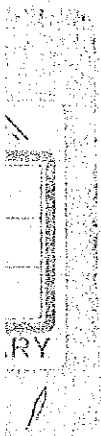


フィリピン共和国  
ルソン島地域  
発電所リハビリテーション・送変電修復計画  
予備調査報告書

1991年 5月

国際協力事業団  
鉱工業計画調査部

鉱計資
JR
91-94





フィリピン共和国

ルソン島地域

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予備調査報告書

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22369

# ルソン系統電力設備図

**LEGEND:**

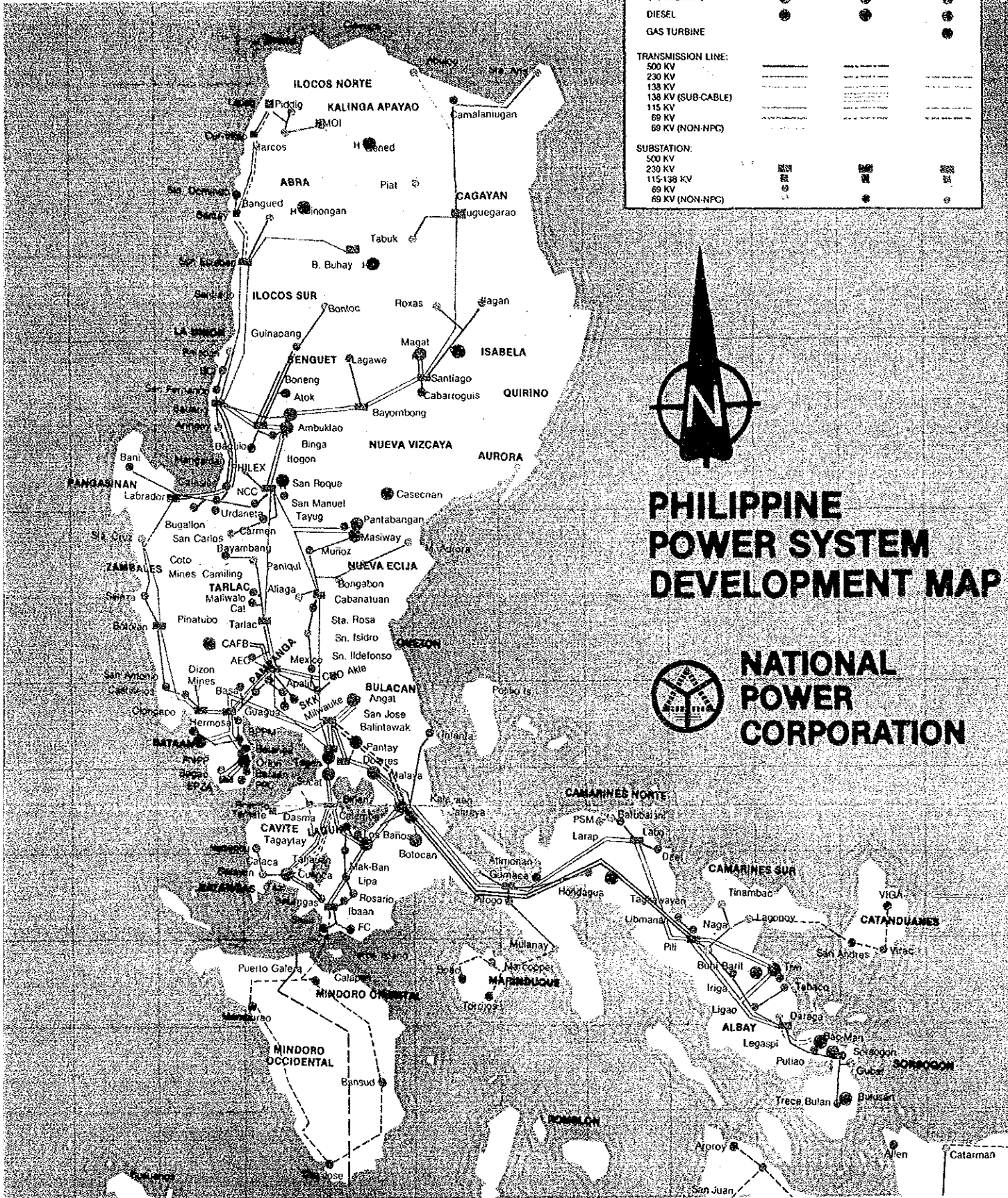
GENERATING PLANT:	EXISTING	ON GOING	PROPOSED
HYDRO	●	●	●
GEOTHERMAL	●	●	●
COAL THERMAL	●	●	●
OIL THERMAL	●	●	●
DIESEL	●	●	●
GAS TURBINE	●	●	●

TRANSMISSION LINE:	EXISTING	ON GOING	PROPOSED
500 KV	—	—	—
230 KV	—	—	—
138 KV	—	—	—
138 KV (SUB-CABLE)	—	—	—
115 KV	—	—	—
69 KV	—	—	—
69 KV (NON-NPC)	—	—	—

SUBSTATION:	EXISTING	ON GOING	PROPOSED
500 KV	■	■	■
230 KV	■	■	■
115-138 KV	■	■	■
69 KV	■	■	■
69 KV (NON-NPC)	■	■	■



## PHILIPPINE POWER SYSTEM DEVELOPMENT MAP



## NATIONAL POWER CORPORATION



# 予備調査報告書 目次

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# I. 総論



# I. 総論

## 1. 予備調査の目的

フィリピン政府で国家開発計画を総括するNEDA (National Economic Development Authority) より要請あった。

- 発電設備リハビリテーション
- 送・変電設備リノベーション
- 運転・保守システム改善
- 電力設備環境対策

等のルソン島電力設備改善に対し、日本政府が供与する技術支援・協力についてフィリピン側が起草したTOR (Terms of Reference) を基に具体的なI/A (Implementation Agreement) の確認を行い、合意に達した場合には署名することを目的として実施した。

## 2. 案件要請に至る背景・経緯及びTerms of Reference (T/R)

ルソン島地域における全発電設備は、1989年時点で4322MWでフィリピン全体の74.7%を占める。またルソン島地域のピーク需要は2938MWで数値上は、十分な供給力を保有しているかにみえるが、発電施設の老朽化による事故、発電、送変電設備の修理、保守点検不備による機能低下及びこれに自然災害も加わり、ルソン島電力系統内では定期的に停電、節電を繰り返している。このため、電力の安定供給は、国の政策としてプライオリティーの高いものとなっている。このような背景を基にフィリピン電力公社 (NAPOCOR) は、既存発電設備のリハビリテーション、維持改善、送変電設備の保守、修復等の各計画調査を要請してきた。

これを受けて平成2年10月本件について、プロジェクト選定確認調査を実施した。今回の予備調査はこれを受け実施されたものである。

NEDAが日本政府に要請してきたTORを以下に添付する。



REPUBLIC OF THE PHILIPPINES  
NATIONAL ECONOMIC AND DEVELOPMENT AUTHORITY  
NEDA sa Pasig, Amber Avenue Pasig, Metro Manila

Cable Address: NEDAPHIL  
P.O. Box 419, Greenhills  
Tels. 63+0945 to 64

MAR 19 1991

Mr. Takeshi Yagi  
First Secretary  
Embassy of Japan  
Sen. Gil J. Puyat Avenue  
Makati, Metro Manila

Dear Mr. Yagi:

This refers to the project proposal entitled "Luzon Grid Plant Rehabilitation Plan and Operation/Maintenance Improvement Plan" of the National Power Corporation (NAPOCOR) under the JICA Development Survey Program.

We are transmitting the revised Terms of Reference (TOR) of said proposal for your consideration. We hope that the Government of Japan finds the attached TOR acceptable in order that the Implementation Arrangement between JICA and NAPOCOR could be signed prior to the departure of the JICA Mission on 23 March 1991.

Thank you and best regards.

Very truly yours,

IRMA C. CORALES  
Director  
Public Investment Staff

cc: Mr. Moriya Miyamoto, JICA

## TERMS OF REFERENCE

### 1. REHABILITATION PLAN AND OPERATION/ MAINTENANCE IMPROVEMENT PLAN

The study is to develop a 5-year rehabilitation plan and operations/maintenance improvement plan of generating plants in Luzon.

#### 1.1 Scope of the Study

##### 1.1.1 5-Year Rehabilitation Plan of Power Generation Facilities in Luzon

- a) Development of criteria for prioritizing rehabilitation projects.
- b) Technical survey of Luzon coal, oil geothermal and hydro facilities in the order or priority to determine their existing condition and current operation and maintenance practices.
- c) Prioritizing major maintenance/overhaul of generating facilities.
- d) Development of an integrated schedule of capital expenditures for the prioritized major maintenance/overhaul of generating facilities.
- e) Setting up of the total spare part requirements of each generating plant.
- f) Setting up of the economic level of inventory and reorder quantities and points.
- g) Standardization of test instruments, machine shop facilities and mechanical/electrical repair tools and equipment.

- 2 -

1.1.2 Operations and Maintenance Improvement Plan

- a) To study of effective interfacing of operations and maintenance organizations at both plant and regional levels.
- b) Establishment of recommended administrative and technical procedures.
- c) Standardization of maintenance documents.
- d) Establishment of an information feedback system.

1.1.3 Technology transfer to NAPOCOR Counterpart Engineers

2. RENOVATION OF TRANSMISSION LINES AND SUBSTATIONS IN THE LUZON GRID

This study is to develop a 5-year renovation plan for transmission lines and substations in the Luzon Grid.

2.1 Scope of the Study

2.1.1 Scope of renovation works on transmission lines

- a) Measure to prevent tower failures
- b) Measures to prevent breakage of pole cross-arms
- c) Measures to prevent failures of splicing joints on ACSR conductors
- d) Live-line detection of defective insulators and early replacement thereof
- e) Method of inspection of corrosion on ground wires and damage to structures installations

- 3 -

2.1.2 Scope of Engineering Services

- a) Survey/investigate the present condition of transmission lines
- b) Prioritizing and scheduling of renovation works
- c) Implementation of renovation works programmed in Item B
  - Preparation of cost estimates
  - Preparation of detailed work schedule

2.2 Renovation of Substations

2.2.1 Scope of Renovation Works

- a) Renovation/improvement of substation system equipment and protective relays

2.2.2 Scope of Engineering Services

- a) Detailed investigation of the present condition of substation system, equipment and protective relays.
- b) Identification of substation system and equipment requiring renovation/improvement
- c) Preparation of list of needed equipment
- d) Preparation of schedule of renovation/improvement

- 4 -

### 3. ENVIRONMENTAL CONCERNS

- 3.1 Data and Information Collection concerning environmental control rules and regulations in the Philippines.
- 3.2 Survey and Disposal of PCB (polychlorinated biphenyl)
  - 3.2.1 Establishment of methodology to remove the equipment employing PCB oil as the insulation materials
  - 3.2.2 Recommendation of administration of PCB equipment
- 3.3 Recommendation of environmental monitoring system including cost estimate in Luzon.



### 3. 計画の概要

本計画の概要は；

- ① ルソン系統の発電施設の5ヶ年リハビリテーション計画の策定。
- ② ルソン系統における送電、変電設備の5ヶ年リノベーション計画の策定。
- ③ ルソン系統電力設備の維持管理及び運転・保守システムの改善計画の策定。

これらの計画の策定のために本格調査においてはルソン系統における発電施設、送電、変電設備の現状を把握し、NAPOCOR による電力設備の維持管理、保守管理について詳細な検討を行うとともに将来の電力需給バランスを考慮し合理的な発電所のリハビリテーションと送電、変電設備リノベーションのプライオリティーを経済的な評価と共に確定する。

また電力設備の運用に付随する環境対策（例として、変圧器PCB油の処理等）についても調査を行い、有効な技術移転を行う。

### 4. 調査団員構成及び調査日程

#### 団員構成

千原大海（団長・総括）	JICA 国際協力専門員
福田義夫（調査企画）	JICA 資源調査課
高岡拓也（送変電計画）	電源開発(株) 国際営業室 次長
百瀬 勲（発電計画）	電源開発(株) 国際営業室 課長
江戸 清（業務調整）	JICA 資源調査課

日 程 3月13日～3月23日

日順	月日	曜日	調査項目（行程）
1	3/13	水	移動（成田→マニラ PR431）、JICA打合せ
2	3/14	木	NBCA表敬、TOR について打合せ、I/A 協議、NAPOCOR 表敬、TOR について打合せ、TOR の内容の確認、I/A 協議
3	3/15	金	NAPOCOR I/A 協議、資料収集
4	3/16	土	M/M（案）作成、資料整理
5	3/17	日	M/M（案）作成、資料整理
6	3/18	月	マクバン地熱発電所調査（マニラ←→マクバン）
7	3/19	火	NAPOCOR とI/A 協議、M/M 等協議、資料収集
8	3/20	水	大使館表敬、NAPOCOR とI/A 協議、M/M 等協議
9	3/21	木	NAPOCOR とI/A 署名、資料収集
10	3/22	金	大使館、JICAへの報告
11	3/23	土	移動帰国（マニラ←→成田、JL742）

## 5. 現地訪問先と面会者

### 訪問先

- (1) 在フィリピン日本大使館
- (2) JICAフィリピン事務所
- (3) National Economic and Development Authority (NEDA)
- (4) National Power Corporation (NAPOCOR)  
本社 (ケソン市デリマン)  
マクバン地熱発電所

### 面会者

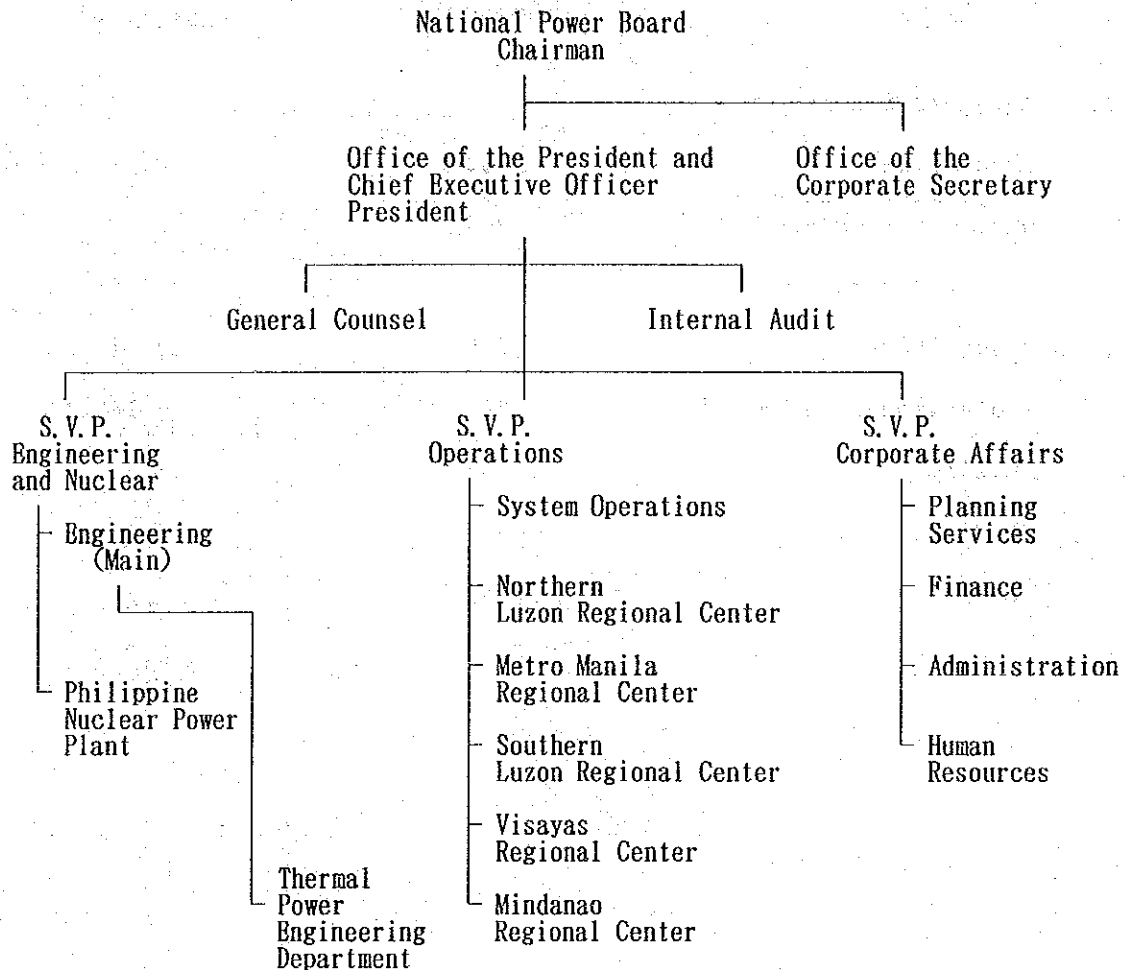
- (1) 在フィリピン大使館  
佐味祐介 一等書記官
- (2) JICAフィリピン事務所  
竹内喜久男次長、斉藤克郎所員
- (3) National Economic and Development Authority (NEDA)
  - a. MR. EUGENIO INOCENTES  
Chief of Programme Financing Public Investment Staff
  - b. MR. JOSE MONTBRO  
Chief, Energy and Power Div.
  - c. MR. JOAN ALITAGTAG  
Senior Economic Development Specialist
- (4) National Power Corporation (NAPOCOR)
  - a. MR. ARMANDO C. PLATA  
Senior Vice President, Operations
  - b. MR. HECTOR N. CAMPOS  
Vice President, Operations
  - c. MR. LEONARDO F. OSILLA  
Dept. Manager, Efficiency & Reliability Dept.
  - d. MR. JACINTO G. VICTA  
Assistant manager, MAK-BAN GPP
  - e. MR. PRIM SANIAGO  
Regional Security Officer, Souther Luzon Region

## 6. 関係機関

本件のフィリピン側関係機関はフィリピン電力会社 (National Power Corporation) である。National Power Corporation (NAPOCOR) は電気事業を目的として1936年に政府の全額出資によって設立された。これは1935年のCommonwealth Act, No. 120 に基づくものである。1972年、NAPOCOR Charter と、Presidential Decree 40によって事業範囲が大幅に拡大され、現在は国の経済社会開発政策に沿って、あらゆる電力資源の調査、開発を行い、全国の送電網を整備し、発生電力を全国の電化協同組合と、マニラ電力会社に卸売供給している。1988年末の発電設備容量は 5,782MW、従業員数は11,294人である。

NAPOCORの事業政策に関する一切の審議、決定は理事会によって行われる。各理事は大統領によって任命される。NAPOCORの組織要員構成及びブルソン系統電気料金表を以下に示す。

Organization of NPC



NAPOCOR STAFF PROFILE  
(As of 31 March 1990)

<u>Level</u>	<u>Number</u>	<u>% of Total</u>
I. Managers & Executives		
Executives	38	0.39
Department Managers	91	0.94
Division Managers	245	2.52
Subtotal	374	3.84
II. Supervisors	1,295	13.31
III. Professional/Technical	5,267	54.14
IV. Skilled	1,742	17.91
V. Clerical	695	7.14
VI. Unskilled	<u>356</u>	<u>3.66</u>
Total	<u>9,729</u>	<u>100.00</u>

National Power Corporation  
Electricity Tariff as of 26 March 1990

LUZON GRID

UTILITIES

Applicable to electric power and energy supplied to electric utilities in Luzon served by NAPOCOR.

Demand Charge (P/kW/Month)

First 500 kW of Billing Demand	13.20
Next 19,500 kW of Billing Demand	17.60
Over 20,000 kW of Billing Demand	24.20

Energy Charge (P/kWh/Month)

First 200 kWh per kW of Billing Demand	1.1079
Next 200 kWh per kW of Billing Demand	1.1299
Over 400 kWh per kW of Billing Demand	1.1541

INDUSTRIES AND NON-UTILITIES

Applicable to electric power and energy supplied to industries and non-utilities in Luzon served by NAPOCOR.

Demand Charge (P/kW/Month)

First 1,000 kW of Billing Demand	19.80
Next 9,000 kW of Billing Demand	20.90
Over 10,000 kW of Billing Demand	22.11

Energy Charge (P/kWh/Month)

First 200 kWh per kW of Billing Demand	1.1904
Next 250 kWh per kW of Billing Demand	1.1519
Over 450 kWh per kW of Billing Demand	1.1189



## Ⅱ. I / A協議及び合意内容





## II. I/A協議及び合意内容

### 1. 協議の要点

- (1) 今回の予備調査はTORが公式ルートで日本政府に届いていない状況で訪比したので業務の開始はNEDAの本件に関する手続きの確認から行った。

NEDAはTORの内容のうち特に環境に係る項目について案件全体との整合が出来ていない事を指摘し、実行機関であるNAPOCORに対してTORの見直しを求めている状況であった。

NAPOCORは3月18日(月)までに内部で作業を進め3月19日(火)午前中にNEDAに正式に再提出した。

NEDAはNAPOCORより再提出されたTORを検討し同日中に在フィリピン日本国大使館に正式な協議要請を行った。


- (2) 本件は運転・保守技術の向上をめざすソフトウェアの技術移転が特に重要であることから、NAPOCORからも出来る限り長期に現地共同作業の実行が可能になるよう強く望まれた。また通常業務から独立した専門対応組織が必要であることも相方において確認した。
- (3) 火力発電所の環境対策についてNAPOCORは当初日本での実績に基づく具体的な技術移転を期待した。しかしながら予備調査団は本調査の主旨に鑑み、①環境対策としてPCB油の管理技術②火力発電所大気汚染モニタリングの概要③地熱発電所のH<sub>2</sub>S対策の技術説明に限定し合意を得た。
- (4) NAPOCORのTORのうち、電力設備の活性化と直接的に整合出来ないもの(マスタープランレベルを越えて相当に詳細な内容に入り込んだもの等)については、本調査団の作業スケジュールをさまたげない範囲で協力する事で合意した。
- (5) NAPOCORは本件にかかわる機材供与を要望したが業務の性質が機材供与になじまないもので明確に否定した。

2. 署名した1/A


IMPLEMENTING ARRANGEMENT  
FOR  
MASTER PLAN STUDY  
ON  
REHABILITATION/RENOVATION AND  
OPERATION/MAINTENANCE IMPROVEMENT  
OF  
POWER FACILITIES  
IN  
LUZON GRID  
IN  
REPUBLIC OF THE PHILIPPINES

AGREED UPON BETWEEN  
JAPAN INTERNATIONAL COOPERATION AGENCY  
AND  
NATIONAL POWER CORPORATION

MARCH 21, 1991



HIROMI CHIHARA  
Leader of  
Preparatory Study Team  
JAPAN INTERNATIONAL COOPERATION  
AGENCY



ARMANDO C. PLATA  
Senior Vice-President  
Operations  
NATIONAL POWER CORPORATION

## I. INTRODUCTION

In response to the request of the Government of the Republic of the Philippines (hereinafter referred to as "GOP"), the Government of Japan (hereinafter referred to as "GOJ") decided to implement the Master Plan Study (hereinafter referred to as "the Study") on Rehabilitation/Renovation and Operation/Maintenance Improvement of Power Facilities in Luzon Grid and exchanged the Notes Verbales with GOP concerning the implementation of the Study.

The Japan International Cooperation Agency (hereinafter referred to as "JICA"), the official agency responsible for the implementation of the technical cooperation programme of GOJ, will undertake the Study in accordance with the relevant laws and regulations in force in Japan.

On the part of GOP, National Power Corporation (hereinafter referred to as "NAPOCOR") shall act as a counterpart agency to the JICA study team and also as a coordinating body in relation with other governmental and non-governmental organizations concerned for the smooth implementation of the Study.

The present document constitutes the implementing arrangement for the Study between JICA and NAPOCOR under the above-mentioned Notes Verbales exchanged between the two Governments.

## II. OBJECTIVE OF STUDY

The Study is (1) to formulate the Master plan on a 5-year rehabilitation/renovation for NAPOCOR's power facilities (generating plants, transmission lines, and substations) in Luzon grid, (2) to recommend operation and maintenance plan in undertaking the rehabilitation/renovation and maintenance programs for the power facilities and (3) to recommend

environmental aspects to be applied to the power facilities.

### III. SCOPE OF STUDY

#### 1. 5-year Renovation Plan of Power Facilities in Luzon Grid

The Study Team in coordination with the NAPOCOR counterparts shall undertake a comprehensive study at a master Plan level in preparing a 5-year Rehabilitation/Renovation Plan in Luzon Grid which covers the following work activities:

- 1) To collect the Data and Information
  - a) Fundamental data of each power plants including installed capacities, actual maximum outputs, annual energy productions, year of installation, names of equipment manufacturers, historical major faults, major repair works to be done urgently
  - b) Fundamental data of NAPOCOR's proposed transmission lines for renovation, including the names of transmission lines types of towers, voltages, types of insulators, types of conductors, causes of damage, year of installation
  - c) Load forecast and power development program in Luzon Grid (1990)
  - d) NAPOCOR's rehabilitation and renovation plan (timing, required outage period, etc.)
- 2) To review the collected data, and identify the rehabilitation/renovation work items to be required for each power facilities.
- 3) To perform the site technical survey on the selected

power facilities in order to collect and confirm the information necessary for the study.

- 4) To analyze causes of deterioration/damage/faults, and to recommend the method of rehabilitation and renovation including major maintenance/overhaul of the power facilities.
- 5) To establish a criteria for prioritizing rehabilitation and renovation projects and to prioritize rehabilitation/renovation projects.
- 6) To set up the schedule of rehabilitation and renovation projects.
- 7) To access the inventory level of spare parts and NAPOCOR's spare parts management system, and to prepare recommendation on the spare parts management system.
- 8) To set up the total spare parts requirement on the selected power facilities
- 9) To develop an integrated schedule of capital expenditures for the prioritized rehabilitation/renovation projects.
- 10) To perform economic study of the rehabilitation/renovation projects

2. Recommendation on Operation and Maintenance Plan of NAPOCOR's Power Facilities

The Study shall also cover the improvement of efficiency of maintenance through improvement of the NAPOCOR's management and administration systems in undertaking the rehabilitation/renovation and maintenance programs for

the power facilities.

1) Data and Information Collection

- a) NAPOCOR's organization including duty and responsibility of personnel, role of National Power Board
- b) NAPOCOR's operation and maintenance management system
- c) NAPOCOR's management information system
- d) NAPOCOR's operation and maintenance staff training system and facilities
- e) Past records of financial assistance to the operation and maintenance of NAPOCOR's power facilities
- f) Past studies on the operation and maintenance by NAPOCOR, JICA, ADB, IBRD, etc.
- g) NAPOCOR's operation and maintenance problems by interview

2) To review the collected data/information, identify the area of problem to be improved on NAPOCOR's operation and maintenance system, and prepare recommendation for improvement plan. The matters to be concerned may be as follows:

- a) Maintenance management system
- b) Training of operation and maintenance staff
- c) Training for management staff (junior, middle, senior)

- d) Safety education system
- e) Risk management system
- f) Emergency procedures at fault, social disturbance, typhoon, landslide, earthquake, etc
- g) Maintenance procedure
- h) Protective relay system maintenance
- i) Spare parts management system
- j) Operation manuals
- k) Maintenance manuals
- l) Reporting forms

3) To study the effective interfacing of operations and maintenance organizations at both plant and regional levels.

4) To establish recommended administrative and technical procedures, including criteria of Economic Load Dispatching.

5) To standardize maintenance documents.

6) To establish an information feedback system

7) To standardize test instruments, machine shop facilities and mechanical/electrical repair tools and equipment.

3. Environmental Concerns

- 1) Data and Information Collection concerning environmental control rules and regulations in the Philippines.
- 2) Survey and Disposal of PCB (polychlorinated biphenyl)
- a) Establishment of methodology to remove the equipment employing PCB oil as the insulation materials
  - b) Recommendation on administration of PCB equipment
- 3) Recommendation of environmental monitoring system including cost estimate in Luzon Grid.

*Ofund*

#### IV. STUDY SCHEDULE

The Study will be executed in accordance with the tentative study schedule shown in Appendix I as attached herewith.

#### V. REPORTS

JICA will prepare and submit the following reports in English to GOP in accordance with the tentative time schedule.

- 1. Inception Report (10 copies)
- 2. Interim Report (20 copies)
- 3. Draft Final Report (6 copies)
- 4. Final Report and its summary (20 copies)

*\* ltel:*

#### VI. UNDERTAKING OF GOP

In accordance with the Notes Verbales exchanged between GOJ and GOP, GOP shall accord privileges, immunities and other



benefits to JICA study team and, through the relevant authorities, take necessary measures as follows to facilitate smooth conduct of the Study.

1. GOP shall be responsible for dealing with claims which may be brought by third parties against the members of JICA study team and shall hold them harmless in respect of claims or liabilities arising in the course of, or otherwise connected with the discharge of their duties in the implementation of the Study, except when such claims or liabilities arise from the gross negligence or willful misconduct of the abovementioned members.
2. NAPOCOR shall, at its own expense, provide JICA study team with the following, in cooperation with other relevant agencies, if necessary;
- 1) necessary data, information and materials,
  - 2) counterpart personnel,
  - 3) administrative and technical support staff, and laborers as needed,
  - 4) suitable office space with necessary equipment
  - 5) credentials or identification cards and
  - 6) necessary vehicles and vessels with drivers and crew, fuel and spare parts.
3. NAPOCOR shall take necessary measures with the governmental and non-governmental organizations concerned for the following;
- 1) to secure the safety of JICA study team,

- 2) to permit the members of the JICA study team to enter, leave and sojourn in the Philippines for the duration of their assignment therein, and exempt them from alien registration requirements and consular fees,
- 3) to exempt the members of the JICA study team from taxes, duties and any other charges on equipment, machinery and other materials to be brought into and out of the Philippines for the conduct of the Study,
- 4) to exempt the members of the JICA study team from income tax and other charges of any kind imposed on or in connection with any emoluments or allowances to be paid to the members of the JICA study team for their services in connection with the implementation of the Study,
- 5) to arrange customs clearance, handling and storage at the airport/port and island transportation of equipment, machine, instruments, tools and other articles to be brought into the Philippines in connection with the implementation of the Study,
- 6) to provide necessary facilities to JICA study team for remittance as well as utilization of the funds introduced into Philippines from Japan in connection with the implementation of the Study,
- 7) to secure the permission for entry into private properties or restricted areas for the conduct of the Study,
- 8) to secure the permission for JICA study team to take all data and documents (including photographs and maps) related to the Study out of Philippines to Japan, and

- 9) to provide medical services as needed  
Its expenses will be chargeable on members of JICA  
study team.

#### VII. UNDERTAKING OF GOJ

In accordance with the Notes Verbales exchanged between GOJ and GOP, GOJ, through JICA, shall take the following necessary measures for the implementation of the Study;

1. to dispatch, at its own expense, the study team to the Philippines and
2. to pursue technology transfer to the Philippine counterpart personnel in the course of the Study.

#### VIII TECHNICAL UNDERTAKING

The division of technical undertakings by JICA and NAPOCOR is details in Appendix II as attached herewith.

#### IX. CONSULTATION

JICA and NAPOCOR shall consult with each other in respect of any matter that may arise from or in connection with the Study.



APPENDIX II DIVISION OF TECHNICAL UNDERTAKING

Working Items	Undertaking by JICA	Undertaking by NAPOCOR
1. 5-year Renovation Plan		
1) Collection of data & information	1. Carrying out	1. Preparation of all available data, report & information 2. Assisting JICA's collection
2) Review of data & identification of renovation	1. Carrying out	
3) Site technical survey	1. Carrying out	1. Assignment of C/Ps for guidance & discussions
4) Establishment of a criteria	1. Carrying out	1. Assignment of C/Ps
5) Prioritization of renovation	1. Carrying out	1. Assignment of C/Ps
6) Study of spare parts, its management	1. Carrying out	1. Assignment of C/Ps
7) Setting up the total spare parts	1. Carrying out	1. Assignment of C/Ps
8) Development of capital expenditure schedule	1. Carrying out	1. Assignment of C/Ps
9) Economic study of renovation project	1. Carrying out	1. Assignment of C/Ps
2. Recommendation on Operation and Maintenance of Power Facilities		
1) Data & information collection	1. Carrying out	1. Preparation of all available data, report & information 2. Assisting JICA's collection

*of*

*of*

Working Items	Undertaking by JICA	Undertaking by NAPOCOR
2) Review of data, identification of NAPOCOR's system problem and preparation of recommendation	1. Carrying out	1. Assignment of C/Ps
3) Study of interface between maintenance and operation	1. Carrying out	1. Assignment of C/Ps
4) Establishment of administration and procedure	1. Carrying out	1. Assignment of C/Ps
5) Standardization of maintenance/operation documents	1. Carrying out	1. Assignment of C/Ps
6) Establishment of a feedback system	1. Carrying out	1. Assignment of C/Ps
7) Standardization of test instrument, etc.	1. Carrying out	1. Assignment of C/Ps
3. Environmental Concerns		
1) Data & information collection	1. Carrying out	1. Preparation of all available data, report & information
		2. Assisting JICA's collection
2) Survey & disposal of PCB	1. Carrying out	1. Assignment of C/Ps
3) Recommendation of monitoring system	1. Carrying out	1. Assignment of C/Ps

*Spent*

*1-7-81*

March 21, 1991

MINUTES OF MEETING

The Preparatory Study Team dispatched by Japan International Cooperation Agency for Master Plan Study on Rehabilitation/Renovation and Operation/Maintenance Improvement of Power Facilities in Luzon Grid in Republic of the Philippines (hereinafter referred to as "the JICA Team") had a series of discussion with the relevant officials of National Power Corporation (hereinafter referred to as "NAPOCOR") from March 14 to 21, 1991 in Manila.

The result of the discussion is summarized as follows:

1. Clarification of the NAPOCOR's Terms of Reference issued on March 18, 1991 and the JICA Team's comments on the items

General concept

Both parties have confirmed that the general concept of the study for the rehabilitation/renovation shall be at a master Plan level. Feasibility studies, design work and preparation of the implementation program for the specific units scheduled for rehabilitation/renovation shall be undertaken in a later stage, not in this study.

The intent of the study will basically be a transfer of technology (systems and methods) of how maintenance is planned, how rehabilitation/renovation projects and/or maintenance/overhaul of units is planned, etc.

Item 1 Technology Transfer to NAPOCOR Counterpart Engineers

Clarification

NAPOCOR requests that the works should be performed in close relation with the JICA Study Team.

JICA Team's comment

The JICA Team has understood the NAPOCOR's request and the request will be reflected to the man-month schedule of the Study.

Item 2 Scope of Renovation Works on Transmission Lines

- a) Measure to prevent tower failures
- b) Measures to prevent breakage of pole cross-arms

- c) Measures to prevent failures of splicing joints on ACSR conductors
- d) Live-line detection of defective insulators and early replacement thereof
- e) Method of inspection of corrosion on ground wires and damage to structures/installations

JICA Team's comment

The items are too specific and too detail, however, the JICA Team noted that the matters are very serious to NAPOCOR, therefore, the JICA Study Team will recommend the suitable methodology as a part of the study.

For the replacement of wooden poles by steel towers of important 230 kV transmission lines in Luzon, the work is considered to be included a part of the studies for 5-year Rehabilitation/Renovation Plan in Luzon Grid.

NAPOCOR's comment

Agreed to the JICA Team's comments.

- 2. Implementing Arrangement for Master Plan Study on Rehabilitation/Renovation and Operation/Maintenance Improvement of Power Facilities in Luzon Grid

JICA Team's comment

In the Chapter III of the Implementing Arrangement for Master Plan, a whole scope of works which is requested by NAPOCOR has been covered. Both parties agreed the Implementing Arrangement and signed on it on March 21, 1991 in Manila.

- 3. Other requests from NAPOCOR

- (1) Supply of environmental monitoring equipment

JICA Team's comment

This is the study for a Master Plan and the required equipment would not be used for the study purpose, therefore, JICA can not supply the equipment

NAPOCOR's comment

Understood the JICA's position.

check comment

5/7



- (2) Study on the rehabilitation of the Ambuklao and Binga dams

JICA Team's comment

In the past, various studies have been made on the rehabilitation of the Ambuklao and Binga dams which has been buried by silt. The major reasons of difficulty are as follows:

- a) to remove the silt from the reservoir economically
- b) to transport the silt to a disposal area economically
- c) to find a suitable area for disposing the silt

The JICA Team considers that this proposed study will be a part of the study for 5-year rehabilitation/renovation plan. However, a brief study based on the existing data and report can be acceptable since the full study could not be made within the working period of the study.

NAPOCOR's comment

Agreed to JICA Team's comment

- (3) Recommendation of emission abatement system for H<sub>2</sub>S gas from the geothermal power plants

NAPOCOR's request

NAPOCOR has faced to the environmental problem for emission of H<sub>2</sub>S gas particularly from the Tiwi Geothermal Power Plants and is looking for the countermeasure to reduce the H<sub>2</sub>S gas emission.

JICA Team's comment

In Japan, used steam by the geothermal power plant has been released to open air without any treatment on removal of sulphur from the steam like Philippines. However, the general technology transfer including the cost estimate at the information level can be made by JICA Study Team since the methodology for removing sulphur from exhausted steam has been established.

NAPOCOR's comment

Agreed to JICA Team's comment


4. NAPOCOR Task Force

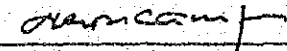
A NAPOCOR task force team dedicated to this study, which will work jointly with the JICA Study Team during their stay in the Philippines, is highly required. NAPOCOR will appoint such group during the implementation of the study.

5. Counterpart Training in Japan/Experts Assignment

The NAPOCOR requested a counterpart training in Japan regarding the power facilities maintenance program (methodology and system). The Study Team will forward this request to Tokyo.

Also, a necessity of assigning the Experts to NAPOCOR in the area of operations/maintenance has been noted. The Study Team will also forward this concern to Tokyo.

  
\_\_\_\_\_  
Hiromi Chihara  
Leader of  
Preparatory Study Team  
JAPAN INTERNATIONAL COOPERATION  
AGENCY

  
\_\_\_\_\_  
Hector N. Campos  
Vice President  
Operations  
NATIONAL POWER CORPORATION

Attachment:

1. List of Persons concerned

LIST OF PERSONS CONCERNED

1. Embassy of Japan  
MR. YUSUKE SAMI  
First Secretary
2. National Economic and Development Authority (NEDA)
  - a. MR. EUGENIO INOCENTES  
Chief of Programme Financing Public Investment Staff
  - b. MR. JOSE MONTERO  
Chief, Energy and Power Div.
  - c. MR. JOAN ALITAGTAG  
Senior Economic Development Specialist
3. National Power Corporation (NAPOCOR)
  - a. MR. ARMANDO C. PLATA  
Senior Vice President, Operations
  - b. MR. HECTOR N. CAMPOS  
Vice President, Operations
  - c. MR. LEONARDO F. OSILLA  
Dept. Manager, Efficiency & Reliability Dept.
  - d. MR. JACINTO G. VICTA  
Assistant manager, MAK-BAN GPP
  - e. MR. PRIM SANTIAGO  
Regional Security Officer, Souther Luzon Region
4. JICA Philippines Office
  - a. MR. KIKUD TAKEUCI  
Depty. Resident Representative
  - b. MR. KATURO SAITOU  
Assistant Resident Representative
5. JICA Preparatory Study Team
  - a. MR. HIROMI CHIHARA, Leader
  - b. MR. YOSHIO FUKUDA, Member
  - c. MR. TAKUYA TAKAOKA, Member
  - d. MR. ISAO MOMOSE, Member
  - e. MR. KIYOSHI EDO, Member

Dr. H. C. ...

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### Ⅲ. フィリピンにおけるエネルギー政策 と電力事情



### Ⅲ. フィリピンにおけるエネルギー政策と電力事情

#### 1. エネルギー政策

フィリピンにおけるエネルギー政策は、現政権に替わってから新たに中期開発計画（1987年～1992年）が策定され、エネルギー計画の見直しが行われた。これによると輸入石油の依存度を下げてエネルギー供給の安定化を図るため、石油・石油製品の供給源の多様化、国内代替エネルギーの開発促進、エネルギーの効率的利用のためのインフラ整備、農村地帯における分散型エネルギー技術の普及及びエネルギー備蓄の推進を基本政策とし、輸入石油への依存度を下げるとした総合エネルギー政策を踏襲している。また、1987年に経済発展の促進を目的とした民間セクターの電気事業への進出を認めている。（Executive-Order 215）

#### 2. 電力政策

(1) フィリピンの電気事業は、独立以来国営のフィリピン電力会社（NAPOCOR）が電源開発を担当し、民営のマニラ電力会社（MBLARCO）がマニラ首都圏を中心に電力供給を行ってきたが、1969年に国家電力庁（NEA）が設立されマニラ首都圏を除く全国各地に組織された電化共同組合を通して需要家に電力を供給している。NAPOCORは、新政権になってから従来のエネルギー省の管轄から大統領府（Office of President）直轄とされ、大統領府内に設置されたエネルギー管理委員会（Energy Regulatory Board：ERB）及び国家電力委員会（National Power Board：NPB）の管理を受けている。したがって、開発計画を総括するNEDAと並べて位置付けられている。一方、地方の電化を担当する（National Electrification Administration：NBA）は、省庁の系列に組み入れられており、環境資源庁（Department of Environmental & Natural Resources：DENR）の管轄下にある。

(2) 1989年9月13日、国家開発計画を総括するNEDAは、大統領の承認を得て219億ペソ（約1,500億円）に相当する1990年の国家基盤整備計画を発表した。同時に中期公共事業投資計画（MTPIP）の見直しを発表し、総括3,140億ペソ（約2兆2千億円）のうちその27.6%を電力、エネルギー及び農村電化計画に当てることとしている。この発表と同時にアキノ大統領は、地方の貧困対策の優先を強調し、生活必需品の適性な流通を図るための基盤整備を指示している。また同日NEDAが承認した電力関連プロジェクトとして、ADB融資によるNPC整備補強計画（1990年～93年）2億ペソ及びビサヤス系統整備計画1.7億ペソの2件がある。

#### 3. 電力事情

(1) フィリピンの電力系統は、ルソン系統、ビサヤス系統及びミンダナオ系統に分けられる。ル

ソン系統は、マニラ首都圏を中心とした南部のカマリネス地方を含むルソン島全域であり、ほぼ全島が230kVで結ばれている。特に、カマリネスの中部ナガ開閉所とカラヤーン発電所は500kV系で連携されており、近い将来、マニラ市北方のミルウォーキー開閉所まで延長される予定である。これに対してビサヤス系統は、セブ、ネグロス、レイテ、サマル、ボホール、パナイ各島のそれぞれ独立した系統を総称するが、レイテ-サマル間は連携されており、近く230kVに昇圧される予定である。ミンダナオ系統は、南部のミンダナオ島全域の独立した系統であり、ほぼ全域が138kV系で連携されている。

- (2) 1988年末における全系統の設備容量は5,782MWであり、その71%にあたる4,111MWがルソン系統に属している。因みに、ビサヤス系統は604MW、ミンダナオ系統は1,077MWである。1988年の発電量は、全系統で約230億kWhであり、そのうちルソン系統が76%にあたる174億kWhを占めている。これに対して販売電力量は、全系統で212億kWhで、ルソン系統は同じく76%に当たる161億kWhである。対象人口は全系統で5,385万人であり、そのうちルソン系統は55%にあたる2,969万人で、一人当たりの電力消費量は全系統393kWhに対してルソン系統では542kWhとなっている。
- (3) 電源構成はフィリピン全系統で、石油火力が41%に当たる2,359MW、石炭火力が7%に当たる405MWで、火力発電が48%を占める。水力はカラヤーン揚水発電所の300MWを含めて37%に当たる2,124MWで、残りの15%が894MWの地熱発電である。ルソン系統は、全体の71%に当たる4,111MWであるが、その内訳は石油火力1,925MW(47%)、石炭火力300MW(7%)、水力1,226MW(30%)、地熱発電660MW(16%)あり、他の国の系統構成に比べて地熱発電の役割の大きいことが特徴である。
- (4) 将来の需要予測については、米国のベクテル社が1988年3月に纏めたルソン系統の電力開発調査の中の需要予測を参考にしてNAPOCOR 独自で予測を行って、1988年6月に全系統の1988年から2000年に至る12年間の電力開発計画にまとめあげている。これによると、フィリピン全系統における1988年の最大電力予測3,765MW(1987年の実績値は3,432MW)に対して12年後の2000年の最大電力を約2.3倍の8,787MWと推定している。同じ数字をルソン系統に見てみると、1988年予測値2,799MW(1987年実績2,592MW)に対して12年後の2000年は、2.4倍の6,730MWとしている。この値は、ベクテル社の9%経済成長のケースの高い予測よりやや低く、6%経済成長のケースの標準予測よりかなり高い予測となっており、余裕を考えた数字と判断できる。
- (5) NAPOCORの2000年時点までの電源開発計画は、2000年の最大電力予測8,787MW(ルソン系統6,730MW)に対して展開されている。この計画はベクテル社の提案をそのまま受け継いだもので、2000年時点においてフィリピン全系統の設備出力は12,078MWに達し、37%の予備率が確保される。電源構成は、石油火力27%、水力20%、地熱23%、石炭火力30%で石炭火力の飛躍的増大が特徴である。同じことをルソン系統に見ると、2000年時点の設備は9,336MWで予備率38%を有することとなり、電源構成は、石油火力28%、水力13%、地熱23%、石炭火力35%で、石炭



火力の比率が更に高く、水力が少ないことが特徴で、調整力の不足が懸念される。

- (6) ルソン系統の具体的な電源開発は、ベクテル社の水力開発は経済的でないとの見解の基に展開されており、地熱及び石炭火力の開発を中心としている。特に1994年の時点において極端な電力不足が懸念され、1989年 500MW、1991年 200MWのガスタービンの投入を計画している。ルソン・レイテの系統連携が現在問題となっているが、計画では1995年、96年にレイテの地熱合計 880MW（トンゴナン計画）をルソン系統に導入することになっているので1995年時点でのレイテ・サマール・ルソンの連携が必要である。カラカの第Ⅱ期は、1994年投入が計画されているが、現在見積図書及の審査中で、2～3年程度の遅れを考慮する必要がある。1993年に予定されている石炭火力ⅢはBOT方式による建設を含め検討中である。1996年運開予定の石炭火力（マシンロック）はサンバレスに、1999年運開予定の石炭火力Bは適地選定を含めF/Sの実施が早急に行われる予定である。
- (7) 最近の傾向として開発計画が余りにも輸入炭に偏っているため、国内資源の見直しが指摘されてきた。特に、調整源資として水力導入の検討を開始したことに関連し、5,000MW以上の包蔵水力を有するルソン島内の水力地点の見直しと、特にカラヤーン揚水発電所の増設が検討されている。なお、現在問題となっているマカティにある火力のロックウエル発電所が老朽化したことと市内中心にあたるための公害問題からその補修及び移転が問題となっており、この可能性調査のためUSAIDとのグラントに関する協定が1989年9月に調印されている。この発電所は、60MW 3機、25MW 5機、計 305MWであるが、既に25年から38年経過して60MW 2機が動いているだけである。



#### IV. ルソングリッド電力設備の現況



#### IV. ルソングリッド電力設備の現況

##### 1. 発電設備

(as of 31 December 1989)

Grid/Plant	Location	Unit No.	Rated Capacity (MW)	Date of Commissioning
<u>LUZON GRID</u>				
<u>HYDRO</u>				
1. Ambuklao	Bohod, Benquet	1	25.00	December 1956
		2	25.00	December 1956
		3	<u>25.00</u>	September 1957
			<u>75.00</u>	
2. Angat	Norzagaray, Bulacan	1	50.00	October 1967
		2	50.00	October 1967
		3	50.00	August 1968
		4	<u>50.00</u>	June 1968
			<u>200.00</u>	
Aux.		1	6.00	July 1967
		2	6.00	July 1967
		3	6.00	October 1978
		4	<u>10.00</u>	July 1986
			<u>28.00</u>	
3. Binga	Itogon, Benquet	1	25.00	January 1960
		2	25.00	January 1960
		3	25.00	March 1960
		4	<u>25.00</u>	April 1960
			<u>100.00</u>	
4. Masiway	Pantabangan, Nueva Ecija	1	<u>12.00</u>	January 1981
5. Pantabangan	Nueva Ecija	1	50.00	April 1977
		2	<u>50.00</u>	April 1977
			<u>100.00</u>	
6. Magat	Ramon, Isabela	1	90.00	May 1983
		2	90.00	August 1983
		3	90.00	September 1983
		4	<u>90.00</u>	November 1983
			<u>360.00</u>	

7. Caliraya	Lumban, Laguna	1	8.00	October 1945
		2	8.00	November 1945
		3	8.00	October 1947
		4	8.00	February 1950
			<u>32.00</u>	
8. Kalayaan Pumped Storage	Kalayaan, Laguna	1	150.00	August 1982
		2	150.00	April 1982
			<u>300.00</u>	
9. Botocan	Majayjay, Laguna	1	8.00	May 1948
		2	8.00	November 1948
		3	0.96	December 1946
			<u>16.96</u>	
10. Buhi-Barit	Buhi, Cam. Sur	1	1.80	September 1957
11. Gawayan		1	0.40	
	Subtotal Hydro		<u>1,226.16</u>	
<u>GEOHERMAL</u>				
12. Tiwi Plant	Tiwi, Albay	1	55.00	December 1978
		2	55.00	May 1979
		3	55.00	December 1979
		4	55.00	April 1980
		5	55.00	December 1981
		6	55.00	March 1982
			<u>330.00</u>	
13. Mak-Ban	Bitin, Bay Laguna	1	55.00	April 1979
		2	55.00	July 1979
		3	55.00	April 1980
		4	55.00	June 1980
		5	55.00	June 1984
		6	55.00	September 1984
			<u>330.00</u>	
	Subtotal Geothermal		<u>660.00</u>	
<u>THERMAL</u>				
14. Bataan	Limay, Bataan	1	75.00	September 1982
		2	150.00	February 1977
			<u>225.00</u>	
15. Sucat	Muntinglupa, M. Mla.	1	150.00	August 1968
		2	200.00	January 1970
		3	200.00	July 1971
		4	300.00	July 1972
			<u>850.00</u>	

16. Manila	Ermica, Manila	1	100.00	September 1965
		2	<u>100.00</u>	October 1965
			<u>200.00</u>	
17. Malaya	Pillila, Rizal	1	300.00	September 1975
		2	<u>350.00</u>	March 1979
			<u>650.00</u>	
	Subtotal Thermal		<u>1,925.00</u>	
18. Batangas	Calaca,	1	300.00	August 1984
Coal Fired	Batangas			
	Subtotal Coal-Fired		<u>300.00</u>	
19. Bataan Gas	Limay, Bataan	1	30.00	July 1989
Turbine		2	30.00	July 1989
		3	30.00	July 1989
		4	<u>30.00</u>	July 1989
			<u>120.00</u>	
20. Malaya Gas	Pillila, Rizal	1	30.00	June 1989
Turbine		2	30.00	June 1989
		3	<u>30.00</u>	
			<u>90.00</u>	
	Subtotal Gas Turbine		<u>210.00</u>	

Summary

	<u>Hydro</u>	<u>Geo</u>	<u>Oil-Fired</u>	<u>Coal</u>	<u>Diesel</u>	<u>Total</u>
Luzon grid(MW)	1226.2	660	2135	300	-	4321.2

2. 送電設備

as of 31 December 1989

LUZON GRID

	500kV	230kV	138kV	115kV	69kV	34kV以下
Existing (Circuit Km)	490	3600	—	499	2705	528
Ongoing (Circuit Km)	168	129	—	—	28	—

3. 変電設備

as of 31 December 1989

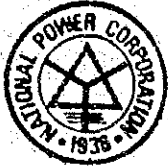
LUZON GRID

	500kV	230kV	138kV	115kV	69kV	34kV以下
Existing (MVA)	—	7590	—	1977	666	200
Ongoing (MVA)	—	50	—	—	—	—



#### 4. 運転、保守

ルソングリッドの系統運用を表す資料としてフィリピンの英字新聞広告を参考のため、以下に示す。



## REPUBLIKA NG PILIPINAS PAMBANSANG KORPORASYON SA ELEKTRISIDAD (NATIONAL POWER CORPORATION)

### POWER OUTLOOK FOR LUZON APR. 08 — APR. 14, 1991

NAPOCOR has been publishing the weekly power supply outlook for Luzon to help the public plan their activities and cooperate in the energy conservation program.

The reserve capacity for the week is not adequate and therefore, occurrence of brownouts in the residential and commercial areas is probable.

ITEM	8	9	10	11	12	13	14
	MON	TUE	WED	THU	FRI	SAT	SUN
GENERATING CAP. (MW)	3100	3100	3100	3100	3160	3160	3160
FORECAST PEAK DEMAND (MW)	2850	2600	2900	2900	2900	2770	2450
RESERVE (MW)	250	500	200	200	260	390	710
REQUIRED RESERVE (MW)	350	350	350	350	350	350	350

Therefore, in case of simultaneous forced-outages of two or more generating units, the Power Scheduling Contingency Plans A, B & C will be implemented, whereby the Industrial firms directly connected to NPC and those connected to Meralco will voluntarily reduce their load between 5 p.m. to 9 p.m. as agreed upon by the Multi-Sectorial Task Force on Power Scheduling while residential & commercial customers may experience 2-hour rotating brownouts once-a-day.

この広告は昨年同時期のものに比較して若干の改善が見られるが；

- (1) 要求予備率に対して実行予備力が月曜日から金曜日までのWorking day に 約100MW不足で運用されている。
- (2) 要求予備率が約12%で充分とは考えられない。
- (3) ルソンの発電設備容量 4,300MWに対して、可能発電容量が 3,100MWであり、約30%の発電設備が休止している。
- (4) 休日（日曜日）は、リザーブマージンが 300MWを超え、最大容量設備（マラヤ 300MW）が停止出来る。

この様にルソングリッドは大変に厳しい系統運用を強いられているので、運転信頼性の向上と合理的な保守計画等、効果的な実行プログラムの策定が強く望まれている。

NPC内部でも Efficiency and Reliability Department (ERD) を中心として、電力事業の根幹にかかわる問題として本件を認識しており、運転・保守に係る技術移転（特にソフト面での）に強い期待を寄せている。

以下に1989年末に開催された本件に関するナショナルパワーボードの議事録を参考のために添付する。

EXCERPTS FROM THE MINUTES OF THE REGULAR MEETING OF THE NATIONAL POWER BOARD HELD ON DECEMBER 5, 1989

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RESOLUTION NO. 89-380

"RESOLVED, That the proposed Creation of the Efficiency and Reliability Dept. (ERD) to function as the Heat Rate Improvement Program (HRIP)-Productivity Council, and to provide support in the improvement of plant and system efficiency and reliability of all NPC plants, substations and transmission facilities, accountable particularly for the following:

1. Providing management with the state of plants' performance on efficiency and reliability;
2. Providing SOD with relevant efficiency and reliability parameters in support of economic load dispatching;
3. Providing the Regions/Plants with efficiency and reliability-related data/information;
4. Providing assistance to the Plants in the root cause analysis of unplanned/emergency outages, and in the improvement of their efficiency and reliability;
5. Providing the Engineering Group with efficiency and reliability-related data relevant to the design of future facilities;
6. Prioritizing and facilitation of proposed rehabilitation and upgrading projects;

and consisting of seventeen (17) positions contained in the Table of Organization (copy attached as Appendix A), is hereby approved."

XX

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APPROVED, December 19, 1989.

PONCIANO G. A. MATHAY  
Chairman

DOMINGO R. VIDANES  
Member

NESTOR M. A. NOGUERA  
Member

ERNEST C. LEVING  
Member

GREGORIO S. ALVAREZ  
Representing the  
Secretary, DPWH

*vid duplication with  
her departments, recruit  
in existing staff to  
minimize need for additional  
annual.*

CERTIFIED TRUE AND CORRECT:

MANUEL S. CRUDO JR.  
Corporate Secretary

CERTIFIED TRUE COPY:

MANUEL S. CRUDO JR.  
CORPORATE SECRETARY

## A PROPOSAL FOR PRODUCTIVITY IMPROVEMENT PROGRAM

**Objective:** To help increase the level of performance of NPC by reducing operations/maintenance costs/losses and generate savings thru improved resource utilization.

**Mechanics:**

How to boost Capacity Factors  
Generate Revenue & avoid Brownouts

Improvement in Capacity Factor can be achieved by pursuing three main targets:

1. Shortening the Annual Inspection Outage
2. Long Cycle Operation
3. Reducing the number of Forced Outages

**Shortening the Annual Outage:**

Work during the annual outage falls into two categories: Regular Inspections and Special Work.

- a) Regular inspections must be gradually decreased to 10% specifically for all Thermal Power Plants. In case of Geothermal Power Plants, the regular inspection can be reduced from 35 days to 20 days.
- b) Special work can be reduced to 30% gradually.

The above "Regular Inspections and Special Work" can be achieved thru enhancement of inspection schedule control; improvement of equipment and system reliability; streamlining of inspection and test procedures and preventive/predictive maintenance to avoid equipment failure.

- c) Long Cycle Operation.

This is specifically addressed to all Geothermal Power plants whose operation can be extended from 12 months to 14 or 16 months, through the use of improved systems and equipment and rigorous quality control.

- d) Reduction in Forced Outages:

Reduction in Forced Outages can be achieved by intensive work to prevent recurring problems; implementation of Preventive Maintenance programs; and improving the qualifications of operations & maintenance personnel by expanding and enhancing education and training programs, both on the job and at training centers.

Probable savings in Revenue that can be generated annually

1. Shortening the Annual Inspection Outage specifically for Geothermal Power Plants from 35 days to 20 days.

Generation Replacement Cost from Gas Turbine:

$$\frac{(\text{P}1,273,800.00)}{\text{day}} \times 15 \text{ days} \times 12 \text{ units} = \text{P} 229,284,000.00$$

2. Repair of 4 units Gas Compressors at Mak-Ban Geothermal Power Plant = 66,610,000.00

3. Heat Rate improvement by 1% = 76,287,000.00

4. For CALACA

- a) Reduction of Forced Outage Rate from 6.897% to 3.45% = 69,000,000.00

- b) Improvement of Fuel Management to avoid spontaneous combustion = 21,758,000.00

5. Repair/Eliminate the Butterfly valve leak at Caliraya H.E. Plant

$$2 \text{ MW/hr} \times 3760 \text{ hrs/yr.} \times \frac{\text{P}1.00}{\text{Kw-hr}} = 17,000,000.00$$

TOTAL SAVINGS

₱ 479,939,000.00

#### RECOMMENDATIONS TO ATTAIN OBJECTIVES:

1. Standardize Root Cause Analysis in NPC to establish a strong Data Base and to determine NPC's deficiency.
2. Improve qualifications of Operations and Maintenance personnel by expanding and enhancing Education and Training Programs both on-the-job and at Training Centers.
3. Uplift employee Motivation and Performance thru Incentives out of the benefits that will be generated from Savings in areas of:
  - a) Innovation
  - b) Creativity
  - c) Resourcefulness
  - d) Dedication
  - e) Honesty

## 5. 環 境

電力関係の環境問題は国内炭専焼火力発電所カラカ I の運転開始後に問題が顕在化しカラカの環境問題の現状はカラカ発電所の増設を左右するほどの社会問題になりつつある、又、他の電力設備の運用についても環境問題に対してのパブリックアクセプタンスが必要になっており、NAPOCOR としては、民営化、電力料金改訂等と共に事業経営の将来に影響を与える問題としている。

NAPOCOR 内部でも環境問題への認識と対応は極めて積極的であり別紙に示す組織及び活動が環境問題に対して真剣に取り組んでいるNAPOCOR を表している。しかしながら環境問題は即電力料金に転嫁される問題でもあるところから資金の不足が大きな障害として立ちはだかっている事も事実である。

以下に環境に関連する資料を添付する。

Organizational Structure

ENVIRONMENTAL MANAGEMENT DEPARTMENT (EMD)

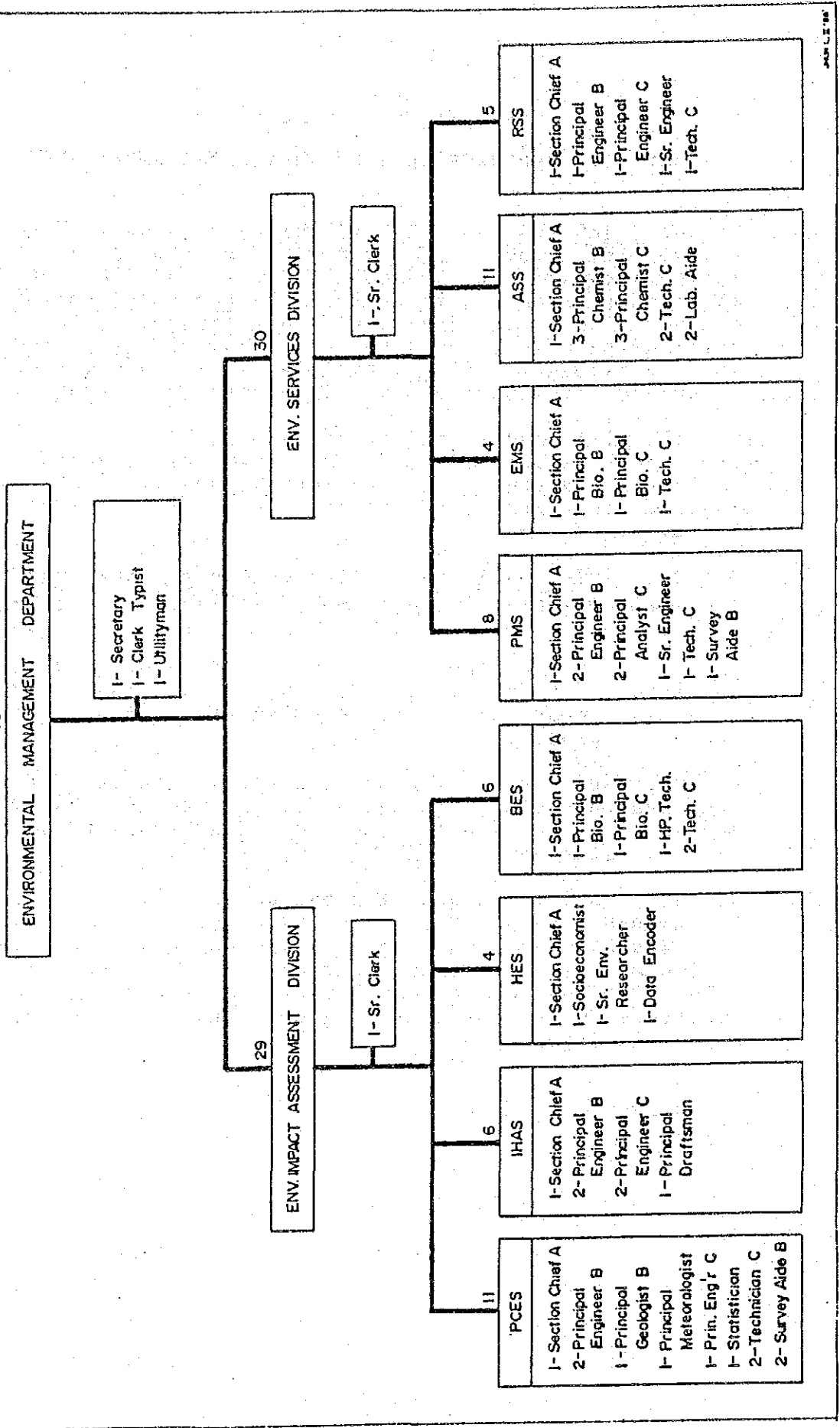
Office of the  
Department Manager

Environmental Impact Assessment Division (EIAD)	Environmental Services Division (ESD)
1. Physical and Chemical Environment Section (PCES)	1. Pollution Monitoring Section (PMS)
2. Biological Environment Section (BES)	2. Ecological Monitoring Section (EMS)
3. Human Environment Section (HES)	3. Analytical Services Section (ASS)
4. Industrial Health and Abatement Section (IHAS)	4. Radiological Services Section (RSS)



# EXISTING TABLE OF ORGANIZATION

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PAGE 12 OF 18

National Power Corporation

BASES OF CORPORATE ENVIRONMENTAL MANAGEMENT WORK

1. Republic Act (RA) No. 6395 (1936) as amended by Presidential Decree (PD) 380 - provides that in the prosecution and maintenance of its projects and plants, the Corporation shall adopt measures to prevent environmental pollution and enhance the conservation, development and maximum utilization of natural resources, including the improvement and beautification of its reservoirs to promote tourism and to provide for the necessary corporate funds thereof.
2. PD 1121, 1151 and 1586 (issued 1976, 1977, 1978) - Statement of the Philippine Environmental Policy, creation of the National Environmental Protection Council (NEPC) and the institutionalization of the Environmental Impact Assessment System.
3. PD 984, 1978 - Existing Pollution Control Law was revised and implemented by the National Pollution Control Commission (NPCC).
4. Executive Order (EO) 848, 1978 - Housing and Land Use Regulatory Board (HLRB) zoning rules and regulations requiring among others the securing of locational clearance for power projects.
5. EO 927, 1984 - Establishing regulatory authority of the LLDA over projects along the shores of the Laguna Lake. Three (3) NPC power plants are located along the Laguna Lake shoreline and its watershed.
6. EO 1927, 1987 - Reorganizing the Department of Environment, Energy and Natural Resources renaming it as the Department of Environment and Natural Resources, creating the Environmental Management Bureau (EMB) and abolishing the NEPC, NPCC and Environmental Center of the Philippines whose functions were integrated under the EMB and the DENR regional offices.

## The Philippine Environmental Regulations

The first regulations that set forth Philippine environmental policy were promulgated by presidential decree in 1976 and 1977. PD 1121 created the National Environmental Protection Council, now called Environmental Management Bureau while PD 1151 defined the Philippine Environmental Policy of 1977. Four significant provisions were spelled out by the decree: (1) The National Environmental Policy; (2) National Environmental Goal; (3) Right to a Healthy Environment; and (4) Environmental Impact Statement (EIS) System. This fourth provision requires that "all agencies and instrumentalities of the national government, including government-owned corporations, as well as private corporations, firms and entities shall prepare, file and include in every action, project or undertaking which significantly affects the quality of the environment a detailed environmental impact statement" (EIS) or Environmental Impact Assessment (EIA) report. The above regulations and other subsequent supporting regulations serve as bases for the corporate environmental policy of the National Power Corporation.

It is worth mentioning however that even before the promulgation of these environmental regulations, the NPC Charter had stipulated that in the prosecution and maintenance of its projects and plants, the Corporation shall adopt measures to prevent environmental pollution and enhance the conservation, development and maximum utilization of natural resources, including the improvement and beautification of its reservoirs to promote tourism and to provide for the necessary corporate funds thereof.

## Main Functions of the Environmental Management Department

The formulation, supervision and implementation of an environmental management program to ensure that all proposed power plants in existing 41 power plant complexes with 141 power generating units are made environmentally compatible and acceptable, and are issued proper licenses and clearances; and

The establishment and implementation of an industrial hygiene program to ensure that all workplaces are free from undue health hazards, in compliance with relevant labor rules and regulations.

## ENVIRONMENTAL IMPACT ASSESSMENT DIVISION (EIAD)

Responsible for the conduct of Environmental Impact Assessment (EIA) study and preparation of environmental reports, i.e. Environmental Impact Statement (EIS), Initial Environmental Examination (IEE), Environmental Characterization (EC), Project Description (PD), Engineer's Report (ER) of NAPOCOR projects to fulfill the requirements of regulatory bodies, (i.e., Environmental Management Bureau) (EMB), Environmental Quality Division (EQD), Laguna Lake Development Authority (LLDA), Housing and Land Use Regulatory Board (HLRB), Department of Labor and Employment, Local Government) to provide environmental data/design input to NAPOCOR feasibility studies; and to ensure NAPOCOR power plants and other facilities are environmentally acceptable and do not pose hazards to plant workers and the public.

Responsible for securing Mayors' Permit (MP), Locational Clearance (LC), Authority to Construct (AC), and Permit to Operate (PO) pollution sources and control facilities for NAPOCOR power projects and support facilities prior to their construction or operation.

## PHYSICO-CHEMICAL ENVIRONMENT SECTION

Responsible for planning, formulation and prosecution of baseline studies on geology, seismicity, pedology, air quality/meteorology/climatology and water quality/hydrology/oceanography in proposed NAPOCOR project sites; to assess the impacts of site preparation, construction and operation of power projects on the same; and to recommend/formulate measures during the feasibility, design stages of project to avoid/control/mitigating adverse impacts and ensure environmental compatibility/acceptability of projects and plants and compliance with the regulations and standards of the Environmental Management Bureau and other environmental regulatory agencies.

## HEALTH AND LICENSING SECTION

Responsible for planning and formulation of industrial hygiene/occupational health and public health program to ensure health and safety of plant personnel and the public and to comply with the regulations and standards of the Department of Labor and Employment.

Responsible for securing pre-operational clearance/permits such as Mayor's Permit (PM), Locational Clearance (LC), Environmental Compliance Certificate (ECC), Authority to Construct (AC) and Permit to Operate (PO) pollution sources and control facilities for NAPOCOR power projects.

### BIOLOGICAL ENVIRONMENT SECTION

Responsible for planning and implementation of baseline studies on terrestrial and aquatic ecology in NAPOCOR project sites, conduct of environmental impact assessment of project construction and operation, formulation of mitigating measures, preparation of environmental reports, conduct of audit during project construction, formulation and implementation of special studies and projects to mitigate adverse impacts and enhance beneficial ones.

### HUMAN ENVIRONMENT SECTION

Responsible for the planning, design and prosecution of baseline studies on socioeconomics and land/resource use to identify/predict and assess the impacts of project construction and plant operation on demography, employment, income, housing, social and economic institutions/infrastructures, social services, transportation/communication network, lifestyle, and land/resource use; formulation and implementation of environmental mitigation/enhancement measures and conduct of socioeconomic impact monitoring studies during project construction.

## ENVIRONMENTAL SERVICES DIVISION (ESD)

Responsible for the preparation of environmental management program, conduct and documentation of regular environmental monitoring and formulation of mitigating measures to ensure safe and environmentally acceptable operation of NAPOCOR power plants and support facilities and the protection of lives and property in plant environs and to comply with the regulations, limits and standards imposed by environmental regulatory agencies.

Responsible for securing of renewals of the Permit to Operate (PO) pollution sources and control equipment of operating power plants and support facilities.

Provide radiological inputs to impact assessment, monitor the amount of radioactivity resulting from operation of coal-fired and geothermal plants, and maintain operational capability to monitor environmental radioactivity around the mothballed Philippine Nuclear Power Plant (PNPP).

## POLLUTION MONITORING SECTION (PMS)

Responsible for planning, scheduling and implementation of monitoring of air/noise/water quality in the environs of operating power plants to determine the effects of plant operations thereon and to comply with the rules and regulations of the DENR, Environmental Management Bureau and Laguna Lake



Development Authority (LLDA); study of conformity with or deviation from predicted impacts in environmental impact assessment; conduct of information dissemination on monitoring data and findings; formulation of recommendations based on monitoring data of precautionary/mitigating measures; securing of renewals of Permits to Operate pollution sources and control facilities of operating plants from the DENR; conducts workplace hazard assessment to protect workers from occupational exposures to health/safety risks.

#### ANALYTICAL SERVICES SECTION (ASS)

Responsible for the management/operation of the Environmental Laboratory and the provisions of analytical services including the development and standardization of procedures to meet special and routine analytical requirements of all functional groups of the Department.

#### ECOLOGICAL MONITORING SECTION (EMS)

Responsible for: the planning and implementation of monitoring programs for terrestrial and aquatic ecosystems as well as public health to assess and document operational impacts of power plant facilities, the mitigation of significant adverse impacts of plant effluents/emissions' on biological and human ecosystems; and the conduct of research studies to improve understanding/mitigation of such impacts.

RADIOLOGICAL SERVICES SECTION (RSS)

Provide comprehensive nationwide radiological surveillance in order to monitor additional amount of radioactivity released to the environment resulting from the operation of existing coal-fired and geothermal power plants of the corporation.

Provide radiological inputs to impact assessment studies on ambient radiation levels made on NPCC proposed coal-fired and geothermal power plant sites prior to project implementation. Maintain capability for monitoring environmental radioactivity around the PNPP-I.

LIST OF ON-GOING ACTIVITIES  
OF THE  
ENVIRONMENTAL MANAGEMENT DEPARTMENT

A. Environmental Impact Assessment Division (EIAD)

1.0 Conduct/implementation of Environmental Impact Assessment (EIA) studies and preparation of Environmental Impact Statements (EIS)

- 1.1 Bacon-Manito Geothermal Project II
- 1.2 Luzon Gas Turbine Power Project-Phase C
- 1.3 Casecnan Transbasin Diversion Project
- 1.4 Luzon Coal-Fired Thermal Power Project-III
- 1.5 Luzon Coal-Fired Thermal Power Project-A
- 1.6 Visayas Gas Turbine Power Projects

- 1.6.1 Anibong GT Barge
- 1.6.2 Mandaue GT Barge
- 1.6.3 Naga GT (inland)

1.7 Mindanao GT Power Projects

- 1.7.1 Davao GTPB
- 1.7.2 General Santos GTPB
- 1.7.3 Zamboanga GTPB

- 1.8 Maibarara Geothermal Power Project
- 1.9 Makban 7 GPP
- 1.10 Palinpinon GPP II
- 1.11 Balog-Balog HEP
- 1.12 Bago HEP
- 1.13 Agus III HEP
- 1.14 Sucat GTPP

2.0 Conduct of Initial Environmental Examination (IEE)

2.1 Luzon Transmission Line Projects (69 KV)

- 2.1.1 Mindoro T/L Project (257 km)
- 2.1.2 Mabalacat T/L Project (26 km)
- 2.1.3 Catanduanes T/L Project (46 km)
- 2.1.4 Masbate T/L Project (116 km)
- 2.1.5 Marinduque T/L Project (57 km)

- 2.2 Visayas T/L Projects (189 km)
  - 2.2.1 Cebu T/L (20 km)
  - 2.2.2 Panay T/L (10 km)
  - 2.2.3 Leyte-Samar T/L (102 km)
  - 2.2.4 Bohol T/L (45 km)
  - 2.2.5 Barge to Isabel T/L (12 km)
- 2.3 Mindanao T/L Projects (331 km)
  - 2.3.1 Tungawan-Siraway-Siocon T/L (35 km)
  - 2.3.2 Malangas-Olutangan T/L (50 km)
  - 2.3.3 Cateel-Bugangga T/L (45 km)
  - 2.3.4 Digos-Malita T/L (56 km)
  - 2.3.5 Barobo-San Francisco T/L (30 km)
  - 2.3.6 Isulan-Lebak T/L (63 km)
  - 2.3.7 Gen. Santos-Sari-Malapatan-Clan T/L (27 km)
  - 2.3.8 Jasaan-Balingoan T/L (135 km)
  - 2.3.9 Marawi-Malabang T/L (75 km)

**B. ENVIRONMENTAL SERVICES DIVISION**

**1. Air/Water Pollution /Noise Monitoring for Operating Power Plants (as per P.D. No. 984 implemented by NPCC)**

**1.1 Geothermal Power Plant - twice a year**

- 1. Tiwi Geothermal Plant - Tiwi, Albay
- 2. Makban Geothermal Plant - Makban, Laguna
- 3. Tongonan Geothermal Power Plant - Tongonan, Leyte
- 4. Palinpinon Geothermal Plant - Negros Oriental

**1.2 Diesel Power Plants - twice a year**

- 1. Cebu Diesel I - Naga, Cebu
- 2. Cebu Diesel II - Talavera, Cebu
- 3. Amlan Diesel - Amlan, Negros Oriental
- 4. Panay Diesel I - Dingle, Iloilo
- 5. Aplaya Diesel - Jasaan, Misamis Oriental
- 6. General Santos Diesel - Gen. Santos, Davao
- 7. Power Barge I
- 8. Power Barge II
- 9. Power Barge III
- 10. Power Barge IV
- 11. Panay Diesel II - Capiz

**1.3 Thermal Plant (oil and coal-fired) - twice a year**

1. Naga Coal Thermal I and II - Naga, Cebu
2. Rockwell Thermal Plant
3. Sucat Thermal
4. Manila Thermal
5. Malaya Thermal
6. Bataan Thermal
7. Batangas Coal Thermal

1.4 Hydroelectric Plants - once a year or as necessary

1. Ambuklao HEP
2. Binga HEP
3. Angat HEP
4. KPSPP
5. Magat HEP
6. Amlan HEP
7. Loboc HEP
8. Bohol HEP
9. Agusan HEP
10. Caliraya HEP
11. Barit HEP
12. Agus I, II, IV, VI, VII
13. Pulangi IV

2. On a yearly basis, prepares, submits, follow-up the applications, technical specifications, engineers report for permits to operate pollution sources/control facilities to the DENR for all operational NFC power plants, in compliance to P.D. 984.

3. Performs the laboratory and chemical analyses for various environmental media (air, water, soil, biota, sludge, scales, fuel, e.g. coal, oil) taken from the environmental monitoring of operating power plants. Parameters being analyzed are physico-chemical characteristics, toxic heavy metals and trace elements, organics and natural radioactivity. Per power plant, there are several air/water/soil/biota/waste monitoring stations where several samples per station are taken for analyses of at least 10 physico-chemical parameters, 15 metals/elements, organics and natural radioactivity (Ra 226, Uranium, Bi 214, Th 232 per sample).

Analysis requires sample preparation, laboratory and equipment preparation and calibration, data collection/retrieval/analysis and report writing.

4. Performs investigations of complaints against power plant operations - minimum of once per month

- 4.1 Geothermal plants - request for relocations, roof corrosion, wildlife, (most frequent subject of complaints)/vegetation/aquatic life damages, noise
  - 4.2 Coal thermal plants - coal dusts, air particulates, acid rain, ground water contamination, thermal effluents, aquatic life damages
  - 4.3 Diesel /oil thermal plants - noise, soot, dust, acid rain, oil sleaks/spills, thermal effluents
  - 4.4 Hydroelectric plants - siltation, forest denudation, drinking water pollution
5. Performs special studies to verify results and establish implications of monitoring results for adoption of mitigation measures. Field experiments and analyses, mathematical modelling consultation with experts, data interpolations are involved.

LIST OF REPORTS/PUBLICATIONS  
ENVIRONMENTAL MANAGEMENT DEPARTMENT

- A. Environmental Impact Statements (EIS) or Environmental Impact Assessment Reports
1. Kalayaan Pumped Storage Project EIS \*
  2. Tiwi Geothermal Power Plant Complex Environmental Characterization Report (ECR) \*
  3. Bulalo Geothermal Power Plant Complex ECR \*
  4. Batangas Coal-Fired Thermal Power Project I EIS \*
  5. San Roque Multi-Purpose Project EIS \*
  6. Cebu Thermal Complex EIS \*
  7. Batangas Coal-Fired Thermal Power Project II EIS
  8. Bacon-Manito Geothermal Power Project I EIS
  9. Zamboanga Power Barge IV EIS
  10. Luzon Gas Turbine Power Project Phase A EIS
  11. Agus Hydroelectric Project I
  12. Luzon Gas Turbine Power Plant Phase B
    - 12.1 Inland GT
    - 12.2 Power barge
  13. Wood Pole Processing Plant
- B. Environmental Impact Assessment Reports for Feasibility Studies
1. Zamboanga Diesel Power Plant Environmental Considerations (EC)
  2. Bislig Coal-Fired Thermal Power Station
  3. Bago Hydroelectric Project EC
  4. 8th Power Transmission Project EC
  5. Bacon-Manito GPP I EIA
  6. Binongan Hydroelectric Power Project EIA \*
  7. Palinpinon Geothermal Power Project II EIA
  8. Pulangi Hydroelectric Power Project III EIA \*
- C. Initial Environmental Examinations (IEE) and Project Descriptions (PD)
1. Zamboanga Diesel Power Project IEE
  2. Bislig Coal-Fired Thermal Power Station IEE
  3. Iloilo Power Barge PD
  4. Luzon Gas Turbine Power Project Phase B PD
  5. Wood Processing Plant PD

D. Special Studies

1. Maibarara 5.5 MW Pilot Geothermal Power Project  
Environmental Implications
2. Environmental Implications of the Proposed Rockwell  
Thermal Power Station Rehabilitation
3. Environmental Considerations of the Proposed Sucat-  
Malaya Oil Pipeline Project
4. Caliraya Lake Socioeconomic Study
5. Caliraya Fisheries Survey Report
6. Chlorination Effects Literature Study
7. Land Uses Under the Southern Luzon EHV TL
8. Environmental Considerations in the Selection of  
LCFTPP-III Site
9. NPC Oil Spill Contingency Plan and Procedures
10. Environmental Impacts of Geothermal Power Development
11. Roof Corrosion Study around Geothermal Power Plants

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\* Performed with consultants



## V. 関連情報



## V. 関連情報

### (1) マクバン地熱発電所現地調査

実施日 : 3月18日(月)

目的 : 地熱発電所の使用済蒸気の大気放出による環境影響調査

報告 :

NPC's TORに地熱発電所に於けるEmission abatementについて技術移転を求めた記述が有り、現地調査打合せの席上具体的説明を求めた。

NPCはビンガ地熱発電所が本TORの意図するEmission abatementを問題とする地点であるが、マニラからの距離が遠く、また予備調査団への治安上の配慮から比較的にマニラから近いマクバン地熱発電所を指定した。

マクバン地熱はマニラからラグナデベイに沿って約150km(車で1時間30分)南下した樹林の中に開発されており、Bulalo火山を熱源として84の蒸気井が掘られている。発電所はNPCの管理で運営されていたが、蒸気供給はPGIが責任を持ち、現在も安定した運転が行われていた。

#### 【マクバン地熱発電所】

出力 : 55MW×2台を3セット 計 330MW

機器 : MHI (Japan)

主要緒元 : (別添)

問題になったEmission abatementについては、添付写真に示す様に、大気放出を連続して行っていたが、H<sub>2</sub>Sガスによる周辺への環境影響については周囲が奥深い樹林で民家が無く、具体的な聞き取り調査は行う事が出来なかった。

また、NPCも月に1度程度の移動モニタリングを実施して対応してる状況で、マクバン地熱発電所の現状では問題となるような環境影響は発生していないとの説明を受けた。

地熱発電所のEmission abatementについては、日本でも大気放出が行われている。H<sub>2</sub>S除去の技術は確立されているが、環境基準をクリアしているので、電力設備への適用が行われていない実情である。将来は地球的な環境保全意識の高まりの中でフィリピンでも脱H<sub>2</sub>Sの技術が必要となることが想定されるため、地熱発電所・H<sub>2</sub>S除去の技術移転要請になったものと考えられる。

**MAK-BAN GEOTHERMAL  
PLANTS  
BAY, LAGUNA**

**LOCATION:**

Approximately 74 kilometers south of Manila, the Mak-Ban Geothermal Power Plant complex which lies in scenic Laguna is nestled between the two major non-active Makiling and Banahaw volcanoes.

Plant A which comprises Units 1 & 2 is located in Bitin, Bay, Laguna while Units 3 & 4 sit on Tamlong, about 1-1/2 kilometers southeast of Plant A. Plant C with Units 5 & 6 is also located in Tamlong adjacent to Plant B.

**CAPACITY:**

The Plant Complex generates 330 megawatts from Plants A, B and C consisting of two (2) x 55 MW units each.

**START OF COMMERCIAL OPERATION:**

**Plant A:**

Unit 1 - September 12, 1979  
Unit 2 - November 4, 1979

**Plant B:**

Unit 3 - August 11, 1980  
Unit 4 - October 10, 1980

**Plant C:**

Unit 5 - September 8, 1984  
Unit 6 - December 8, 1984

**FINANCING:**

The two Mak-Ban Geothermal Power Plants A & B constructed at a cost of P1.612 million. Of this amount, some P1.538 million (\$204.25M) representing the foreign exchange requirements, covered the cost of electro-mechanical equipment of the balance of plant and their installation. The peso portion of P74 million came from government equity and NPC internal cash generation.

The latest addition to the complex were Units 5 & 6 of Plant C (civil works was undertaken by Hydro Resources & Contractors Corp.) were built at a cost of P1,130.36-M. The foreign financing Bank of Montreal, Mitsubishi Bank and Eximbank of Japan for Plants A, B & C, respectively.

**PLANT COMPLEX STATISTICAL  
and PHYSICAL DATA**

1. Installed Capacity - 330 MW (6x55MW)
2. X Contribution (Luzon Grid) - 7.64
3. X Contribution (Total Philippines) - 5.51
4. Cooling Tower (6 sets) - 15mW x 110mL x 23mH
5. Switchyard - 412.5 MVA
6. Estimated Project Cost - P 2,742,394 M
7. Cost per KW installed - P 8,310
8. Aggregate Energy Production (1979-90) - 21,455,617.35 KWH
9. Equivalent barrel of oil based on consumption rate of 600 KWH energy production per barrel of oil used - 35,759 M
10. Saving on oil imports based on \$10/barrel of oil - \$ 357.59 M
11. Contractors/Suppliers

**A. Civil Works**

1. Plant A - Philippine Infrastructure, Inc. (PII)
2. Plant B - F. F. Cruz, Inc.
3. Plant C - Hydro Resources and Contractor Corporation (HRCC)

**B. Electro-Mechanical Equipment and balance of plant  
Mitsubishi Heavy Industries, Ltd.**

**12. PGI Geothermal Wells:**

- Discovery well - Bulalo 1, Nov. 25, 1974
- No. of wells - 84 (58 producers, 22 injectors, 11 hot, 5 cold, 6 emergency, 4 plugged & abandoned)
- Deepest well - Bulalo 65 (3,141 meters)
- Shallowest well - Bulalo 64 (655.5 meters)
- Production well average depth - 1,938.41 meters
- Average steam production/well - 56,689 kg/hr
- Reservoir temp. - 500 - 600 °F
- Average drilling time - 40 days
- Average cost/well - US \$1.2 M
- No. of satellite station supplying Mak-Ban - 6
- Average No. of well/satellite station - 8
- Steam temp. at turbine inlet - 164-167 °C
- Steam line press. - 6-7 kg/cm<sup>2</sup>
- Electrical Generating capacity - 330 MW gross

## GEOHERMAL ENERGY AND OPERATION:

Geothermal energy may be briefly defined as heat generated within the earth. The earth consists of crust, mantle and core. The magma rises through the crust collects in pool near the surface. Rainwater penetrating the surface is heated by hot rocks and gushes up as hot water or steam through the surface crevices. This phenomenon is predicated on the presence of cap-rock effect. The steam conditions vary depending on the location of the plant.

The Mak-Ban reservoir represents a phenomenon of hot water dominated field. The steam with a moisture content of 0.25% wetness and/or saturated is submitted to the centrifuge with a high separating efficiency where the solids brought up from the depth are eliminated. The steam is supplied to the turbine inlet at a rate of about 433 tons/h at 6.68 kg/cm<sup>2</sup> abs. The steam generates 55,000 KW in each turbine.

After doing work at the turbine blades, the steam goes to the condenser where it is blended and cooled by the cooling water and where the non-condensable gases are discharged through the ejector or gas compressor into the atmosphere.

Condensation of steam and the action of the ejector create a vacuum in the condenser. The condensed water is collected in the hot well from which it is pumped up to the cooling tower. The condensed water, which has been cooled in this tower, is collected in the cold well from where the cooling water to the condenser, the oil cooler and other auxiliaries, are taken.

The turbine drives the generator which produces electric power at a generated voltage of 13.8 kilovolts. This voltage is stepped up to 230 kilovolts through a transformer and electricity is transmitted to a local substation for distribution to franchise holders.

### TECHNICAL FEATURES: Major Equipment

*Plants A & B units as modified/  
Plant C units as built*

#### 1. Steam Turbine

Type - Double flow single pressure impulse reaction condensing

Rated Output - 55,000 KW

Rated steam Pressure - 6.68 kg/cm<sup>2</sup> abs

Rated Steam Temperature

162.3 °C (0.25% wetness)/

162.3 °C (saturated)

Steam Flow at Rated Output -

8 kg/kwh / 7.745 kg/kwh

(on gas compressor operation)

8.35 kg/kwh / 8.45 kg/kwh

(on gas ejector operation)

Rated Turbine Exhaust Pressure-

101.6 mmHg abs.

NCG content - 1% / 2.5%

No. of stages - 5

#### 2. Generator

Type - Horizontal cylindrical rotating field, conventional, hydrogen cooled turbine generator

KVA Output - 68,750

KW Output - 55,000

Power Factor, - 0.80/0.965

Voltage, KV - 13.8

Current, Amp. - 2,876

Exciter - static/brushless

#### 3. Condenser

Type - Direct contact condenser with spray type main condensing part and cascade type gas cooling part

Vacuum - 101.6 mmHg Abs.

Cooling Water Temperature - 30.6 °C

Hotwell Outlet Temperature - 48.9 °C

#### 4. Hotwell Pump

Type - Vertical, single stage double suction volute type

No. of Sets - 4 sets each plant

#### 5. Cooling Tower

Type - Industrial cross flow/mechanical draft tube

No. of Sets - 2 sets each plant

Fan Type - Induced draft

#### 6. Gas Extraction System

##### a. Steam Jet Ejector removal system

Type - Single element, two stages

No. of Set - One (1) set/unit

Suction Press. - 0.13 kg/cm<sup>2</sup> abs.

Discharge Press. - 1.312 kg/cm<sup>2</sup> abs.

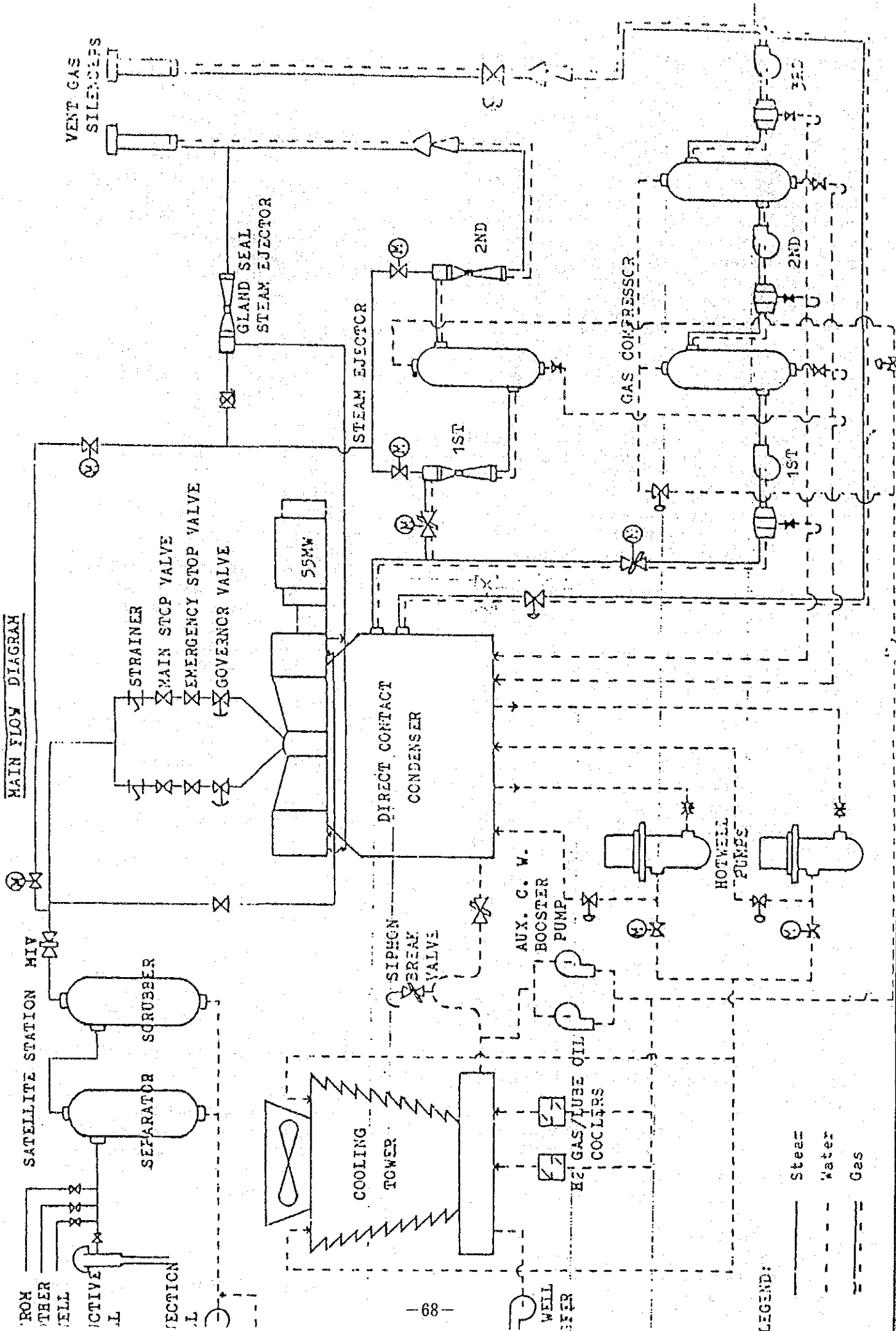
Guaranteed Steam Consumption- 19,330kg/hr

##### b. Gas Compressor Removal System

Type - three (3) stages motor driven centrifugal compressor (750 kw)/ package type - motor driven compressor (2 KW)

(Produced by PECS/Results Section, Jan. 1991)

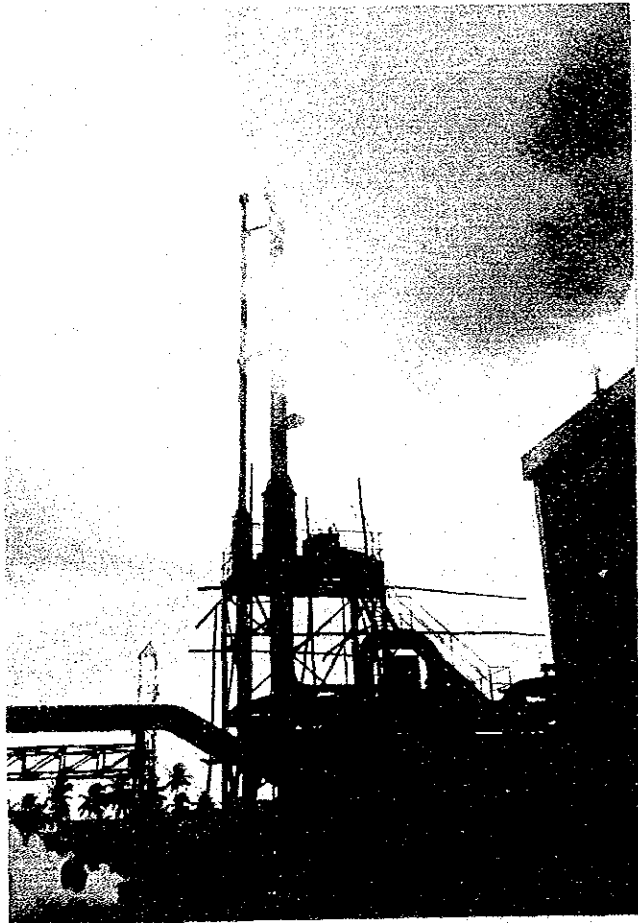
MAIN FLOW DIAGRAM



LEGEND:

- Steam
- - - Water
- Gas

マクバン地熱発電所H<sub>2</sub>S 大気放出状況







## VI. 本格調査に当たっての留意および関連事項



## VI. 本格調査に当たっての留意および関連事項

### 1. 本格調査留意事項

#### (1) カウンターパート

本調査は、発電、送電、変電に関する電力設備の運用を効率的に実施するための具体的な要綱を定める事であり、従来のハード技術の移転に更に、電力設備の運転と保守に係るソフト技術の移転が求められている。

したがって、技術移転についてもレポートによって主に伝達される従来型の方法に加えて、直接的にカウンターパートと共に合理的な結果を追究すると言う極めて協調度の高いスタディの方法が期待されている。

この目的を実行するために NAPOCORは技術移転の受入れ機関として質の高い実施組織を用意する事で合意しているが、この組織の具体的な構成、人員、職種等については本調査を担当するコンサルタントの指導によって確定する。

#### (2) プロジェクトサイト調査

本件はマスタープランレベルの結論を期待されている調査であるが同時に NAPOCOR内部で既に数多くの類似調査が実施されている事が確認されている、したがって基本的には実施済みレポートのレビューと問題点の抽出が優先され、作業の状況に応じてサイト調査を計画する事になる。しかしながら NAPOCORも国内治安問題については十分に認識しているのでサイト調査の実施については、NAPOCORと十分に協議しサイト調査の必要性について決定する又、NAPOCORカウンターパートによる委託調査も考慮する。

#### (3) 実施計画

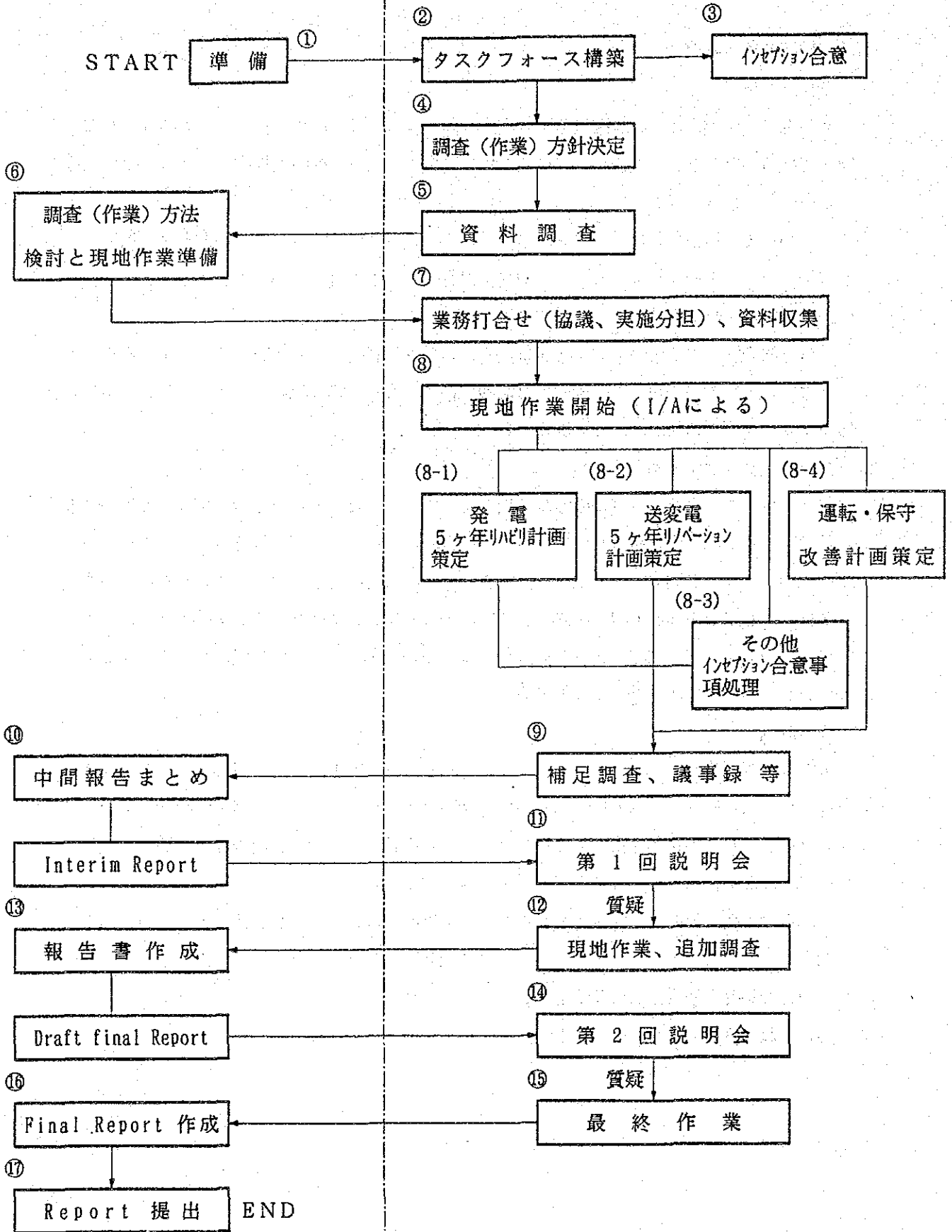
本調査に基づくリハビリテーション、リノベーションの実施計画は当然公的ファイナンスを意図した借款手続きの基本条件となるので、計画実施の効果、優先度、経済的評価等についてマスターレベルでの結論を出し、F/S レベルの調査指針、更には工事実施仕様書等への展開について NAPOCOR側に充分の理解を与える事に留意する。

又、電力設備の運転、保守技術のソフトウェア移転については NAPOCORの実行意思と結果(効果)をフォローアップする必要があるので NAPOCORのタスクフォースによるポストエバリエーションを強く勧告する必要がある。

#### (4) 想定される作業のフローチャート

日本

フィリピン



## 2. 関連事項

NAPOCOR 内部で電力設備のリハビリテーション、リノベーションを統括しているエンジニアリングの部門は明確ではないが、予算管理部門では関係部から上提されるプロジェクト予算書が集まるので結果として、本件に関する実行プロジェクトが調査出来る。以下に1990年1月時点でのリハビリテーション（リノベーション）プロジェクトの実行達成表を参考のために添付する。

CURRENT STATUS OF REHABILITATION PROJECTS

As of January 1990

LUZON

sheet 1 of 2

NAME OF PROJECT/ FINANCING SOURCE/ CONTRACTOR	ESTIMATED PROJECT COST (In Million)	STATUS (%) ACCOMP.	SLIPPAGE	DATE STARTED	TARGET COMPLETION DATE	PROBLEMS ENCOUNTERED/REMARKS
9. Sucat 1 & 4 Rehabilitation Project (Japan Eximbank, KFN) Contractors: Marubeni Corp. & Siemens AG	\$ 118.782 P 154.000	69.63	7.47	09-87	06-90	The actual progress of accomplishment for Sucat 1 is 97.29% while that of Sucat 4 is 33.59%. Sucat 1 have completed the performance and efficiency test on January 24, 1990. Based on initial indications, rehabilitation of Sucat 1 appears to be successful. The remaining works are mostly on insulation and various commissioning test of the auxiliary equipment. For Sucat 4, the repair of the generator stator core and its progressing on schedule. It is no longer a critical item considering that the bottom winding bars were already re-installed and tested and ready for the reinstallation of the top winding bars.
8. Caliraya Service Spillway Rehabilitation		77.00	23.00	05-89	03-90	
Schedule I - Leak Sealing of Conc. Shaft Contractor: ALA INDUSTRIES CORP.	P 1.500	73.00	9.00	05-89	03-90	Highlight of this period is the delivery to site of rolled steel liners and its preparator works, such as chamfering, boring of holes, etc. prior to installation inside the spillway shaft.
Schedule II - Fabrication & Inst. of Stoplogs Contractor: LP ENGINEERING	P 0.680	59.00	15.00	05-89	03-90	Stop log installation was stalled due to needed "adaptor" which will serve as remedial measure to close the trapezoidal recess on the concrete structure.
10. Binga Paren Scouring Protection Works Contractor: GROCUN, INC.	P 12.490	9.65	1.65	05-89	05-90	Officially, work resumed on January 1, 1990. Dewatering, cleaning and rock excavation is in progress.

PCID 02-28-90

CURRENT-STATUS/809



## 資 料

### 1. 質問表及び回答



## Questionnaire

## Answer

### 1. Government Organization

- 1) Central government organization chart
- 2) Organization of NPC
- 3) NPC's relative representatives and organization in charge of the project on:
  - Engineering
  - Administration

Received	Available	* Prepare
	○	
○		
		○

### 2. Existing Rehabilitation Study

- 1) Study Report for the generating plants
- 2) Study Report for the substations
- 3) Study Report for the Transmission Lines

Received	Available	Prepare
	○	
	○	
	○	

### 3. Electric Power Situation

- 1) Annual report of Electrical statistics
- 2) Latest power development program
- 3) Operation and maintenance history on whole generating facilities and substation (switchyard) facilities
- 4) Actual operation conditions of whole of transmission lines
- 5) Scheduled outage of power facilities
- 6) List of power facilities and location map
  - a. for generating
  - b. for substation
  - c. for transmission line

Received	Available	Prepare
○		
○		
		○
		○
	○	
	○	

### 4. Information Required for Economic Study

- 1) Electricity tariff and relevant regulations
- 2) Annual operation and maintenance cost/kWh
  - a. Hydro power plant
  - b. Fuel fired thermal power plant
  - c. Coal fired thermal power plant
  - d. Gas turbine power plant
  - e. Diesel power plant
  - f. Geothermal power plant
- 3) Unit construction cost/kW (cost/kWh)
  - a. Hydro power plant
  - b. Fuel fired thermal power plant
  - c. Coal fired thermal power plant
  - d. Gas turbine power plant
  - e. Diesel power plant
  - f. Geothermal power plant
- 4) Price escalation rates in recent years and forecast
- 5) Statistical yearbook of economy, industry, agriculture, trade, etc.

Received	Available	Prepare
	○	
	○	
	○	
	○	
		○

\* Prepare とは今後NAPOCOR 側で準備するということである

2. 収集資料リスト

番号	資料の名称	版型	頁数	部数
1	1989 ANNUAL REPORT ( ISSN-0115-1290 )	A 4	52	1
2	1990 POWER DEVELOPMENT PROGRAM ( 1990 - 2005 )	A 4	60	1
3	POWER SYSTEM OPERATION ASIA-PACIFIC REGIONAL STUDY	B 5	317	1
4	POWER SYSTEM OPERATION PROCEEDINGS OF THE REGIONAL WORKSHOP	B 5	295	1
5	POWER PLANT MAINTENANCE MANAGEMENT Volume I		241	1
6	POWER PLANT MAINTENANCE MANAGEMENT Volume II		323	1







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