koike
  (C.E.) Chemical Group

EMBASSY OF JAPAN

- Mr. J. Hashimoto
  First Secretary and Commercial
  attache

JICA, Manila Office

- Mr. M. Nakamura

Note:
M.E. ; Mechanical Engineer
E.E. ; Electrical Engineer
C.E. ; Chemical Engineer

- Mr. M. E. Espeleta
  Mechanical Maint. Superintendent A

- Mr. A. Carmona
  Principal Tech. Analyst B

- Mr. R. Abon
  Tech. Services Superintendent A

- Mr. J. Santos
  Sr. Technical Analyst B

- Mr. M. Posadas
  Principal Engineer C

- Mr. F. Lores
  Tech. Services Superintendet A

System Planning Department

- Mr. D. S. Peralta
  Division Manager C

- Mr. G. Matulac
  Division Manager C

- Mr. L. Cruz
  Specialist III

System Operation Department

- Mr. A. C. Plata
  Manager
  System Operation Department

- Mr. E. J. Macawili
  Officer-in-Charge
  Operations Control Division

Conferees

NAPOCOR Gardner/Snyder Thermal Plant

- Mr. J. G. Villanueva
  Plant Manager

- and Plant Staff

NAPOCOR Malaya Thermal Plant

- Mr. A. V. Raflores
  Plant Manager

- and Plant Staff

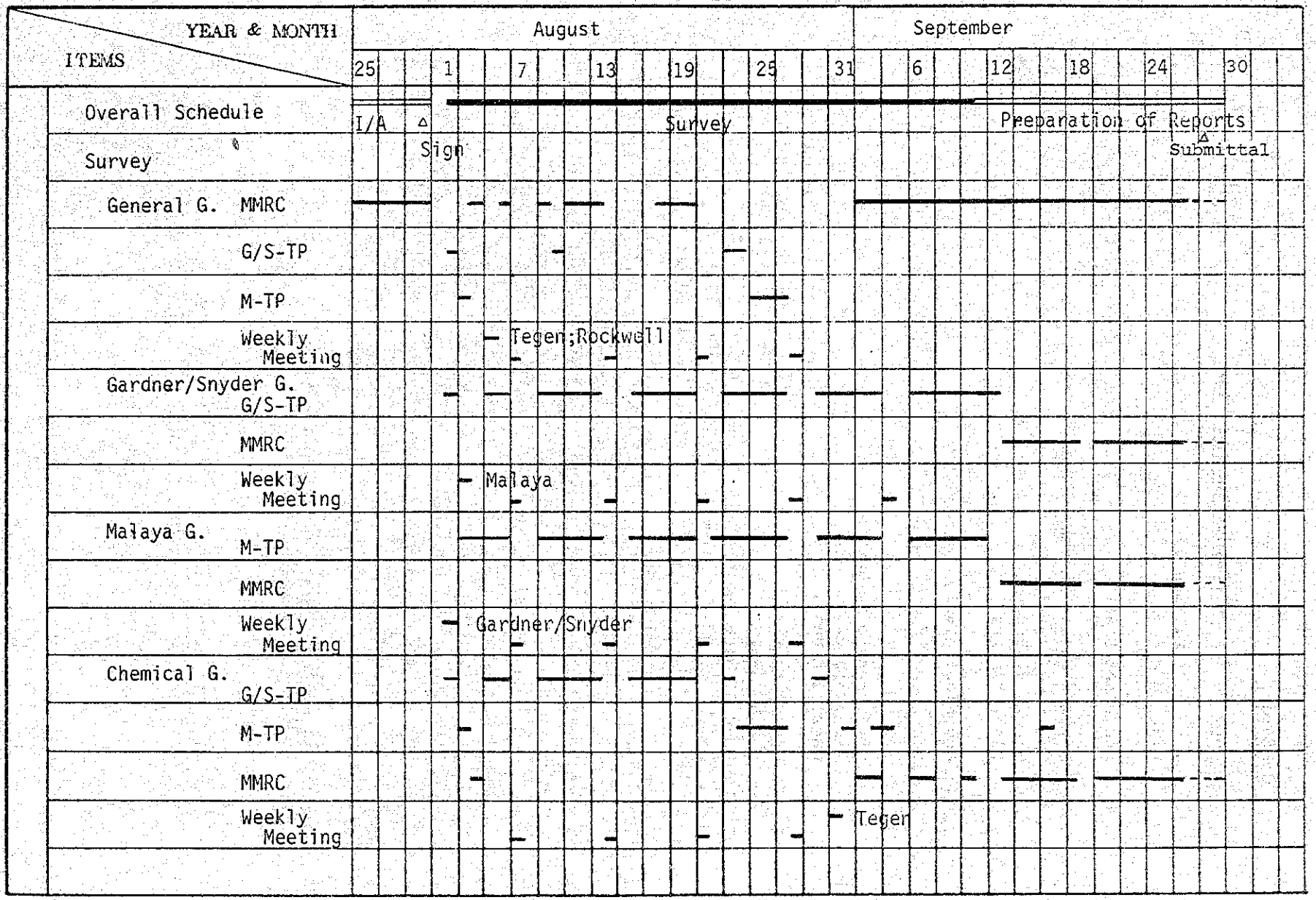
MERALCO

- Mr. Lamberto S. Guzman
  Vice President
  Operation Dept.

- Mr. E. Gonzales
  Sr. Manager
  Load Dispatching Office

SURVEY SCHEDULE

JICA



1.3.2 Survey Region

The survey region is mainly within the Metro Manila area, and the following NAPOCOR power stations with once-through boilers are main objective of this survey including their relevant substations and transmission lines:

- Gardner/Snyder Power Station
- Malaya Power Station

In addition to the above, outline of the Tegen and Rockwell power stations which have drum type boilers, were also surveyed to get good reference for the main objective power stations of this survey.

The locations of the power stations are shown in Fig. 1-1 on the following page.

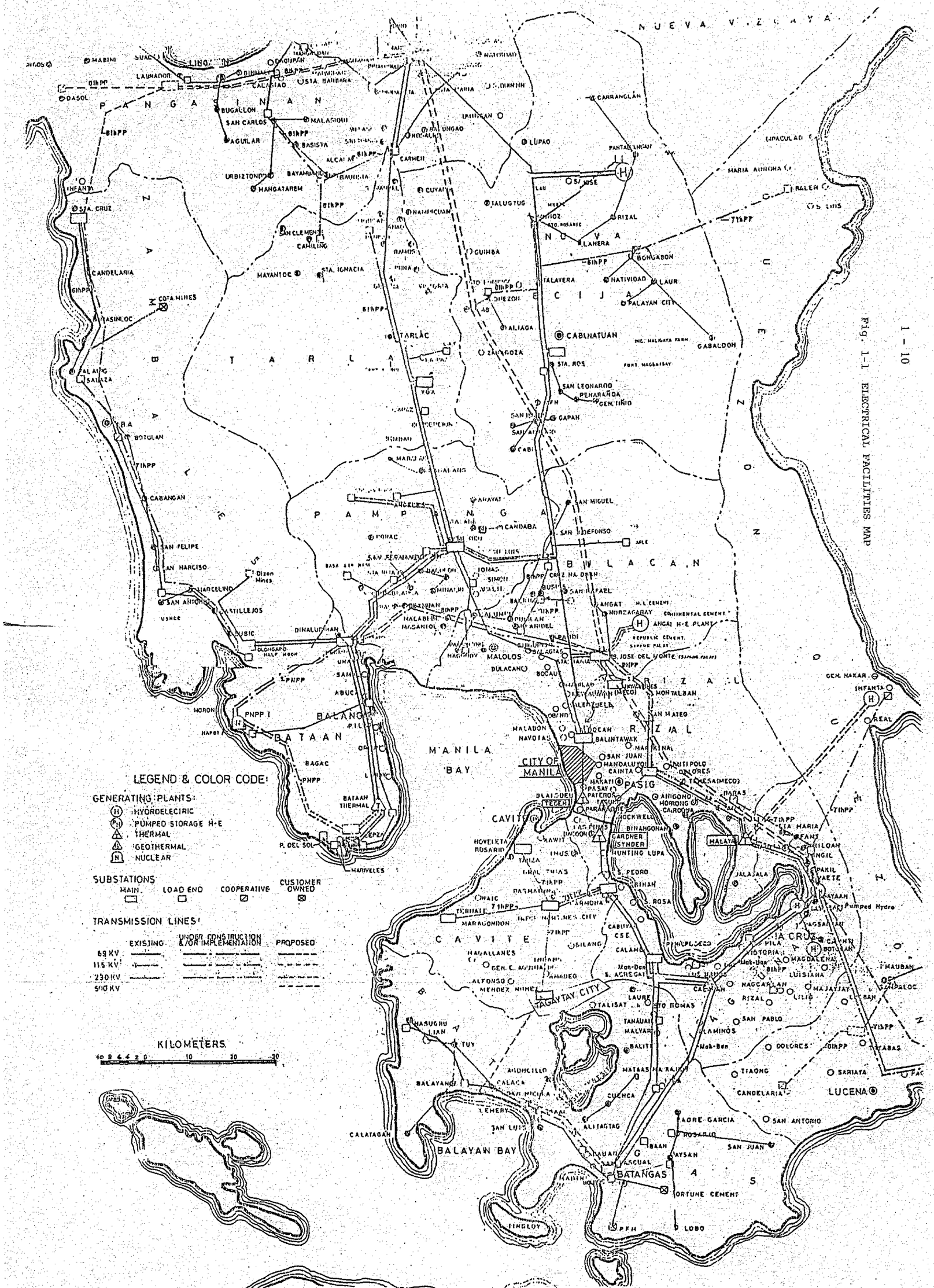


Fig. 1-1 ELECTRICAL FACILITIES MAP

1.3.3 Survey Items

JICA team carried out the site survey on the following survey items needed for the establishment of the rehabilitation program and improvement of operations of thermal power plants in Metro Manila.

1) Improvement of Plant Operations

   a. Supplement lacking items to the existing manual after studying the rehabilitation plan and operating method of each power plant.

   b. Prepare training and/or re-training basic and general text.

   c. Make detailed examination on the necessary items after reviewing the NAPOCOR's operating manuals.

2) Improvement of Plant and Plant Systems

   a. Carry out detail study on the problem items identified as a result of review of the existing data and survey of the site conditions of each power plant.

   b. Advise a practical program for rehabilitation of each power plant.

   c. Examine every identified critical item in detail, and prepare final priority of the rehabilitation including the implementation plan for either replacement or repair.

   d. Re-study and confirm the causes of outages on the basis of the list prepared in the Preliminary Survey, and form a rehabilitation program for classification of items by the practical measures; replacement, repair, chemical washing, etc.

   e. Advise necessary checking way and extent.

3) Improvement of Preventive and Corrective Maintenance

a. Advise the adequate interval and extent of standard maintenance.

b. Advise the imperfect points of existing implementation of maintenance and repair.

c. Advise the corrective measures for insufficiency and/or imperfection in preventive and corrective maintenance.

d. Prepare training and/or re-training basic and general text.

e. Examine kind and quantity of spare parts, kind of equipment in the workshop and prepare improvement program if necessary.

f. Review and study on equipment design and layout and prepare the improvement program on insufficient points.

4) Assessment of Availability

a. Analyze the record of availability and functions of equipments in detail based on the results of the Preliminary Survey.

b. Investigate in detail the reliability and availability for preparation of programs for countermeasures and implementation aiming at the rehabilitation of the plant performance to the greatest extent possible, and study and prepare scheduled outage program for a short and long term including the overall system operation.

5) Planning and Management of Scheduled Plant Outage

a. Provide necessary advice with each item on the basis of the result of the survey in 1) to 4) taking the power demand tendency into account. And necessary recommendations and advices will be prepared on the following items:

a) Plan and schedule of plant overhaul and major repairs and maintenance.

b) Plan and schedule of equipments/materials purchase required for preventive/corrective maintenance.

c) In service inspection and quality assurance services.

d) Plant/unit defficiencies affecting safety unit capacity, efficiency and economics.

e) Equipments maintenance/repair records.

6) Comparison and Advice of Operating Practices and Experience in Japanese and Other Electric Utilities

a. Advice on the items and contents prepared by NAPOCOR and items which JICA acknowledges necessary.

b. All available data and information of the similar cases will be forwarded to NAPOCOR.

2. CONCLUSIONS AND RECOMMENDATIONS

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2.1 GENERAL MATTERS

2.1.1 Organization and Management

1) Task Force for Rehabilitation Program

For the purpose of planning and coordination of the Rehabilitation Program, Task Force has been established since December, 1981 with Quality Assurance (QA) Group and Planning & Programming (P&P) Group as members of Task Force.

Task Force has supervised the management of overhaul schedule and promotion/evaluation of procurement to perform Rehabilitation Program and made many actual results.

The Steering Committee reviews the work of the Task Force and provides the necessary guidelines or framework relative to the rehabilitation program. The Sr. Vice President - Engineering is the Chairman of the Steering Committee and the members consist of the Special Assistant to the Chairman and five (5) Vice Presidents of the different functional groups.

It is appreciated that the Steering Committee has facilitated the procurement matters of four (4) major requirements of the rehabilitation, namely; (a) additional demineralizing plant of GSTP, (b) Ammonex Regeneration facilities of GSTP, (c) Sampling Rack Systems of G-1, G-2, S-1, S-2 and M-1, and; (d) Automatic Boiler Control.

JICA team recognizes that the above Task Force will satisfy the recommendation rendered in the report of preliminary survey team which called for the setting-up of an "Emergency TAsk Force" under the administrative guidance of the Ministry of Energy.

JICA team reiterates the need for a strong group to oversee the implementation of the short and long term program for the improvement of the operation of the thermal plants.

2) Organization of Execution of Overhauling

Annual overhauling carried out by NAPOCOR requires long time at present. It seems that there are some possibilities for shortening the current overhaul schedule of NAPOCOR. Overhauling is performed with cooperation and coordination among many groups, i.e. Plant Maintenance Group, Central Maintenance Division (CMD), Quality Assurance (QA) Group, Planning & Programming (P & P) Group, Project Manager, Subcontractors and Manufacturers.

JICA team has found that the project manager currently assigned to the overhaul at a power station of NAPOCOR was doing very well with excellent coordination of so many groups and he was also exerting his best efforts to attain successful overhaul.

However, the project manager of the overhaul work is selected among the operation superintendent B of the power plant and therefore changes time to time. In ordinary cases it will be very hard work to coordinate and monitor so much works for one superintendent of operation who is not always assigned to the overhauling.

It is observed that the concentration of responsibility is hampered, and smooth and effective implementation is interrupted because of so many groups in the overhaul.

To solve the above problems, it seems to be recommendable that overhauling schedule is controlled by Planning & Programming Group in prementioned Task Force, and that overhauling works are supervised by Plant Manager.

3) Organization for Engineering

At present, Maintenance Section and Instruments/Controls Section cannot afford to be engaged in the engineering, although there are so many engineering works for maintenance of the power plant.

NAPOCOR is now considering the modification of organization. It is recommendable that reinforcement of engineering capability will be promoted.

4) Review on Adoption of Subsidiary

Subsidiary is effective for smooth implementation of overhaul schedule and flexibility of personnel employment. It seems that maintenance of instruments/controls is inferior because of the unavailability of appropriate subcontractor. It seems to be worthwhile to study on it.

5) Personnel Rotation

It seems that personnel are unevenly assigned to various sections. It is also recommendable to promote personnel rotation for up-grading the technical level and discipline.

2.1.2 Human Resources and Training

1) Human Resources

It is said that one of the major reasons for the deterioration of the power plants is due to many drain out of highly experienced engineers abroad from the power plant. Much difficulty would happen in the power plant operations by the decline in the technical capabilities of the power plant personnel. Following countermeasures are taken by NAPOCOR:

a. Hiring of New Employees

Much attention should be paid to the increase in complement because there is a possibility to cause demoralization of plant personnel due to the reduction in their work.

In parallel with the new employment of personnel, the following system of skills and technical competence of existing plant personnel are also needed.

(a) Re-training

(b) Instruction on the works by managers

b. Personnel Rotation

Reinforcement of the Maintenance Section of Mechanical and Instrumentation/Control in the plants will be recommendable by personnel rotation from other plant divisions.

Also, personnel rotation between plants and other offices, including persons holding administrative positions is effective for upgrading the technical level.

c. Arrangement of Working Environment

The present poor environment of the power plant is one of the reasons which hamper the motivation and discipline of plant personnel. Without clean and bright working condition, vitality of the personnel might not be expected.

2) Training

NAPOCOR has exerted their best effort for training of personnel. JICA team was deeply impressed by earnestness of trainees in actual training. Moreover, training of instrumentation/control and mechanical section, distribution of textbook to all trainees, and key engineers dispatched abroad for training on some field are recommendable.

NAPOCOR is planning the construction of a training center, and training simulator for existing thermal power plant is included in the plan. Other training programs are also provided in a sophisticated training center. Early commissioning of this training center is very important.

Rapid progress of technology and skills of trainees will be attained after the completion of this training center and contribute to successful operation and maintenance.

2.1.3 Procurement

It was found during the survey that there are some problems in the procurement system as mentioned below.

1) Procurement procedures take too long time which hampers timely delivery of spare parts and materials for the power plant repair and maintenance.

2) Some wrong equipment/material delivery are experienced at power plants which do not satisfy the original requirement.

3) Purchases by biddings for lower prices sometimes make it difficult to get guarantee from the original manufacturers.

4) Technical specifications to be attached to purchase requisitions are not adequate.

As the solution for the above problems, JICA team considers that the following items are recommendable:

1) Standard technical specifications forms.

2) Assignment of the review of technical specifications of critical items prepared at plants to the centralized technical group with highly experienced engineers like rehabilitation task force.

3) Provision of monitoring system of procurement schedule at Regional Center.

4) Adoption of unit price system.

5) Prequalification system of manufacturers/suppliers and adoption of original manufacturer for essential equipment/materials.

6) Dispatch of a key person of procurement/finance divisions to observe and study the procurement and material management system of foreign electric power utility companies and leading manufacturers.

2.2 POWER PLANT SYSTEM AND EQUIPMENT

2.2.1 General

1) Outline

Metro Manila Region is suffering the chronic deficiency of electric power supply because of the deterioration of capable output of thermal power plant in Metro Manila. In addition to the direct cause of this drop of power plant output, shown in Table 2-1, there are some other problems in other parts also. Restoration of nominal output and recovery of reliability of the plant will be impossible without integrated rehabilitation program.

There are various problems which caused this situation, however, following items are considered to be the major problems:

a. Improper water treatment caused much damages on major equipment.

b. Daily maintenance is not surely done and equipment troubles are left unrepaired causing loss of function of the system.

c. Improper intervals of overhaul accelerate the damage and deterioration of the equipment.

d. Some improper operation of the plant caused big trouble and equipment damage.

The thermal power stations in Metro Manila are in the age which show sign of aged deterioration. As the countermeasures for the above, urgent replacement and repair of damaged and/or deteriorated equipment should be carried out orderly and it is essential to implement the safe and reliable operation of the

plant in line with the well planned daily maintenance and scheduled overhaul together with the improvement on operation and maintenance technique.

In addition to the above, close cooperation among relevant divisions of NAPOCOR to the Rehabilitation Program and counter-measures such as ambient improvement, repair of gas leak for instance, comprehensive procurement system, etc. are desired together with the up-grading of the capability of NAPOCOR employees.

JICA team could not make thorough study of turbine and generator because of insufficient available data, however, it is recommendable to strongly request the manufacturer to proceed the technical solution and guarantee on the defective parts in the process of coming overhauling.

Regarding economical effect of Rehabilitation Program, the fuel cost reduction is estimated to be approximately P 500 million a year, provided that heat rate will be decreased down to the level of thermal power plant in Japan.

Items	Unit	GSTP	MTP	Total	Remarks
Generation	GWH	2620	3403	6023	Actual result in 1981
Fuel	10^3 BBLS	4953	5635	10588	
Heat rate	BTU/KWH	11644	10277	10872	
Fuel cost	10^6 P	1381	1687	3068	
Expected heat rate	BTU/KWH	-	-	9114	
Expected fuel cost	10^6 P	-	-	2572	

Assumption on the improved heat rate is taken from actual results of equivalent unit in Japan (1978).

The main causes which deteriorate the output of the generators are listed in the table on next page.

Table 2-1 THE MAIN CAUSE OF REDUCED OUTPUT OPERATION

NOTE: Actual output as of August 1982

ITEM	Gardner-1	Gardner-2	Snyder-1	Snyder-2	Malaya-1	Malaya-2
Rated Output (MW)	150	200	200	300	300	350
Actual Output (MW)	100	(140)	140	250	250	280
Commercial Operation	Aug. 1, 1968	Jan. 15, 1970	July 1, 1971	July 31, 1972	Sept. 4, 1975	June 26, 1979
1. Boiler and Auxiliaries	1. Reduced pressure operation due to weak tubes (water wall tubes) 1800 psi to 1400 psi 2. Shortage of FDF capacity (study to be made)	1. Reduced pressure operation due to weak boiler tubes (RH tubes) 2700 psi to 2300 psi	1. Reduced pressure operation due to weak boiler tubes (SH, RH tubes) 2700 psi to 2300 psi	-----	1. Reduced pressure operation due to thinning (SH, RH, and water wall tubes) 2700 psi to 2100 psi	1. Reduced pressure operation due to bulging boiler tubes 169kg/cm^2 to 150kg/cm^2 2. A.H. clogging
2. Turbine and Auxiliaries	1. No. 5 HP heater by-pass	1. LP turbine last stage blade cut	1. LP turbine blades out	1. LP turbine blade cut 2. No. 6B HP heater removed 3. Condensate pump suction strainer clogging (study to be made) 4. Excessive leakage of condensate recirculation valve and by-pass valve	1. LP turbine blade cut 2. No. 5A HP heater by-pass	(1. Condenser tube leak)

2) Rehabilitation Items and Schedule:

a. Rehabilitation Items:

JICA team recommends NAPOCOR the extension of the rehabilitation program, currently implemented by NAPOCOR, in order to carry out the additional rehabilitation items such as replacement/repair of deteriorated equipment, newly found out by JICA team this time, and reinforcement of feed water quality control listed in the Table 2-2 "REHABILITATION ITEMS". The actual rehabilitation works will be done in accordance with the time schedule, Table 2-3 "REHABILITATION SCHEDULE".

The priority of the repair modification and replacement items necessary for the rehabilitation program shown in Table 2-2 "REHABILITATION ITEMS" are indicated by double circle and single circle marks in the Table.

◎ is put on the technical items of first priority and is regarded as to be implemented in the short term program.

○ is put on the technical items of second priority and is regarded as to be carried out in the intermediate term program.

As for the items concerning general matters such as organization, training, procurement, etc., they will be planned to be implemented by long term program.

But, concerning the implementation of technical items most of them should be done at shutdown time of the plant and is obliged to be implemented during overhaul as long as the unit will get no serious damage by the continuous operation up to the coming scheduled overhaul.

Therefore, rehabilitation items are also classified into two categories as Primary Rehabilitation Items and Secondary Rehabilitation Items as described below.

(a) Primary Rehabilitation Items: P Items

These items are most urgent and needed to be implemented in the first coming scheduled overhaul. Since primary rehabilitation items for G-1 and G-2 have been completed just recently, items for these power units are not included.

(b) Secondary Rehabilitation Items: S Items

These Items are to be implemented in the scheduled overhaul coming after the primary rehabilitation.

Priority of the rehabilitation items categorized above are indicated by the marks P and S in the Table 2-2, "REHABILITATION ITEMS".

b. Rehabilitation Schedule:

Time sequence of the rehabilitation schedule for each unit is indicated in the Table 2-3, "REHABILITATION SCHEDULE". The overhaul period shown in the SCHEDULE should be most strictly followed so that it may allow other unit overhaul on schedule. NAPOCOR, manufacturers and contractors should be closely cooperative for this purpose.

c. Implementation of Rehabilitation Program:

For the time being, because of the urgency of the project it seems that some outside engineering assistance may be necessary for the planning, basic design, preparation of the specifications, check and review of manufacturer's drawing, supervision of rehabilitation works, maintenance and operation, etc.

For last two (2) items, JICA team recommends NAPOCOR to have some outside engineers to assist management of overhauling schedule, water treatment, mechanical maintenance and control/instrument maintenance.

An example of the engineering schedule is shown in Table 2-3 "REHABILITATION SCHEDULE".

Table 2–2 REHABILITATION ITEMS

ITEM		G–1	G–2	S–1	S–2	M–1	M–2	Engineering	Remarks
Boiler a. Superheater	Detailed inspection of SH tubes	◎S		◎P	◎P	◎P		Ⓜ	
	Complete replacement of SSH tube			◎P				Ⓜ	
	Replacement of SSH lower bent tube including No. 1 ~ 3 straight tubes					◎P		Ⓜ	
	Replacement of deteriorated/thinning tube	◎S	◎S	◎P	◎P	◎P	◎P	Ⓜ	
b. Reheater	Detailed inspection of horizontal RH		○S	○P	○P	○P		Ⓜ	
	Replacement of lower bent tube		○S	◎P		◎P		Ⓜ	
	Replacement of deteriorated/thinning tube	◎S	◎S	◎P	◎P	◎P	◎P	Ⓜ	
c. Water Wall	Partial replacement	◎S		○P	○P	◎S		Ⓜ	
	Replacement of W/W upper baffle tube	◎S					◎P	Ⓜ	
d. Boiler Casing	Repair of leaking boiler casing	◎S		◎P	◎P	◎P		–	
e. Economizer	Installation of non-return valve on the feed water line between economizer and final HP feed water heater		◎S	◎P	◎P	◎P		–	
f. Burner	Inspection and adjustment of air registers	◎S	◎S	◎P	◎P	◎P	◎P	–	
Boiler Auxiliaries a. Forced Draft Fan	Inspection of FDF/GRF	◎S					◎P	–	
b. Air Heater	Replacement of A & B heating elements			◎P	○S	◎P	◎P	–	

LEGEND: ◎ – 1st Priority; ○ – 2nd Priority; Ⓜ – Manufacturer Ⓔ – Engineering

P – Primary Rehabilitation S – Secondary Rehabilitation

ITEM		G–1	G–2	S–1	S–2	M–1	M–2	Engineering	Remarks
c. Steam Coil Air Heater	Replacement of heating elements			◎ P			◎ P	–	
	Improvement of SCAH drip system						○ S	Ⓔ	
d. Constant Differential Fuel Oil Pump	Replacement/repair of CDFOP	◎					◎	–	Immediately
e. Ash Handling System	Replacement of ash handling system	*	*	*	*	◎ P	◎ S	Ⓔ	*Replace after successful operation M-1/2
f. Auxiliary Steam System	Repair of all leakages along the auxiliary steam line					○		–	GSTP study to be made
g. Soot Blower	Repair of rack type soot blower	◎ S		◎ P	◎ P	◎ P	◎ P	–	
h. Piping System	Identification mark/flow direction pipes	◎	◎	◎	◎			–	Including turbine immediately
i. Others	Improvement of ventilating system for burner enclosure					◎ P		–	
Turbine a. HP Turbine	Major inspection	◎ S	◎ S	◎ P	◎ P	◎ P	◎ P	Ⓜ	
	Reinstallation of repaired rotor				◎			Ⓜ	Discussion with manufacturer
b. IP Turbine	Major inspection	◎ S	◎ S	◎ P	◎ P	◎ P	◎ P	Ⓜ	
	Replacement of inner casing				◎ P	◎ P		Ⓜ	

ITEM		G–1	G–2	S–1	S–2	M–1	M–2	Engineering	Remarks
c. LP Turbine	Major inspection	◎ S	◎ S	◎ P	◎ P	◎ P	◎ P	Ⓜ	
	Reblading		◎ S	◎ P	◎ P	◎ P		Ⓜ	Discussion with manufacturer
Turbine Auxiliaries a. Condenser	Preparation of spare tubes					○		–	
	Replacement of all tubes						◎ P	–	
b. Low Pressure Feed Water Heater	Replacement of LPH tubes		◎ S #3	◎ S #3	◎ P #2	◎ S #3		–	
c. High Pressure Feed Water Heater	Replacement of HPH tubes	◎ S #5	◎ S #6B		◎ S #6B	◎ S #5A		–	
	Installation of HP heaters by–pass			◎ P		◎ P		Ⓔ	
d. Monitoring of condenser leakage	Replacement of condenser leakage detector system						◎ P	–	
e. Ball Cleaning System	Repair and replacement of ball cleaning system						○ P	–	
f. Auxiliary Cooling System (Heat Exchanger)	Replacement of heat exchanger tubes	○ S #B					○ P #A	–	
	Additional installation of heat exchanger					○ S		Ⓜ	Study to be made
g. Boiler Feed Water Pump	Replace turbine blades on last stages of T–BFP			◎ P				Ⓜ	

ITEM		G–1	G–2	S–1	S–2	M–1	M–2	Engineering	Remarks
h. Piping System	Repair of damaged pipe insulation	◎ S		◎ P	◎ P	◎ P		–	
i. Others	Servicing of spare parts on the turbine floor						○	–	As soon as possible
	Repair or replacement of powerhouse ventilation fans	◎	◎	◎	◎	◎	◎		Immediately
j. Cooperation with manufacturer	Invitation of Manufacturers supervisor for the above checking/improvement/replacement	◎	◎	◎	◎	◎	◎		Immediately

ITEM		G–1	G–2	S–1	S–2	M–1	M–2	Engineering	Remarks
Electrical Equipment	Generator Repair	–	–	–	*	*	–	–	*Gen. hot spot problem should be solved.
	Additional/Replacement batteries	○ S		○ S		○ S	–	–	
	Automatic start and cabling of emergency diesel generator	S ◎ Automatic start & cabling		P		◎ P Automatic Start		–	
	Additional constant voltage and frequency set	○ S	○ S	○ S	○ P	○ S	○ S	–	
	Additional intercommunication	○				○		–	
	Additional lighting for boiler house and outdoor	○	○	○	○	○	○	–	As soon as possible
	Additional welding power outlet	○	○	○	○	–	–	–	– do –
	Replacement of fire alarm system	○		○		–	–	–	– do –

ITEM			G–1	G–2	S–1	S–2	M–1	M–2	Engineering	Remarks
Instrument and Control	Additional recorder for condensate flow, turbine speed/cam position, condenser vacuum & generator output		S ○	S ○	S ○	S ○	S ○	S ○	–	
	Replacement of local gage and meter		◎	◎	◎	◎	◎	◎	–	Immediately
	Replacement of auxiliary relay		○	○	○	○	○	○	(E)	
	Replacement of ABC and start-up system		–	*	*	(◎)	*	–	(M) (E)	( ) Planning by NAPOCOK * Replace after successful opn. of S–2
	Spare parts		◎	◎	◎	◎	◎	◎	(E)	Immediately
	Rehabilitation of burner control		–	–	–	–	–	◎ S	(M)	
	Installation of furnace TV		○	○	○	○	○	○	(M)	
	Replacement of boiler metal temperature recorder including sensor		–	S ◎	S ◎	S ◎	–	–	–	
	ABC and start up control overhaul/ calibration and fine tuning.		*	S ◎	P ◎	–	P ◎	*	(M) (E)	* On Auto but need overhaul calibration and fine tuning.
	Replacement/ Repair of local Control	Heater & condensate drain control	◎ S	◎ S	◎ S	◎ S	◎ S		(E)	
		Aux. Steam and AH Temp. Control	◎ S	◎ S	◎ S	◎ S	◎ S	◎ S		
		Others	○	○	○	○	○	○		

ITEM	G–1	G–2	S–1	S–2	M–1	M–2	Engineering	Remarks
Inspection of E H C	–	–	◎ P	◎ P	◎ P	–	Ⓜ	
Replacement of sensor for plant interlock and alarm including first out indicator	◎ S	◎ S	◎ S	◎ S	◎ S	◎ S	Ⓔ	
Improvement of central control room air conditioner	–		◎		◎		–	Immediately
Additional control air compressor and modification of piping	○ S Piping	○ S Piping	○ S Piping comp.	○ S Piping	○ S comp.		Ⓔ	
Installation of fuel oil line temperature monitoring			◎		◎		Ⓔ	Immediately
Additional flow integrator for make-up water and deep well water	◎ S	◎ S	◎ S	◎ S	◎ S	◎ S	–	Immediately for deepwell water

REHABILITATION ITEMS (CHEMICAL MANAGEMENT)

ITEM		G–1	G–2	S–1	S–2	M–1	M–2	Engineering	Remarks
Chemical Laboratory a. Equipment	Purchase, improvement or overhauling of equipments in laboratory (flameless atomizer, ultra water purifier, 50 mm cell for spectrophotometer, etc.)		◎				◎	–	Immediately
	Set up of pure water lines at lab. sinks		◎				◎	–	– do –
b. Water analysis method and frequency	Improvement of analysis method (Cl, SiO_2, PO_4, PH, etc.)		◎				◎	–	– do –
	Change of analysis method (Fe, Cu, NH_4)		○				○	–	As soon as possible
	Change of items and frequency		○				○	–	– do –
c. Analytical reagent	Analytical grade		○				○	–	– do –
	Keep shelf-life		○				○	–	– do –
	Record of stocking and consumption		○				○	–	– do –
	List up of required reagents		○				○	–	– do –
Water Quality Management	Keep up with the water quality specification		◎				◎	Ⓔ	Immediately
	Re-estimation of the specifications of the water quality		◎				◎	Ⓔ	– do –
	Modification of water chemistry control								
	Increasing hydrazine concentration		◎				◎	–	Immediately
	Change to all volatile treatment for drum type boiler	○				○		Ⓔ	After units are stabilized