THE REPUBLIC OF THE PHILIPPINES

THE STUDY

FOR

CALACA COAL-FIRED THERMAL POWER PLANT (I)

UPGRADING PROJECT

FINAL REPORT

JANUARY, 1988

JAPAN INTERNATIONAL COOPERATION AGENCY

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1779

PREFACE

In response to the request by the Government of the Republic of the Philippines, the Japanese Government has decided to conduct a survey on the Calaca Coal-Fired Thermal Power Plant No. 1 Unit Upgrading Project in the Province of Batangas, including a survey on the coal quality improvement and increased production at the Unong Coal Mine in Semirara Island, and entrusted the survey to the Japan International Cooperation Agency.

The JICA sent to the Philippines a survey team headed by Mr. Toshio Oga of West Japan Engineering Consultants, Inc. two times during the period from February to August 1987. The team conducted the field survey at Calaca Power Plant and Semirara Island with the cooperation of the officials concerned of the Government of the Philippines. After the team returned to Japan, further studies were made and the present report has been prepared.

I hope that this report will contribute to the stable power supply in the Philippines and to the promotion of friendly relationship between our two countries.

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

January 1988

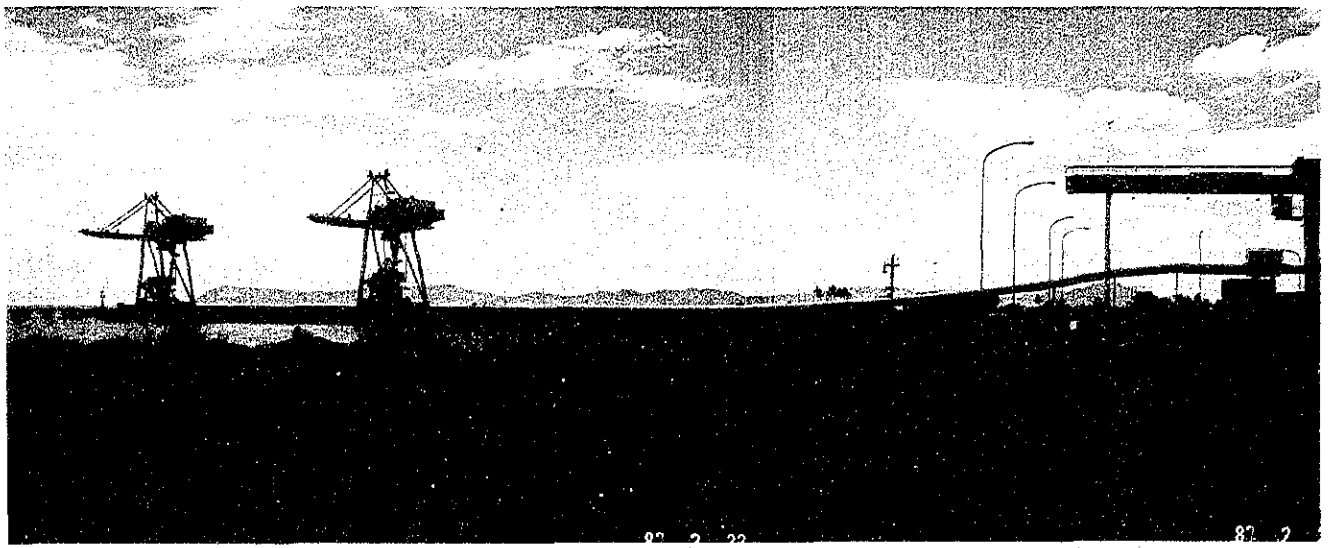
Kensuke Yanagiya

Kensuke Yanagiya
President
JAPAN INTERNATIONAL
COOPERATION AGENCY

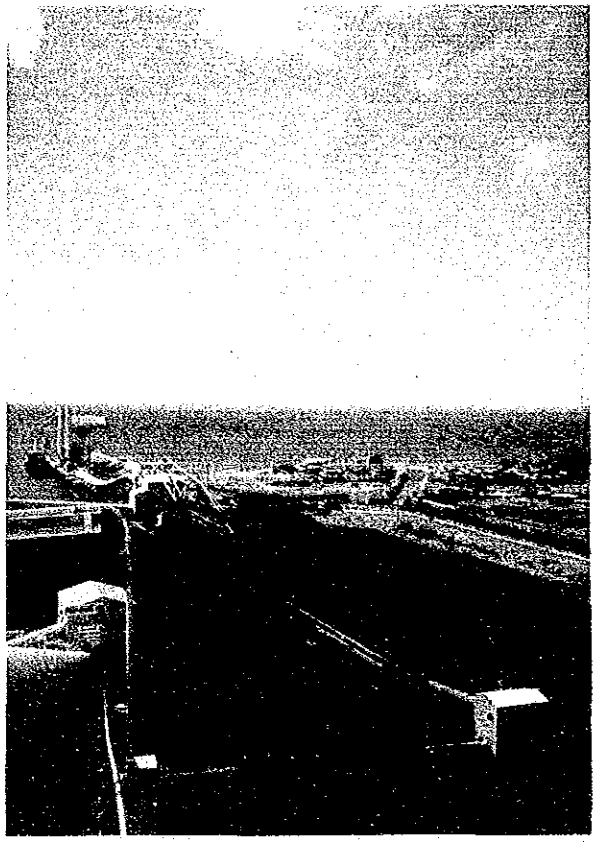
Photo – 1

Panoramic View of Power Plant and Adjacent House
(Viewed from the Unloader Side)

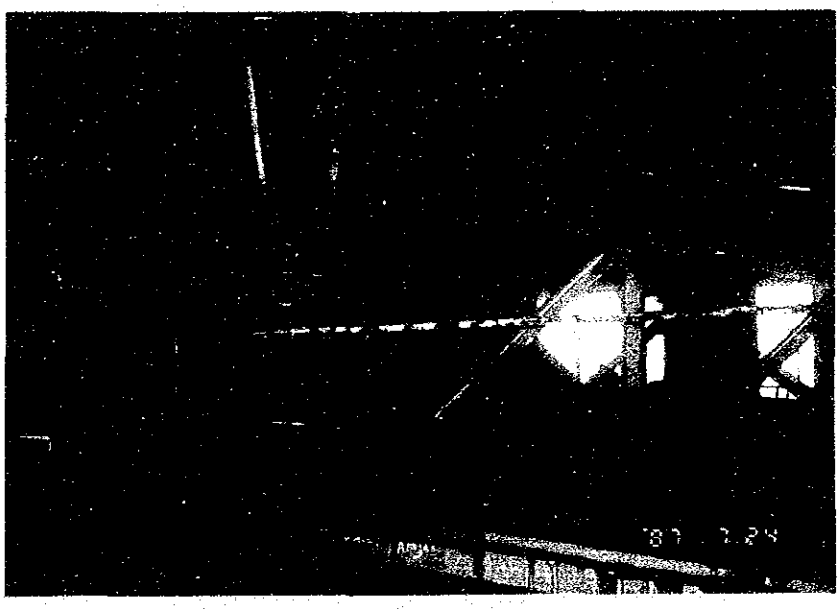
Photo — 2



Unloader and Unloading Conveyor

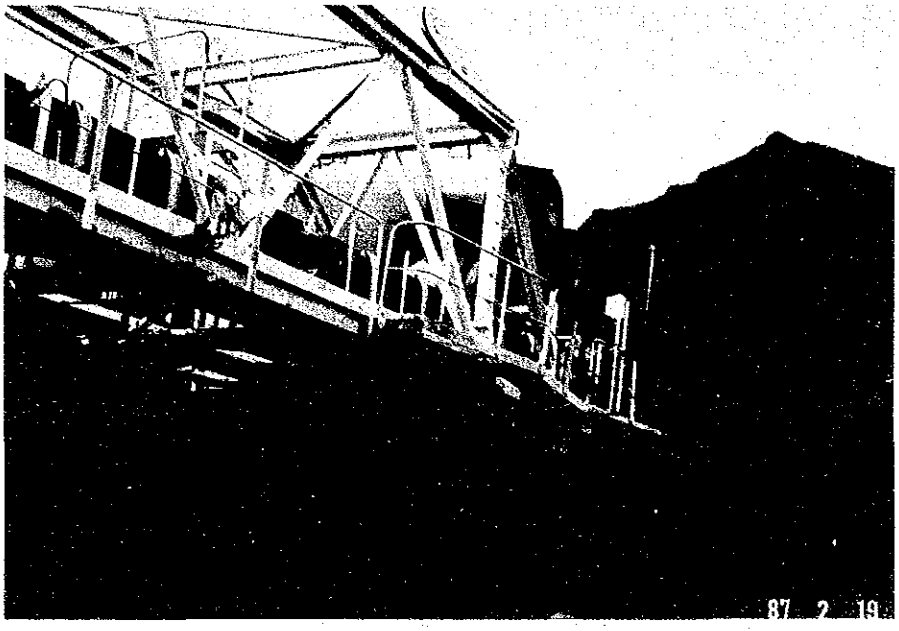


Coal Dust from Unloader and Resettlement Area



Coal Dust in Tripper House

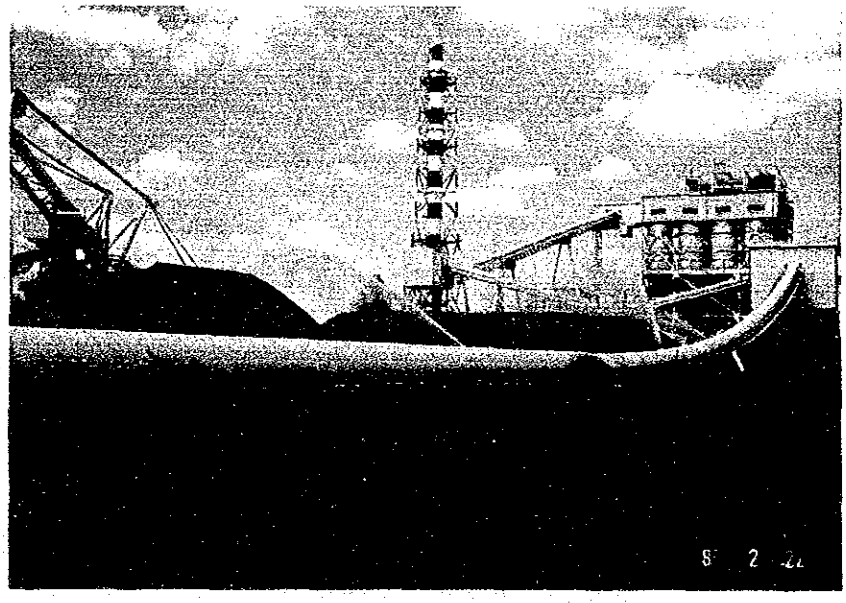
Photo – 3



Coal Dust by Reclaiming

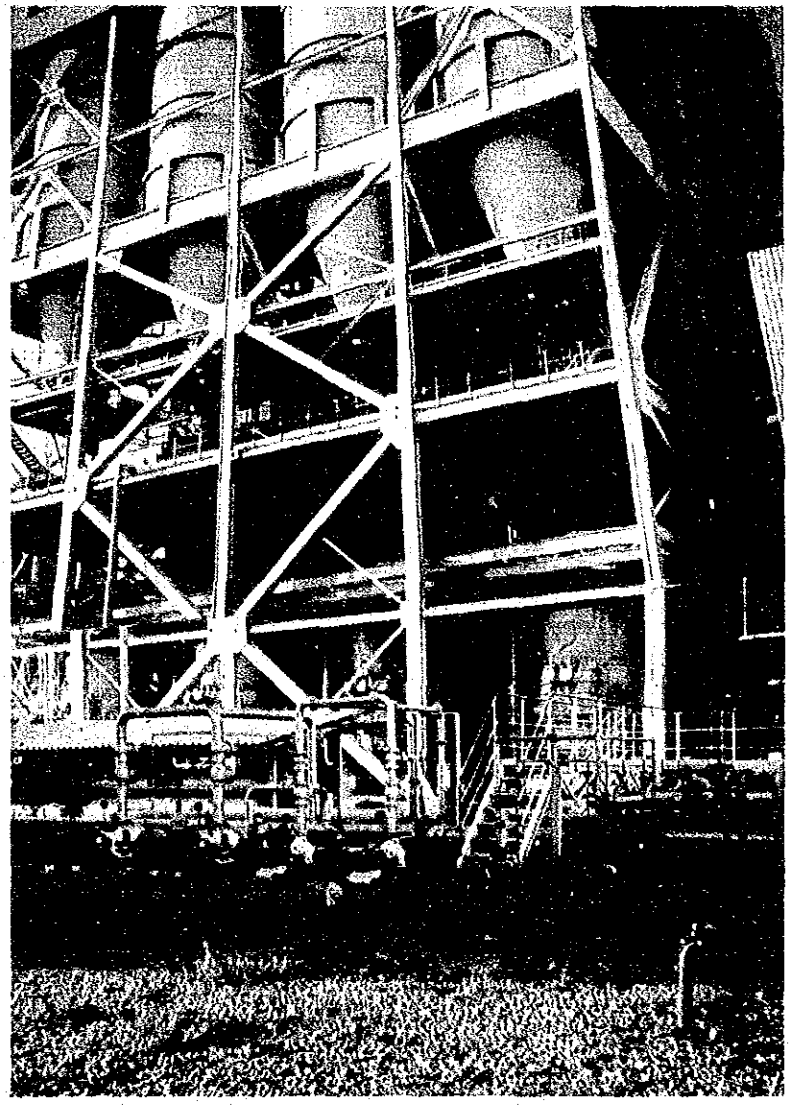
Coal Spill at the Foot of Transfer Tower No. 6

Spontaneous Combustion of Semirara Coal

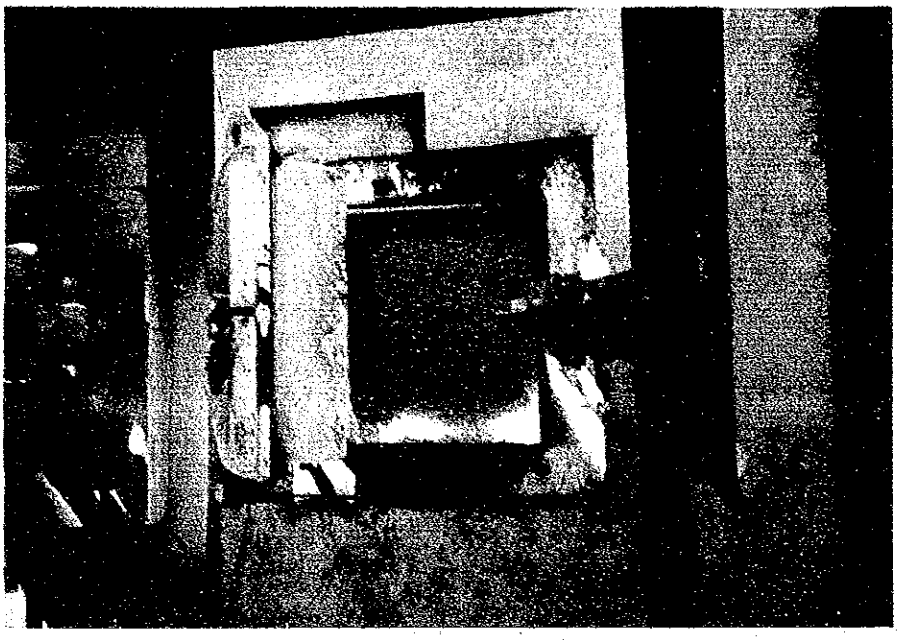


Sprinkler of Coal Yard

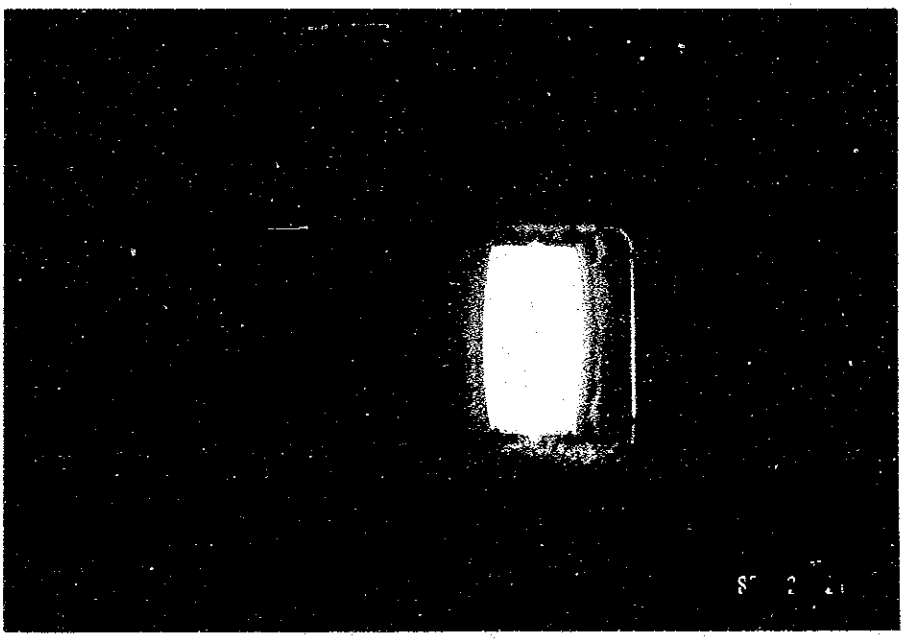
Photo – 5



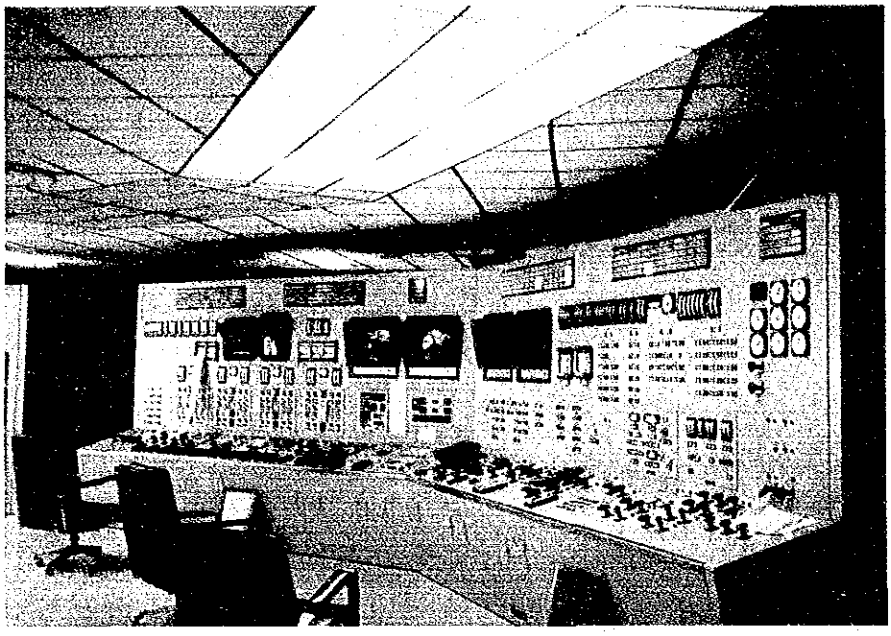
Coal Bunker and Coal Mill



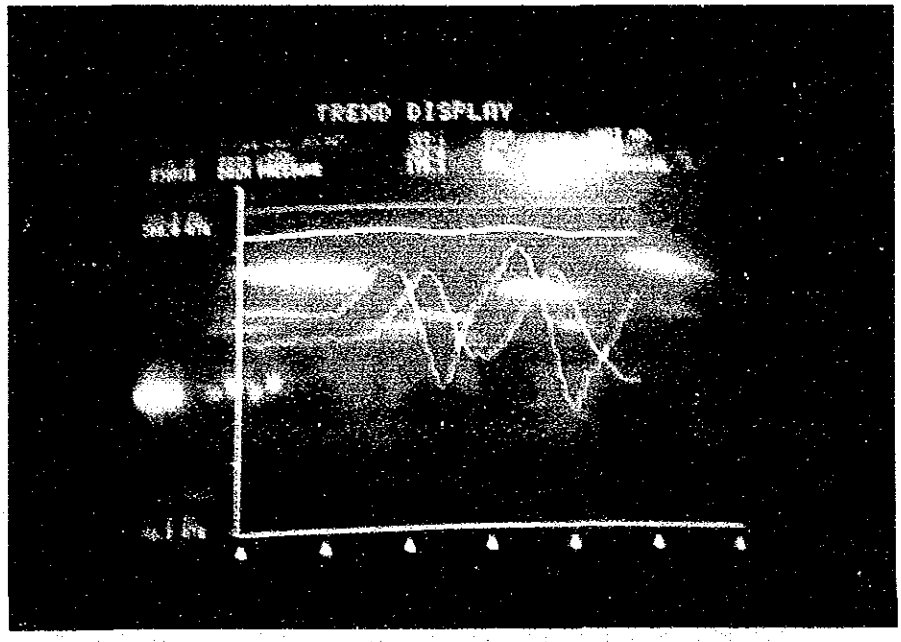
Combustion Condition of the Furnace
(Upper Part of Primary S.H.)



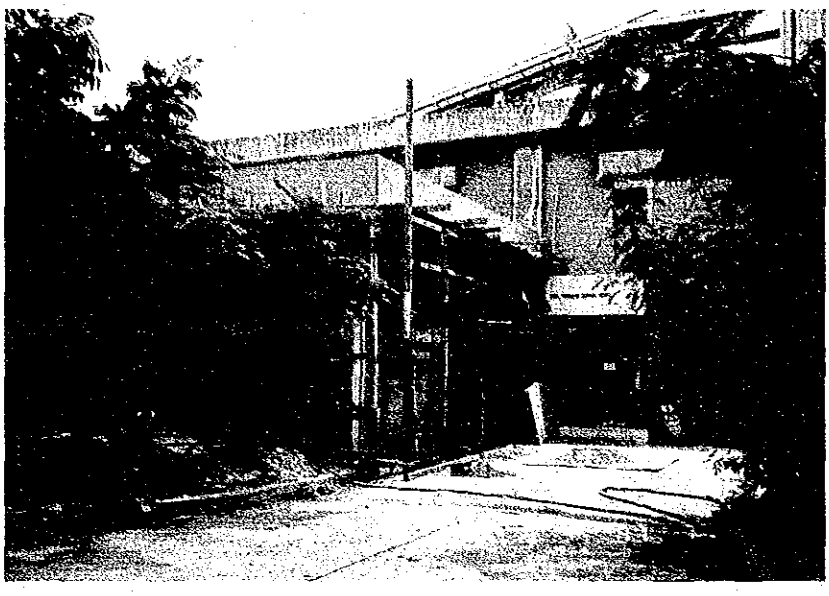
Combustion Condition of the Furnace
(Burner)



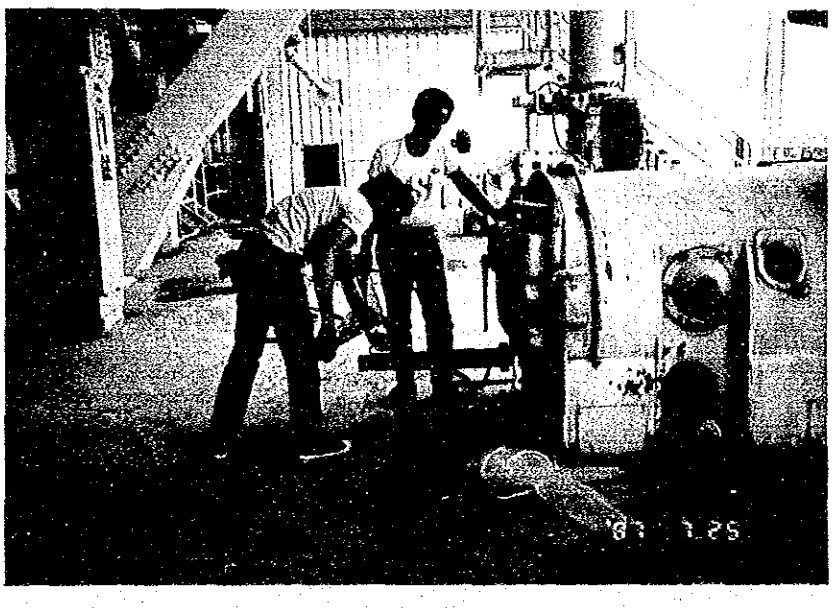
CENTRAL CONTROL ROOM



TRANSIENT RESPONSE OF FEED WATER FLOW AND DRUM LEVEL



Expansion Work of Fuel Laboratory



Coal Sampling at Coal Feeder of the Coal Mill
(During the Combustion Test)

Semirara Industrial Area

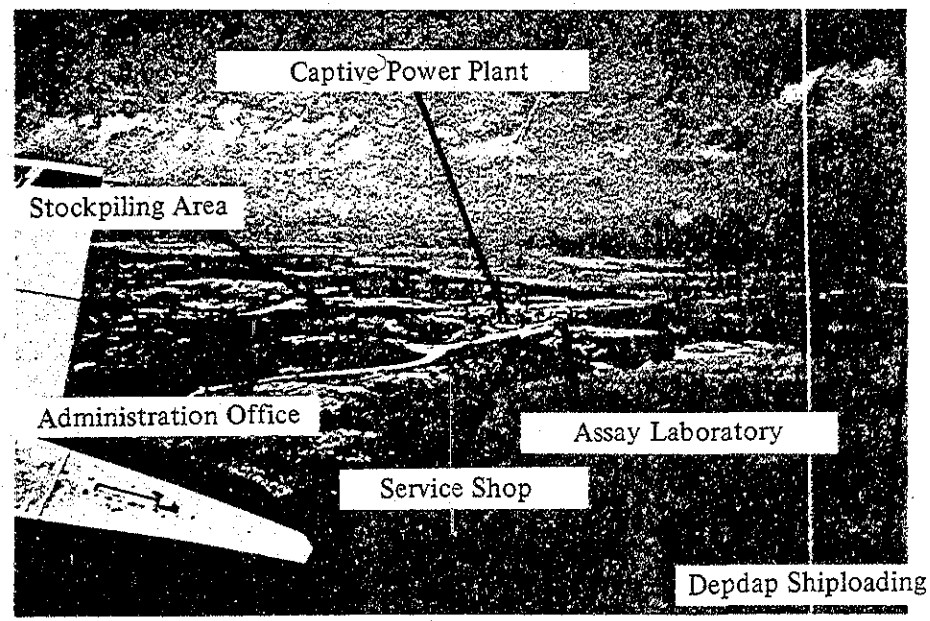


Photo – 10

Unong Pit General View
Looking at the Pit from South to North

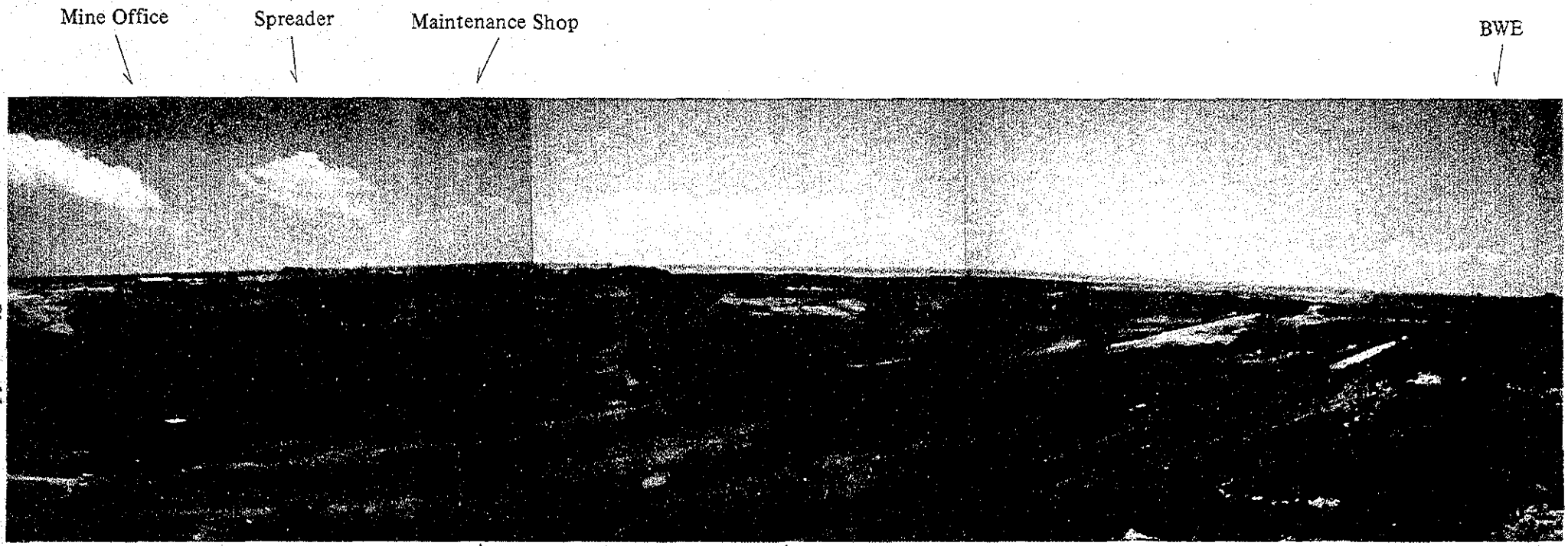
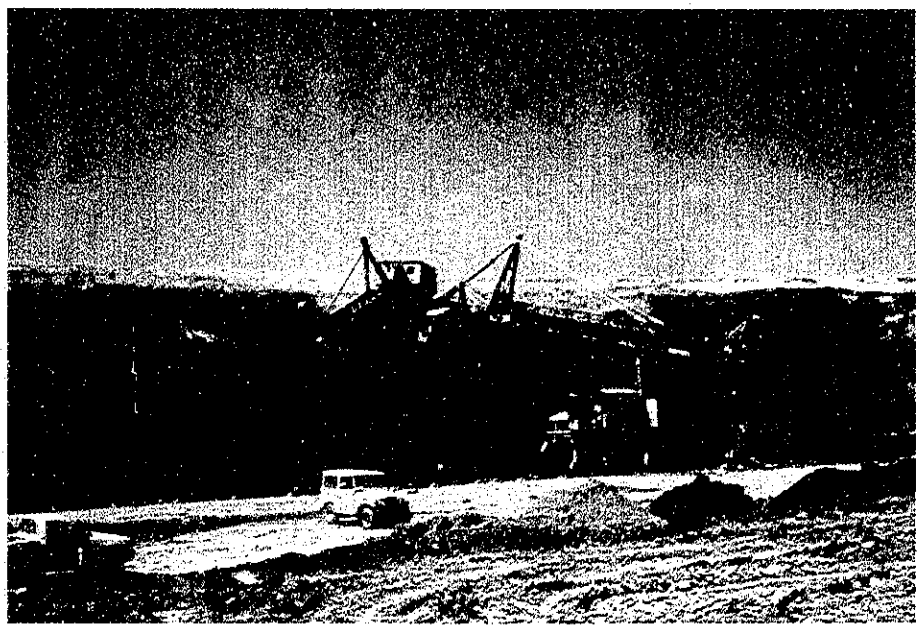


Photo – 11

BWE Operation Line 5, March, 1987

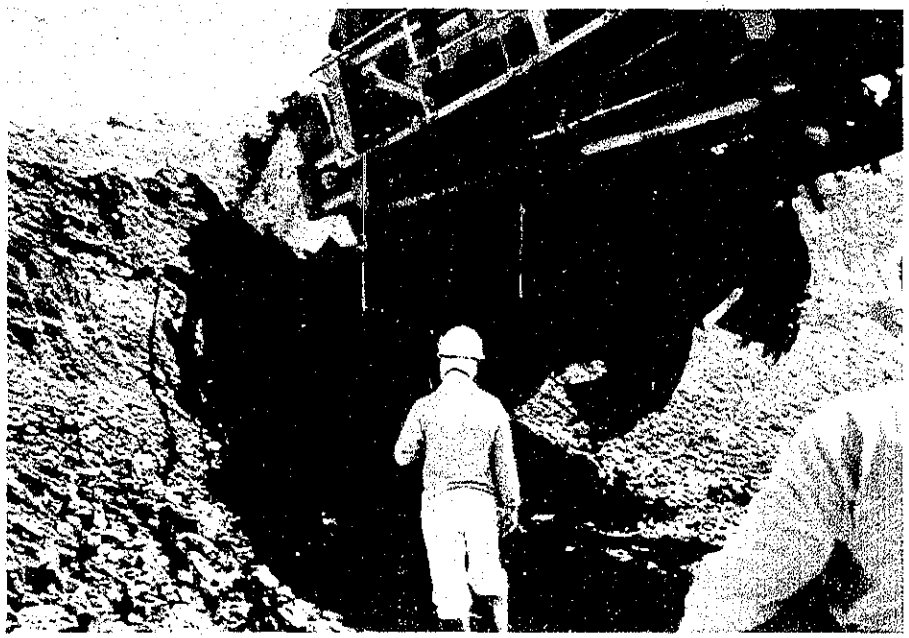
Bucket Wheel Excavator



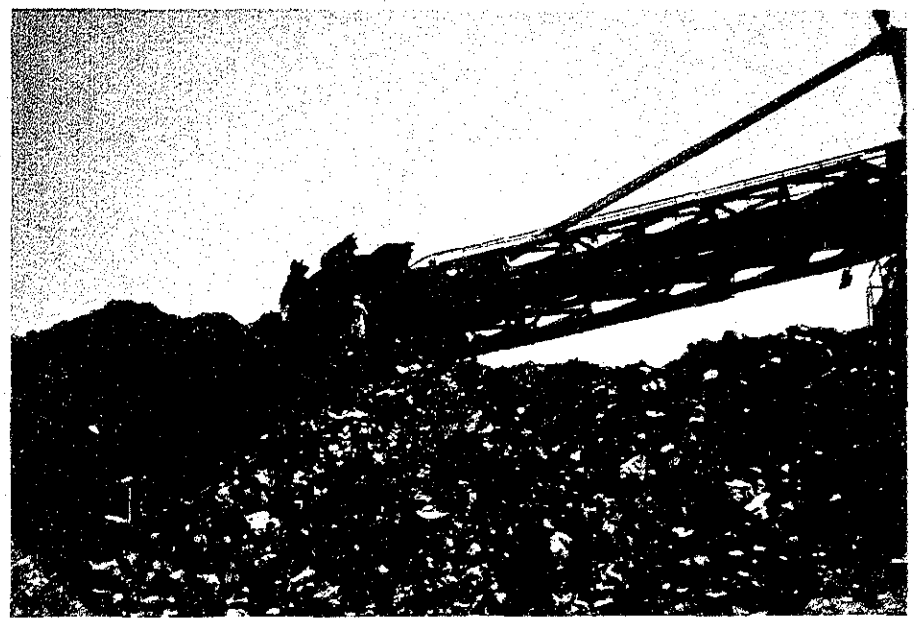
Shiftable Face Conveyor

Hopper Car

Photo – 12



BWE Foreman



BWE Foreman

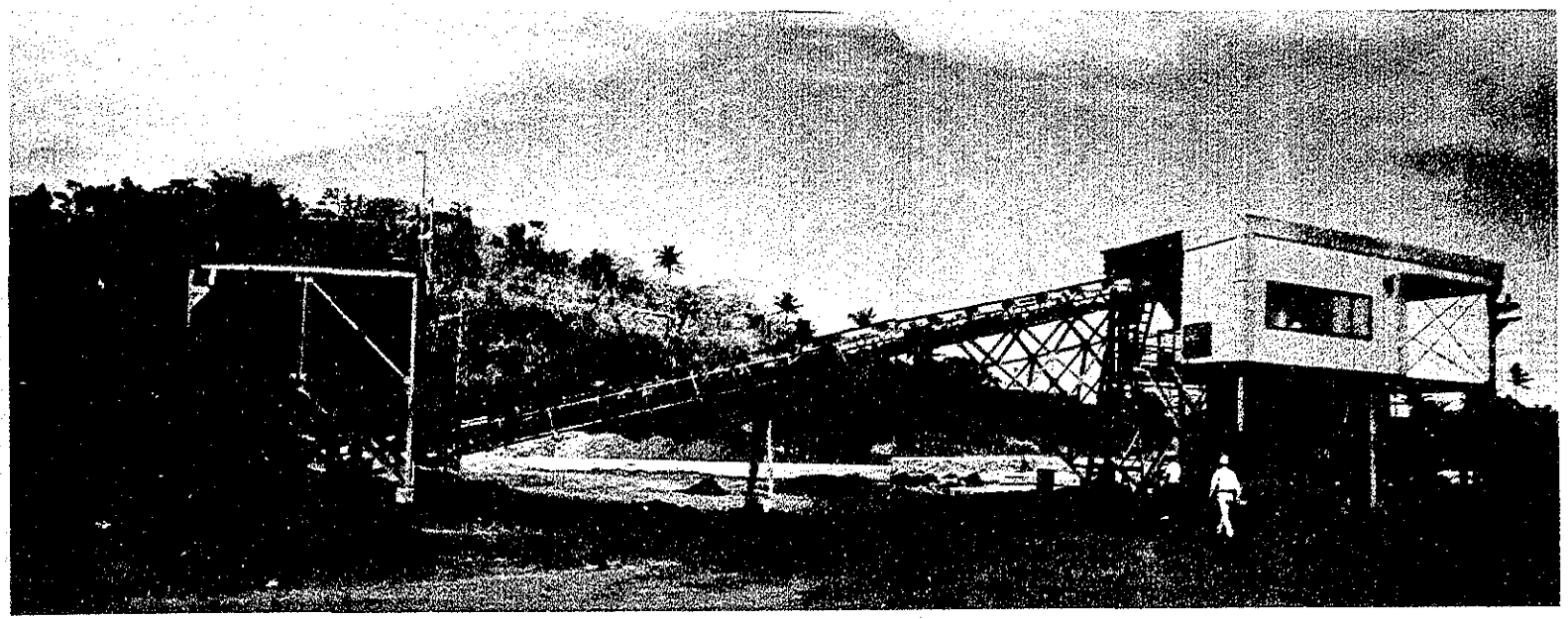
BWE Foreman Gives Order to BWE Operator Watching Cutting Face

Photo — 13

Coal Feed Hopper

Plant Feed Conveyor

Coal Washing Plant



Pilot Coal Preparation Plant

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1. Introduction

1-1 Background of the Study

Calaca Thermal Power Plant Unit No. 1, the first large-scale coal-fired thermal power plant in the Philippines, rated 300 MW, was commissioned in September 1984, but suffered from slagging and fouling of the boiler and could not continue reliable operation because of the inferior quality of the local coal actually supplied from Semirara Island.

To seek for possible countermeasures for the above problems, the Philippine Government made a request to the Japanese Government for technical cooperation as to the improvement of the power plant facilities, betterment of the quality of Semirara coal and its production increase plan.

In response to this request, Japan International Cooperation Agency (JICA). dispatched a preliminary survey team to the Philippines in November 1986 and the main survey team two (2) times during the period from February to August 1987 to Manila, Calaca power station in the province of Batangas and Unong Pit located on Semirara Island to conduct site surveys, discussions with National Power Corporation (NAPOCOR) and Semirara Coal Corporation (SCC), data collection and combustion test of the Calaca Unit No. 1 boiler.

This Final Report contains the results of the study of JICA Study Team based on the data and information collected by the above surveys.

On the other hand, a preliminary report detailing the results of the study on the coal handling system, was presented to NAPOCOR at the end of June 1987 as originally scheduled because of the urgent tendering schedule of Calaca Unit No. 2, the earliest completion of which is desired, and the field survey report and the interim report containing the latest results of the survey and study were submitted to NAPOCOR in September 1987 and October 1987 respectively.

1-2 Purpose of the Study

The purpose of this study is to investigate the present conditions of Calaca Unit No. 1 in detail, to identify the defective points of boiler facilities and coal handling system and to formulate an upgrading plan of the plant as well as to conduct site survey at Unong Pit of Semirara Coal Mine and to make studies on the quality improvement of Semirara coal and production increase plan of Unong Pit.

1-3 Objective Areas of the Survey

The objective areas of the survey are Calaca Coal-Fired Thermal Power Plant in Batangas and Unong Pit on Semirara Island in the Republic of the Philippines.

1-4 Scope of Works and Implementation Method

In order to establish an upgrading plan of Calaca Unit No. 1, JICA dispatched competent experts to the Calaca Coal-Fired Thermal Power Plant and Unong Pit of Semirara Coal Mine and carried out minute investigation on the respective site, collection of relevant data for upgrading plan and study on them, etc. and conducted combustion test with the boiler of Calaca Unit No. 1, with close cooperation by NAPOCOR and SCC.

The works of the JICA study are divided into two (2) stages, Phase I and Phase II to be conducted in the fiscal years of 1986 and 1987 respectively. The works shown on Table 1-1 were performed in accordance with the flow chart as shown on Fig. 1-1.

As for the field survey, JICA Team prepared the Inception Report to conduct the study smoothly, prior to the field survey and held discussion in detail with NAPOCOR and SCC immediately after their arrival in Manila.

As for the survey on the generating facilities, the first field survey was performed from February 15 to March 14, 1987 and the second field survey (boiler combustion tests) was performed from June 5 to August 29, 1987. The field surveys and data collection were satisfactorily performed with the close and extensive cooperation of NAPOCOR Head Office and Calaca Power Station.

As for the field survey on the local coal, the first survey was performed from February 15 to March 21, 1987 and the second survey was conducted from June 28 to August 26, 1987. However, because of the internal restriction of SCC, neither new geological map nor data on accounting was supplied in spite of the original expectation, and thus the study could only be made to that limited extent. And as for the data made available by SCC to the JICA Survey Team this time, strict confidentiality was also required. Since the objective plant of the study is Calaca Unit No. 1, that is getting coal only from Unong Pit, the data related to that coal pit on Semirara Island only were provided.

Table 1-1 Survey Items and Work Division

Work Division / Scope of Works in I/A	1st Phase (Fiscal Year 1986)			2nd Phase (Fiscal Year 1987)		
	Power Plant Team	Coal Team	Survey and Study Items	Power Plant Team	Coal Team	Survey and Study Items
1) Collection, analysis and study of existing data and information	O		Collection of power plant specification and design data	O	O	Arrangement, analysis and study of the collected data
	O		Collection of operation/maintenance records, organization, etc.			
	O	O	Collection of coal data			
	O		Collection of general and social status, and power market data			
2) Survey of operation/ maintenance of Calaca Thermal Power Plant 3) Survey of boiler, coal handling and ash disposal system	O		Survey and confirmation of actual state of power plant facilities	O	O	Summarization, study and arrangement of the collected data, extraction of problems and formulation of upgrading plan
	O		Confirmation of actual state of personnel management and training			
	O		Actual state of coal handling facilities and operation			
			Actual state of fuel analysis equipment and analysis work			

Work Division / Scope of Works in I/A	1st Phase (Fiscal Year 1986)			2nd Phase (Fiscal Year 1987)		
	Power Plant Team	Coal Team	Survey and Study Items	Power Plant Team	Coal Team	Survey and Study Items
	O		Actual state of ash disposal facilities and operation			
	O		Operation/maintenance manual and actual operation			
	O		Actual state of environmental matters			
4) Survey of boiler combustion control	O		Survey of fuel coal in use	O	O	Study of details of boiler facilities and problems in operation records
5) Boiler combustion test	O		Survey of actual practices of boiler combustion control and adjustment	O		Preparation of combustion test manual
	O		Preliminary discussion on combustion test	O	O	Guidance, witness and analysis of results of combustion test
				O		Study on improvement of boiler combustion control and adjustment
6) Coal analysis and evaluation		O	Survey of actual state of Unong Pit		O	Coal sample analysis for coal preparation plant and coal production increase plan

Work Division / Scope of Works in I/A	1st Phase (Fiscal Year 1986)			2nd Phase (Fiscal Year 1987)		
	Power Plant Team	Coal Team	Survey and Study Items	Power Plant Team	Coal Team	Survey and Study Items
		O	Actual state of mixing of imported coal and selected Semirara coal	O	O	Selection and analysis of fuel coal for combustion test
		O	Study of data on coal analysis	O	O	Classification and study of samples based on combustion test
		O	Coal sampling plan and sampling			
		O	Coal sample analysis			
7) Decision of optimum coal blend ratio			–	O	O	Study of coal blend ratio which allows maximum use of Semirara
				O	O	Study of coal quality required for Semirara coal
				O	O	Decision of optimum coal blend ratio based on the study results of the following items 8) and 9)

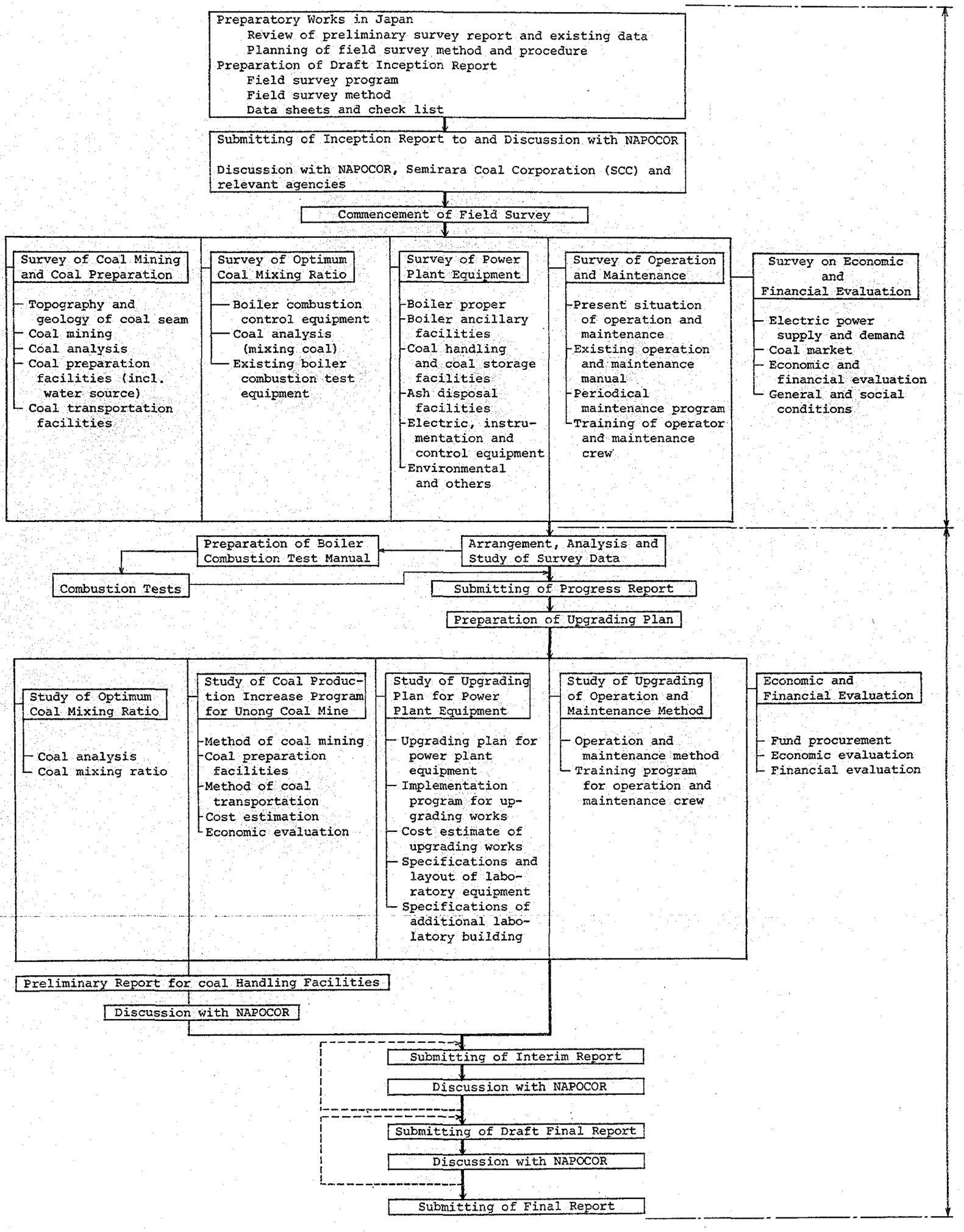
Work Division / Scope of Works in I/A	1st Phase (Fiscal Year 1986)			2nd Phase (Fiscal Year 1987)		
	Power Plant Team	Coal Team	Survey and Study Items	Power Plant Team	Coal Team	Survey and Study Items
8) Survey and study of effects of coal quality improvement by coal preparation and desalination		O	Actual state of test plant for coal preparation in Unong Pit	O	O	Study of basic plant of coal preparation for Seminrara coal based on the study results of items 5), 6) and 7) above
		O	Basic survey for installation of large scale coal preparation facilities			
a. Study of effects of coal quality improvement by coal preparation based on the results of analysis of coal and ash, study of coal production increase plan of Unong Pit and coal mining method					O	Dicision of scale of coal preparation facilities based on the production increase plan and the above basic plan
					O	Preliminary design of coal preparation facilities
b. Study of suitable coal preparation method, and if necessary, method of desalination						
c. Survey of water for coal preparation/ desalination facilities						

Work Division / Scope of Works in I/A	1st Phase (Fiscal Year 1986)			2nd Phase (Fiscal Year 1987)		
	Power Plant Team	Coal Team	Survey and Study Items	Power Plant Team	Coal Team	Survey and Study Items
d. Selection of site proposed for coal preparation/Desalination facilities						
9) Survey of Semirara coal production increase plan		O	Actual state of organization and operation of SCC		O	Summarization of existing data and study results of Unong Pit and estimation of workable coal reserve
a. Survey of present situation of coal production		O	Study progress of feasibility study on coal production increase plan by SCC		O	Conceptional plan for adequate mining, transportation and storage of coal
b. Study of effects of coal production increase plan on the productivity, coal handing system and power plant operation		O	Topography and geology of Unong Pit		O	Study of possibility of mining suitable coal in Unong Pit based on the study of items 5), 6) and 7) above
		O	Actual state of coal mining, transportation and storage in Unong Pit		O	Basic plan for coal production increase
	O	O	Selection of coal sampling points and guidance in coal sampling		O	Preliminary design and specifications of the facilities for coal production increase
			Study of sampling method of fuel coal for combustion test			

Work Division / Scope of Works in I/A	1st Phase (Fiscal Year 1986)			2nd Phase (Fiscal Year 1987)		
	Power Plant Team	Coal Team	Survey and Study Items	Power Plant Team	Coal Team	Survey and Study Items
10) Study of specifications of laboratory equipment	O	O	Actual state of existing laboratory equipment for coal, ash, water and environmental analyses and actual practices	O	O	Study of the problems of the existing equipment
Decision of specifications of laboratory equipment to be furnished by JICA	O	O	Study of necessity and planning of the additional equipment	O	O	Study of necessity and planning of the additional eqipment and preparation of the specifications
	O		Guidance of the additional equipment layout	O		Guidance of the method of analysis with additional equipment
11) Laboratory construction advice and guidance in the specification and construction of laboratory building planned by NAPOCOR	O	O	Survey of actual state of the existing laboratory and building structure			
	O	O	Advice and guidance in basic plan of building on the additional equipment layout			

Work Division / Scope of Works in I/A	1st Phase (Fiscal Year 1986)			2nd Phase (Fiscal Year 1987)		
	Power Plant Team	Coal Team	Survey and Study Items	Power Plant Team	Coal Team	Survey and Study Items
12) Preparation of upgrading plan Based on the above survey, tests, analysis and study, upgrading plan will be prepared and preliminary design, construction schedule, cost estimate, disbursement schedule and economic and financial evaluation will be made and Final Report will be prepared.	O		Basic data collection for economic and financial evaluation	O	O	The following upgrading plans will be prepared based on the survey of the power plant and Unong Pit, various tests, analyses, and studies. – General items and necessity of upgrading – Basic plan and preliminary design – Major specifications – Construction cost and schedule – Economic and financial evaluation – Others

Work Flow of Study
for
Calaca Coal-fired Thermal Plant (1) Upgrading Project



1-5 Job Assignment

The job assignment and service items for the 1st phase (1986) and the 2nd phase (1987) are summarized as follows:

Name	Assignment	Service Items
Toshio OGA (Elect. Engr.)	Team leader	General matters Field survey on electrical equipment Data collection and analysis Planning of boiler combustion test Planning of upgrading plan
Masao KOYO (Mech. Engr.)	Power plant design	Field survey on mechanical equipment Data collection and analysis Study on operation/maintenance manual Planning and supervising of boiler combustion test Planning of upgrading plan
Yoshinobu SHIBATA (Elect. Engr.)	Power plant operation	Field survey on electrical equipment and maintenance works Data collection and analysis Planning and supervising of boiler combustion test Planning of upgrading plan
Ginjiro MATSUO (Elect. Engr.)	Power plant design	Field survey on electrical equipment Data collection and analysis Planning and supervising of boiler combustion test Planning of upgrading plan

Name	Assignment	Service Items
Tadanori AOKI (Chemist)	environmental and water analysis	Field survey on environmental and water quality control Data collection and analysis Guidance of boiler combustion test Study of specifications of laboratory equipment for coal, ash, water and environmental analysis Planning of upgrading plan (Service for 2nd stage)
Kazuhiro ABE (Architect)	Building design	Study of additional laboratory building (Service for 1st stage in Japan)
Takaharu NAKAYAMA (Mech. Engr.)	Power plant Maintenance	Field survey on mechanical equipment Data collection and analysis Planning of upgrading plan
Kenji FUJII (Economist)	Economy	Social status and power market Economic and financial evaluation
Kazuhiko HIRATA (Geologist)	Geology	Field survey on topography and geology of Unong Pit Planning of coal production increase program
Masaoki NISHIOKA (Coal Mining Engr.)	Coal Mining	Field survey on coal production capacity Planning of coal production increase program and improvement plan of coal production facilities Study on upgrading measure of coal quality

Name	Assignment	Service Items
Masaharu KONISHI (Coal Mining Engr.)	Coal preparation	Study on coal preparation facility for upgrading of coal quality Analysis of Semirara coal, Australian coal and coal ash Planning and supervising of boiler combustion test Planning of upgrading plan

1-6 Study Schedule

The Study Schedule is shown in the Table 1-2 as attached.

Table 1-2 Schedule of Study for Calaca Coal-Fired Thermal Power Plant (I) Upgrading Project

ITEMS		FISCAL YEAR / PERIOD	1986 Jan.	Feb.	Mar.	Apr.	May	Jun.	1987 Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.
Overall Schedule	Field Survey, Data Collection			Inception Report												
	Boiler Combustion Tests, Coal Analysis															
	Survey of Unong Pit Study of Coal Preparation Facilities															
	Reports		Commencement of Study					Preliminary Report on Coal Handling Facilities		Field Survey (Progress) Report		Interim Report		Draft Final Report	Final Report	
Field Survey and Discussion	(1) Movement			▽ : TYO → MNL			▼ : MNL → TYO									
	No. of Engrs.			9 1 2	3 1 1 1				1 4 1 1 1	1 5		2 2	1	2 2 1		
	(2) Visit to Authorities Concerned															
	(3) Discussion of Inception Report															
	(4) Field Work and Survey, Boiler Combustion Test and Report															
	(5) Study of Upgrading Plan, Preparation of Reports															
Field survey and study of Upgrading Plan	(1) Data Collection and Analysis															
	(2) Study and Analysis of Operation and Maintenance															
	(3) Study on Upgrading Plan for Boiler, and Coal and Ash Handling System															
	(4) Field Survey on Boiler Combustion Control															
	(5) Boiler Combustion Tests															
	(6) Coal Analysis and Evaluation															
	(7) Study of Optimum Coal Blend Ratio															
	(8) Study of Coal Quality Improvement															
	(9) Planning of Coal Production Increase Program															
	(10) Study and Instruction on Laboratory Equipment															
	(11) Study and Discussion of Additional Laboratory Building															
	(12) Economic and Financial Evaluation															

Legend: Field Survey; Study in Japan; Explanation of Report

1-7 Field Survey

1-7-1 Counterpart

The field survey and boiler combustion test were performed with close cooperation of NAPOCOR counterparts and SCC. The names of the counterparts are as follows.

1) NAPACOR

a. NAPOCOR Head Office

a) NAPOCOR Management

Mr. Josue D. Polintan	Sr. Vice President
Mr. Francisco T. Delgado	Sr. Vice President, Engineering
Mr. Jose T. Ramas	Vice President, System Operations
Mr. Marciano C. Avendano	Vice President, Engineering

b) Thermal Power Projects Dept.

Mr. Guilberto A. Pastoral	Manager, Thermal Power Projects Dept.
Mr. Roberto C. Augustin	Manager Project Design Division
Mr. Gregorio L. Tolentino	Principal Engineer II
Mr. Romeo D. Ordona	Principal Engineer I
Mr. Norberto V. Cabantog	Principal Engineer I
Mr. Rustico G. Nero	Supervising Engineer

c) Engineering Resource Services Dept.

Mr. Romeo M. Pulanco	Manager, Geology and Geotechnics Services Div.
Mr. Alfredo Q. Penarroyo	Principal Geologist II
Mr. Adelo I. Derilo	Principal Geologist II
Mr. Fernando Y. Roxas	Principal Geologist I
Mr. Jose Voltaire F. Manois	Mining Engineer

Ms. Cornelia N. Sanchez	Sr. Geologist

d) System Operation Dept.

Mr. Lino S. Cruz	Manager, Operations Control and Information Service
Mr. Rolando T. Bacani	Manager, Power Resources Planning Division
Mr. Alex P. Sace	Principal Engineer C
Mr. Alberto C. Guanzon	Principal Engineer C

e) Calaca Coal-fired Thermal Power Plant

(i) General Counterpart

Mr. J.V. Favor	Plant Manager
Mr. P.A. Cabrera	Superintendent, Mechanical Maintenance
Mr. A.B. Pena	Superintendent, Electrical Maintenance
Mr. A.L. Cabildo	Superintendent, Technical Services
Mr. A.P. Toong Jr.	Superintendent, Instrumentation & Control
Mr. S.M. Manalo	Superintendent, Operations
Mr. A.C. Kintanar	Superintendent, Operations
Mr. R.C. Tolentino	Superintendent, Operations
Mr. R.M. Lacson	Superintendent, Operations
Mr. A.T. Oronos	Superintendent, Operations
Ms. F.B. Torrefranca	Principal Chemical Analyst
Mr. C.O. Villegas	Result Engineer

(ii) Task force for boiler combustion test

Task force for boiler combustion test was composed of the following members.

Mr. P.A. Cabrera	Leader
Mr. A.L. Cabildo	Superintendent
Mr. S.M. Manalo	Staff

Mr. E.D. Untalan	Staff
Mr. J.M. Ilagan	Staff
Mr. V.S. Leyba	Staff
Mr. R.Q. Jornales	Staff
Mr. D.C. Mateo	Data Recording
Mr. J.B. De Los Reyes	Data Recording
Mr. E.R. Ilagan	Data Recording
Mr. M.A. Fajardo	Data Recording
Mr. J.J. Santiago	Data Recording
Mr. B.S. Macatangay	Data Recording
Mr. I.G. Noche	Data Recording
Mr. A.P. Mendoza	Data Recording
Mr. A.V. Lara	Data Recording
Mr. M.G. Reyes	Data Recording
Mr. E.H. Baque	Data Recording
Mr. E.R. Ayque	Data Recording
Mr. S.E. Descalsote	Data Recording
Mr. H.S. Malabanan	Data Recording
Mr. P.R. De Padua	Sampling
Mr. M.C. Ramos	Sampling
Mr. F.A. Nobleza	Sampling
Mr. R.B. Atajar	Sampling
Mr. E.B. Ranio	Sampling
Mr. V.E. De Leon	Sampling
Mr. L.Q. Sinag	Sampling
Mr. S.R. Sagala	Sampling
Mr. C.M. Julaton	Sampling
Mr. V.P. Salazar	Sampling
Ms. M.M. Fabela	Analysis of Sample
Ms L.Z. Presto	Analysis of Sample
Mr. T.A. Carandang	Analysis of Sample
Ms. E.H. Turbaga	Analysis of Sample

2) Semirara Coal Corporation (SCC)

Mr. G.B. Baquiran	Vice President, Exploration

1-7-2 Organization of Executing Agency

Organization of whole NAPOCOR, Southern Luzon Regional Center and Calaca Power Station are shown on Figs. 1-2, 1-3 and 1-4 respectively.

Fig. 1-2 Organizational Chart of NAPOCOR

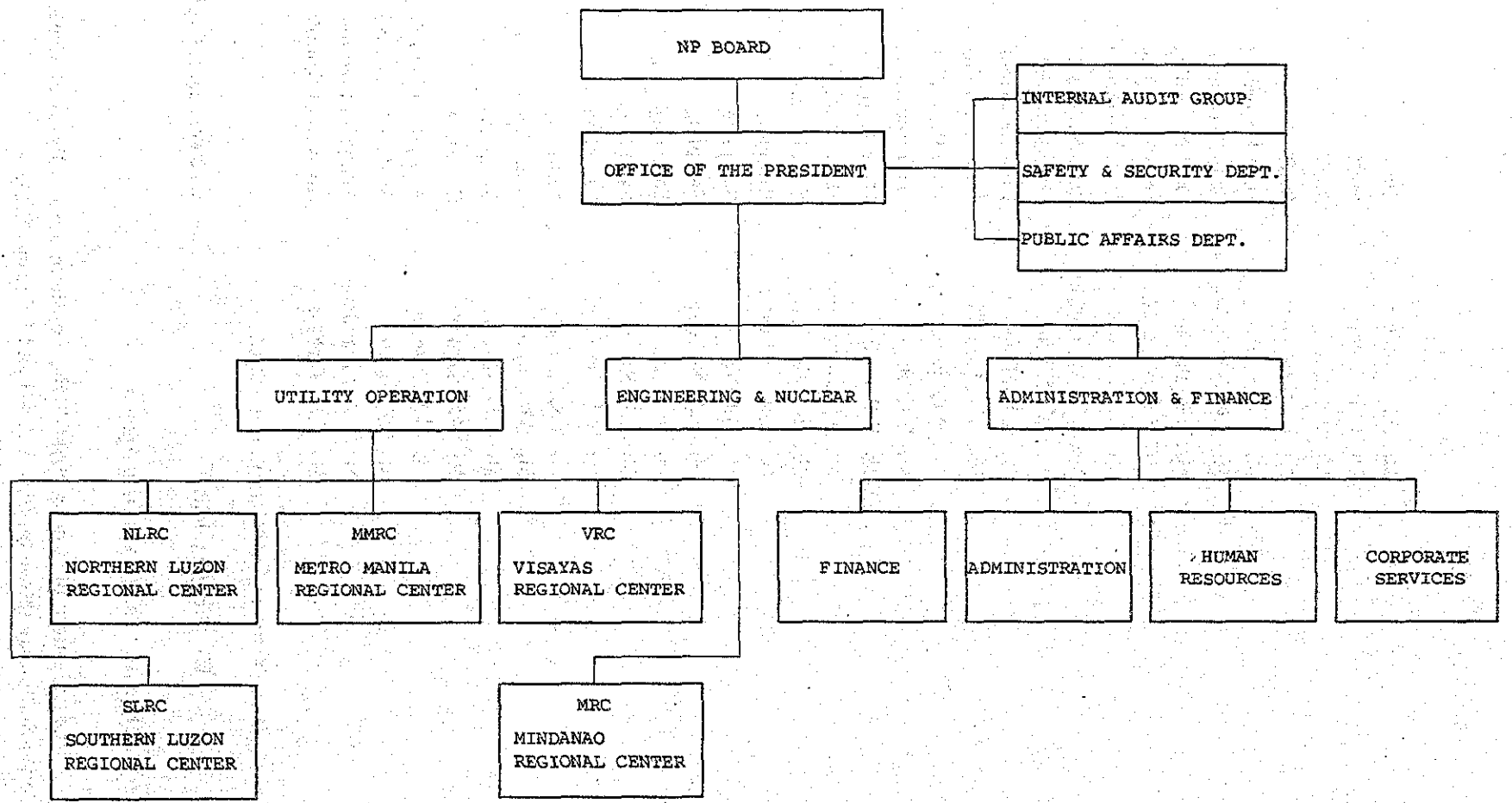
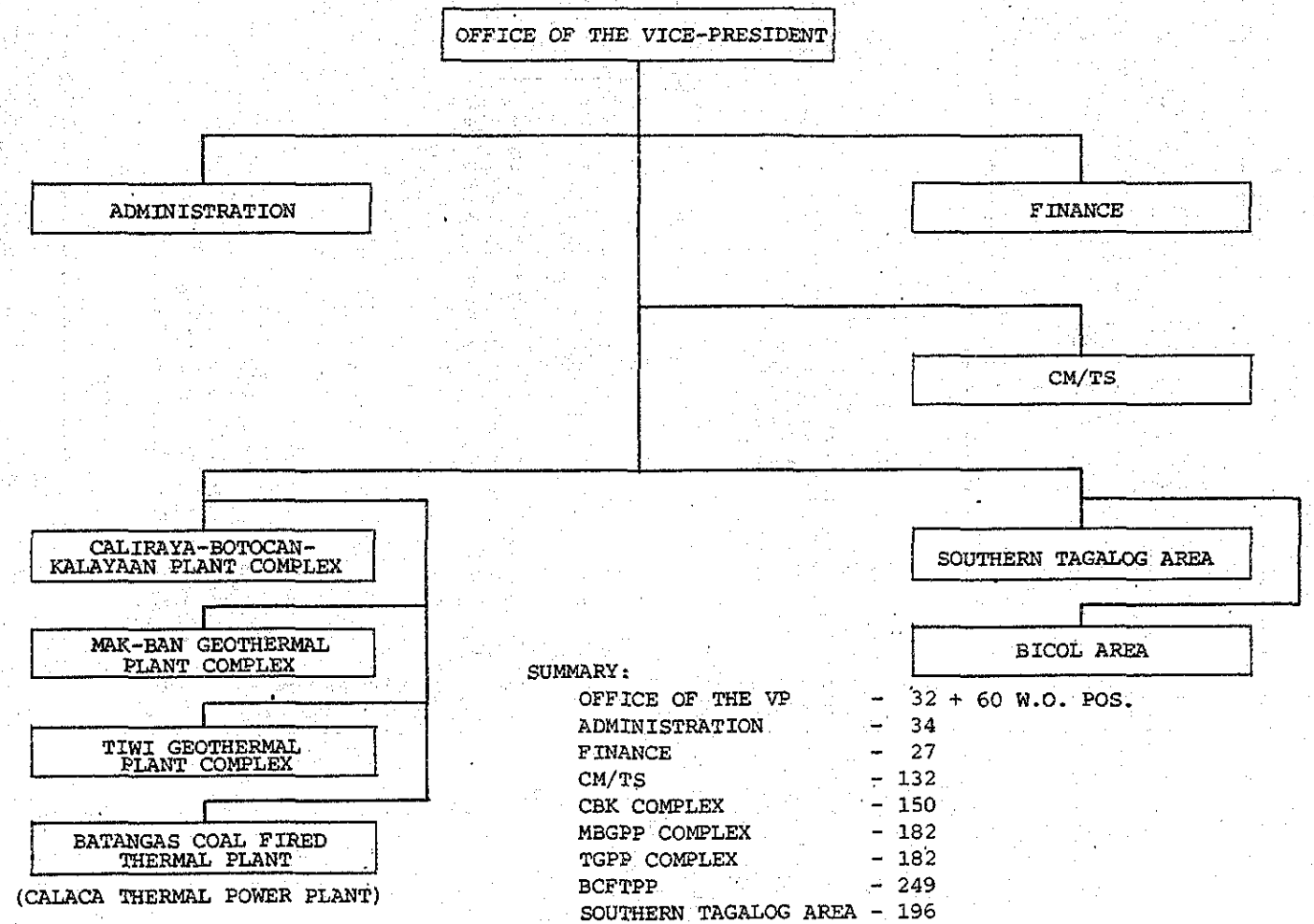


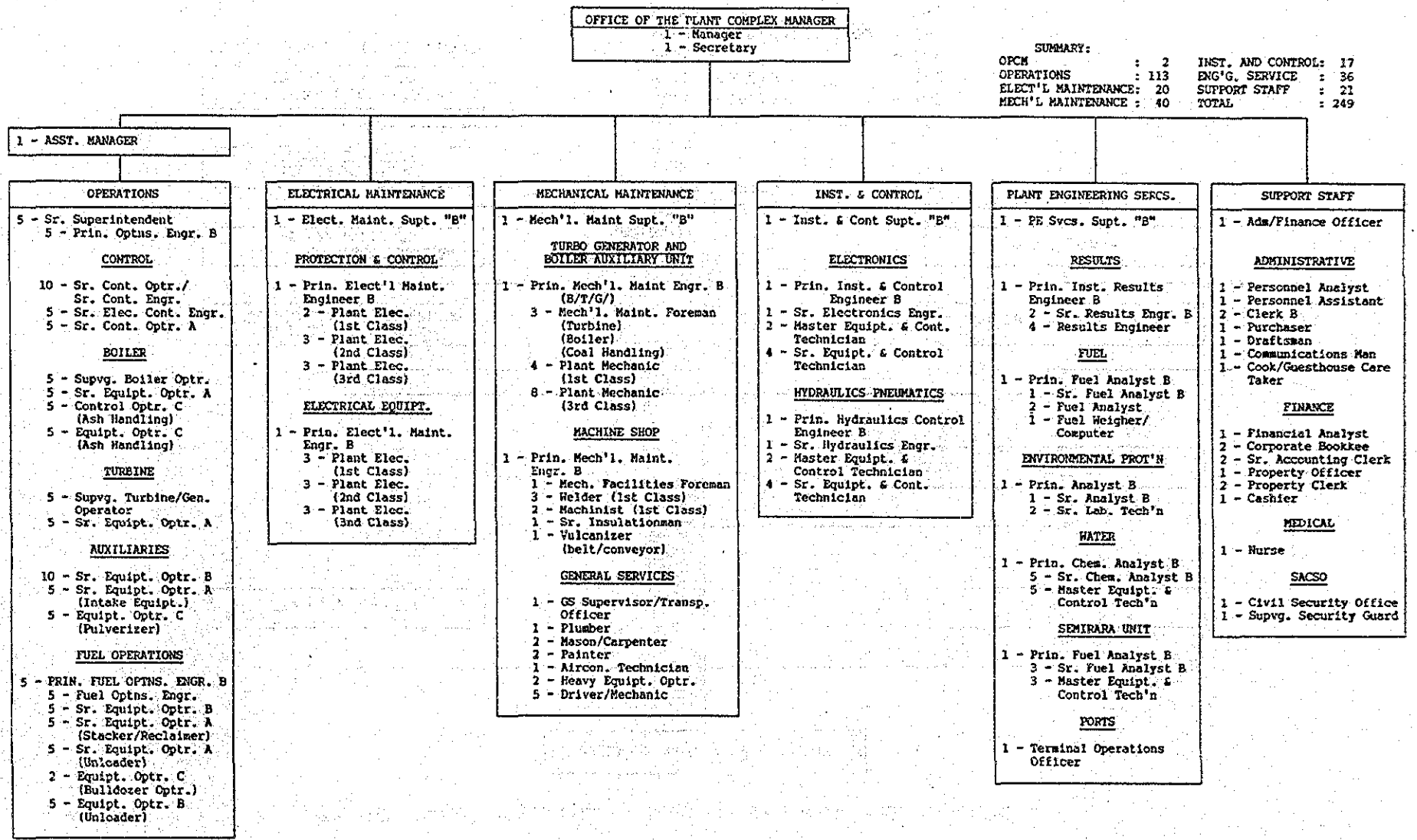
Fig. 1-3 Table of Organization of Southern Luzon Regional Center (SLRC)



SUMMARY:

OFFICE OF THE VP	-	32 + 60 W.O. POS.
ADMINISTRATION	-	34
FINANCE	-	27
CM/TS	-	132
CBK COMPLEX	-	150
MBGPP COMPLEX	-	182
TGPP COMPLEX	-	182
BCFTPP	-	249
SOUTHERN TAGALOG AREA	-	196
BICOL AREA	-	183
TOTAL		1366 + 60 W.O. POS.

Fig. 1-4 1985 Organization of Calaca Coal-fired Thermal Power Plant



2. Conclusion of the Study

2-1 Calaca Coal-Fired Thermal Power Plant

- 2-1-1 Present Situation of Calaca Power Plant
- 2-1-2 Future Prospect of Calaca Power Plant
- 2-1-3 Problems of Calaca Power Plant
- 2-1-4 Recommendations on the Improvement Plan
- 2-1-5 Economic and Financial Evaluation

2-2 Semirara Coal Mine

- 2-2-1 Outline of Semirara Coal Mine
- 2-2-2 Current Status of Unong Pit
- 2-2-3 Production Increase Schemes
- 2-2-4 Coal Quality Upgrading
- 2-2-5 Recommendations for Semirara Coal Mine (Unong Pit)

2. Conclusion of the Study

2-1 Calaca Coal-Fired Thermal Power Plant

2-1-1 Present Situation of Calaca Power Plant

(1) Calaca power plant was commissioned as the largest coal-fired thermal power plant in the Philippines in September 1984.

This power station was planned to use mainly the local coal produced at Unong Pit located on Semirara Island. However, the Run-of-Mine (ROM) coal supplied during the commissioning of the plant had quite different quality from that of design base coal, and it contained much clay and moisture which caused serious troubles like clogging of coal silos, chutes, etc., of the coal handling system, entailing the difficulty of continuous operation of the plant.

Therefore, Semirara Coal Corporation (SCC) changed their mining method and began to supply Selected Semirara Coal (SSC). And thus coal clogging problems have been solved. But, due to the high alkali content in the ash of SSC, slagging (ash deposits on the boiler furnace wall) and fouling (molten ash deposits in the rear pass of flue gas) occurred resulting in the difficulty in the rated output operation with exclusive Semirara coal firing.

Under these circumstances, SSC is being blended with imported coal (mainly Australian coal) at the ratio of 50:50 for daily plant operation up to the present.

Table 2-1 Sample of Coal Specifications

	Design Coal	ROM Coal	SSC	Imported Coal
Total moisture (AR) (%)	19	25.87	27.92	8.58
Calorific value (AR) (kcal/kg)	4,722	3,850	4,390	6,090
Ash (AR) (%)	6.72	17.63	8.10	16.67
Alkali Content ($Na_2O + K_2O$) (DB) (%)	2.57	4.52	8.14	0.50

Note) AR: As Received DB: Dry Base

(2) Meanwhile, Calaca Power Plant people made their utmost efforts to apply various countermeasure and the plant is now operating mostly under stable condition to perform the important role as one of the major power stations in the Luzon Grid. The record of past operation of the plant is shown in Table 2-2.

Table 2-2 Operation Record

	1984	1985 1st half	1985 2nd half	1986 1st half	1986 2nd half	1987 1st half
Utilization factor (%)	29	55	55	57	71	80
Number of shut down (Time)	34	43	14	11	20	9
Thermal efficiency (%)	30.7	33.2	33.9	33.6	35.8	35.3
Operating hours (h)	1,196	3,442	3,363	2,496	3,875	3,814
Forced shut down rate (%)	7.2	11.7	17.4	3.1	0.8	5.5
Coal consumption						
Local coal (t)	24,498	199,659	141,934	141,109	222,281	235,669
Imported coal (t)	53,395	99,527	161,391	154,030	222,281	230,795

(Assumption is included partially.)

(3) In line with the national policy of the Philippines to utilize the indigenous energy and to save foreign exchange, NAPOCOR is trying to maximize the use of Semirara coal.

And as there is a coal supply contract concluded between NAPOCOR and SCC on the "Lift or Pay" basis which requires NAPOCOR to receive 700,000 tons of coal per year at a minimum, use of the local coal is a must for the Calaca Plant from this point of view also.

But, since Semirara coal contains much alkali content and moisture, the use of the coal becomes limited. Calaca Power Plant continued mostly stable operation since the middle of 1986 using Semirara coal blended with the imported coal at the ratio of 50:50, and from the beginning of this year they started to increase the local coal consumption further, and to try exclusive Semirara coal firing on Saturday and Sunday when the system load is low.

(4) Three years have passed since the commissioning, and some deterioration and/or troubles are seen on some equipment. There are also several facilities which are not suited to the handling of the coal currently used.

Therefore, proper maintenance, repairs and improvement of these equipment/facilities will be needed in the near future.

2-1-2 Future Prospect of Calaca Power Plant

(1) The total installed capacity of the generating facilities in the Luzon Grid is 4,111 MW as of May 1987 and the maximum demand is 2,573 MW. The future demand is forecasted to increase at the average rate of 4.5% per year.

Because of such factors as the large share of the hydro power plant (1,226 MW) in the grid, lower reliability of the old thermal power plants by deterioration of facilities, almost constant peak load throughout the year, etc., the power supply/demand balance is always quite tight.

Further, such facts as the mothballing of the nuclear power plant by the Philippine Government and no introduction of new power plant into the grid in near future will make the Calaca Power Plant to operate as one of the most important power stations in the Luzon power system.

(2) The Philippine Government has been promoting the policy of indigenous energy utilization and putting emphasis on boosting of the development of hydro, geothermal and coal thermal power plant projects.

Calaca Unit No. 2 now under planning is also contemplated by NAPOCOR to use local coal, and after the completion of its construction the Calaca Coal-Fired Thermal Power Plant Units No. 1 and No. 2 rated 600 MW in total will be operated as a major base load power station in the Luzon Grid for more than ten years.

(3) To supply local coal to Calaca Unit No. 2, a new coal mine will be developed on Semirara Island. Calaca Unit No. 1 will be operated with blended coal at the maximum local coal ratio possible until the commissioning of Unit No. 2. After the start of local coal supply from the new coal mine, the use of local coal will be increased due to the operation of two units of Calaca Power Plant.

(4) In system operation, the geothermal, coal thermal and hydro (rainy season) power plants will be used as the base load power plants and oil thermal, hydro (dry season) and pumped storage hydro power plants will be used as peak load power plants.

Calaca Power Station will be required to continue heavy load operation as a base load power plant for a long time in future.

2-1-3 Problems of Calaca Power Plant

The following problems were found with the present Calaca Coal-Fired Thermal Power Plant, one of the base load power station in the Luzon Grid.

(1) Quality of Fuel Coal Inferior to Design Coal

a. Though there is a strong request of SCC to the Calaca Plant to use ROM coal, it is very difficult with the existing facilities due to much clay and moisture mingled with the coal, which gives serious difficulty in coal handling, and insufficient calorific value of the coal for the rated output operation. SCC insists that they are not having any problem in handling of ROM coal on Semirara Island. However, it is presumed to be because the coal is right after the cutting out. When ROM coal is kept in the coal stock yard in Semirara before shipment or in the coal yard at Calaca the clay in the coal gets much moisture by rainfall and melts entailing coal handling problems even though it is blended with Australian coal.

b. Even with SSC, Calaca Power Plant experienced the following problems. Only derated operation of the plant is possible with exclusive firing of SSC. Existing facilities are not suited for the rated operation with pure SSC.

a) Alkali content in coal ash is as high as 2 to 9 %. (4.8% on an average for received coal in 1986, while 4% or less is the design base.)

b) Moisture content is as high as 20 to 30 %. (25.7% on an average in 1986; while 19% is the design base.)

c) Calorific value is as low as 4,100 to 4,700 kcal/kg with large

variation. (4,446 kcal/kg on an average in 1986, while 4,722 kcal/kg is the design base.)

c. Study on the quality improvement of Semirara coal by the coal preparation plant was requested by NAPOCOR. However, because of impossibility to reduce the alkali content, increased moisture content than original (32%), much higher coal price, etc., it was concluded that coal preparation of Semirara coal is not recommendable.

If the exclusive firing of the low quality coal mentioned above is required, the replacement of the existing boiler will be the only solution, which would need about US$107 million (¥15 billion) and 4 years construction works, and it is not realistic. Paratial modification of the existing boiler can only give limited improvement with various restrictions. After all, Calaca Power Plant will have to be operated with blended coal of SSC and imported coal.

(2) Provisions for Use of Low Quality Coal

As the plant was originally designed for exclusive firing of the design base coal, some power plant facilities lack the provisions for blended coal firing and/or for handling of the coal currently used with different quality from the design base. In order to enable the handling of the blended coal and to maximize the blend ratio of local coal, the following provisions are needed in the existing plant facilities.

a. Coal scales and coal blending facility

The coal scales for measuring the total quantity of as-received and as-fired coal are already provided. But, coal scales for mono-brand coal reclaimed by each reclaimer is not installed. Also, since no coal blending facility is provided, precise coal blending and/or coal stock management can not be conducted.

b. Coal silo

Because of the small coal outlet of the silo, coal clogging is often encountered, especially with high moisture coal.

c. Dust prevention

Semirara coal is rather fragile and has a tendency to produce coal dust. Coal dust is generated particularly at the unloader, stacker/reclaimer and coal yard, causing dust pollution problems.

d. Coal handling system

When ROM coal was received, many trobules were encountered, and receiving of ROM coal by the existing coal handling system is unrealistic.

(3) Deterioration of Facilities and Troubles

Three years have passed since the commissioning and some deterioration of the facilities is observed. There are also some equipment which are not working at their full capability and/or have insufficient capacity.

For example, ABC system has some functional insufficiency resulting in incomplete plant control. And some measurement systems like O_2 analyzer are out of order.

Spare parts for replacement are already requested for procurement, but due to the delay in the procurement procedure, necessary repairs have not been made. Difficulty in repair works and resulting deterioration of the power plant due to delay in the procurement of spare parts are common and serious problems with the facilities of NAPOCOR, and corporate-wide solution seems urgently needed.

2-1-4 Recommendations on the Improvement Plan

(1) Premises of the Recommendation

The study on the improvement plan of the Calaca Power Plant was made on the following premises;

a. Calaca Power Plant will use the Semirara coal from now on, the quality of which is assumed to be the same as that supplied in the past, of high alkali content and high moisture.

b. ROM coal can not be used for the existing facility of Calaca Unit No. 1

because of the difficulty in handling and low calorific value.

c. No coal preparation plant will be considered for Semirara coal because of little effect on the coal quality.

d. Blended SSC with imported coal will be continuously used.

e. MONENCO report of the study of coal to be supplied to Calaca Unit No. 2, was originally scheduled to be submitted in 1987 and was expected to be made available to the JICA Team. However, as it was not available therefore the coal quality to be supplied to Calaca Unit No. 1 in the future is assumed to be the same as that in the past data of Semirara coal fired at Calaca.

(2) Improvement in Plant Operation

Combustion test as well as sampling and analysis of coal and coal ash was conducted to grasp the static and dynamic characteristics of the existing boiler, for the purpose of obtaining the maximum blend ratio possible of the local coal and finding out the optimum combustion adjustment.

- o Combustion test with blended coal of the current coal blend ratio (SSC/AC: 55/45)
- o Combustion test with 60/40 blend ratio
- o Combustion test with 70/30 blend ratio
- o Combustion test with 100% SSC at 3/4 load (225 MW)

Because of the tightness of demand/supply balance in the system, unavailability of one mill (D mill) out of four mills, lower alkali content of coal ash than the average before and such reasons, some test items like mill changeover test, etc., could not be implemented. However, many of the test items originally scheduled were successfully conducted and various useful data were obtained.

Improvement plans are presented in the following through the study based on the data of the combustion test as well as the data acquired from the past operation of the plant.

a. Restricting items during blended coal operation

a) Particular attention must be paid to fouling during the boiler operation at Calaca Power Plant, and the alkali content in the ash must be maintained below the design base, 4% or less.

b) Moisture content of 22% of the fuel coal was allowable for the plant operation during the combustion test, though design base is 19%. Derated output operation at 225 MW was possible with 26% moisture content of SSC, but 23 to 24% will be the maximum allowable for the rated output operation.

c) Although 80/20 blend ratio of SSC/AC will be possible in view of the calorific value of SSC, the lower blend ratio of SSC will be required by the high moisture content.

b. Considerations needed for blend ratio increase of local coal

On the basis of the combustion test results, the following items are recommended for the future plant operation.

a) For the local coal with less alkali content, the SSC/AC blend ratio can be 60/40. Coal blend ratio must be carefully controlled by monitoring the alkali content in the coal ash. For monitoring of this alkali content, the atomic absorption spectro photometer donated by JICA must be effectively utilized and constant co-operation and exchange of information are indispensable between NAPOCOR and SCC.

In case that high alkali content coal is delivered, increase in the blend ratio of the imported coal or reduction in plant output are the countermeasures to be adopted.

For example, the following countermeasures are recommendable.

Table 2-3 Countermeasures against Alkali Content in Coal Ash

Alkali content in coal ash	Countermeasure by coal blend ratio (SSC ratio)	Countermeasure by output reduction
Less than 6%	60% (at 100% output)	100% (SSC 60% blended)
6 to 7 %	50% (at 100% output)	90% (SSC 60% blended)
More than 7%	40% (at 100% output)	75% (Exclusive SSC firing possible)

b) Since the combustion test at this time had to be conducted under such severe conditions as the high moisture content of the local coal and 3 upper mills operation because of the trouble of the lowest mill, another test is recommendable to try the increase of the local coal blend ratio using 3 lower mills in the dry season when the moisture content of coal is low.

c) Even with low alkali coal, there is a possibility of ash clogging in the boiler, if a high local coal ratio is adopted in blending, depending on the boiler operation method, and careful attention is needed for the prevention of the trouble.

It was observed that the plant had been operated with lower air flow and wider opening of lower air port damper than normal and this is suspected to be the cause of the unburnt carbon in ash and ash clogging.

Due to the trouble of the coal handling system, mixed firing, i.e., different kind coal firing by different mills, is inevitably adopted at times, but as this firing method must be avoided as far as possible for good combustion, proper maintenance of the coal handling system is quite significant.

d) Furnace monitoring must be properly made for quickly detection of abnormal conditions, if any, and regular operation of soot-blowers at right intervals is important for prevention of troubles.

e) For the plant operation with high blend ratio of local coal, strict coal management and combustion control are needed, and there-

fore, measuring instruments and systems for the said management and control must be properly arranged to facilitate stable plant operation.

For example, volume of combustion air, moisture content of fuel coal, etc., must be precisely monitored.

(3) Improvement of the Facilities for Blend Ratio Increase of Local Coal

It is impossible to exclusively fire ROM coal or SSC with the existing plant facilities at the rated output. If it is required, replacement of the boiler will be the only solution, which seems to be impractical. Partial modification of the boiler can only be applied within limited extent due to many restrictions, and substantial increase in local coal ratio of blending can not be expected.

The plan that can be recommended is to retain the existing boiler and increase the blend ratio of local coal as much as possible by the method of operation of the plant.

This plan requires strict monitoring and control of coal quality and operational data of the plant, and the following modifications of the facilities are recommended.

a. Modification of coal silos and coal feeders

As the higher local coal blend ratio will entail higher possibility of clogging in coal silos, proper modification of these systems is recommendable.

b. Addition of sootblowers and observation holes of the boiler

To cope with the worst ash problems, sootblowers and observation holes/monitoring TV will be added to the existing boiler. Needless to say, even with these additional provisions, strict and continuous monitoring of boiler furnace conditions is necessary.

c. Modification of automatic boiler control (ABC) system

The existing ABC system is not functioning satisfactorily, and needs improvement and readjustment for the stable operation of the plant.

d. Installation of coal blending facility

The blending of coal is now being done by two reclaimers by manual adjustment, and the blending ratio is monitored by the coal flow meters installed in the operator's cabin.

Since the blend ratio by the above means fluctuates widely, a coal blending facility is recommended for more accurate blending.

e. Full provision and arrangement of various monitoring, management and measurement system for combustion.

To facilitate the combustion control, arrangement and calibration of O_2 meter and other monitoring instruments, and readjustment of combustion control systems such as air register of burners, classifier vane of coal mills, etc. are needed.

f. Automation of as-fired coal sampler

In order to assure the proper coal management, the as-fired coal sampler will be automated to monitor the coal quality precisely.

In the process of the study of the improvement plan, some other plans like additional installation of air preheater (AH) element, installation of coal dryer, use of coal additives, etc. have also been considered, but they are not recommended in the improvement plan for the moment, because the quality of Semirara coal for future supply could not yet be identified and technical justification is not established. Restudy on these items are recommended to be resumed when the quality of Semirara coal to be supplied in the future is clarified.

(4) Improvement of Other Facilities

Since ROM coal is scheduled to be fired at Calaca Unit No. 2, that is now under planning, the existing coal handling system will have to handle ROM coal. Semirara coal has dusty tendency and often raises environmental pollution.

Improvement works of the existing facilities will have to be implemented with the future plan of the power station taken into consideration as follows.

a. Countermeasures against ROM coal on unloader hopper and chutes of the coal handling system

b. Dust prevention countermeasures such as the sprinkler system, wind break fence, vacuum cleaner, etc.

c. Additional installation of magnetic separator and dewatering system of conveyors

(5) Improvement Work Schedule

Improvement work schedule is as shown in Fig. 2-1.

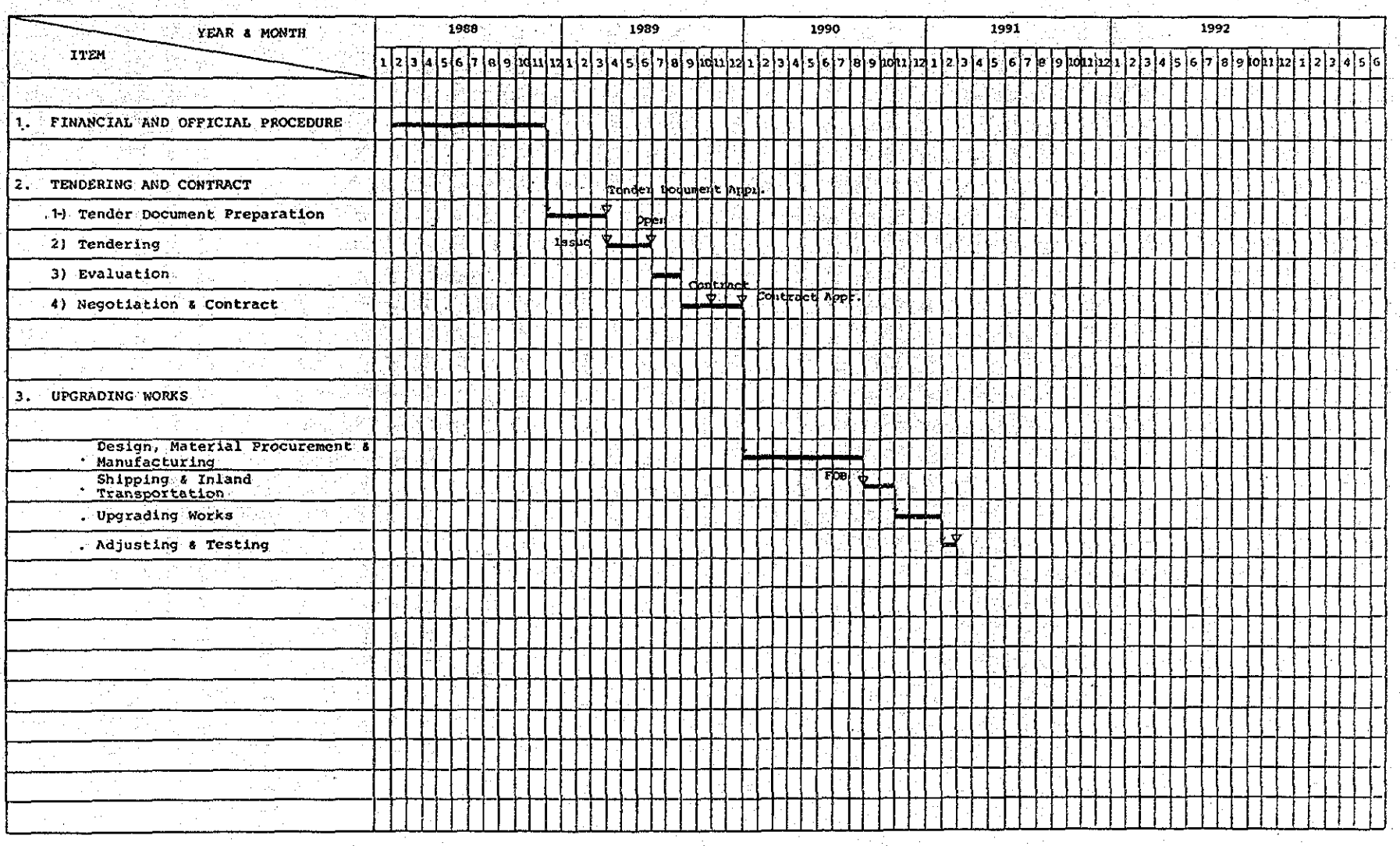


Fig. 2-1 Improvement Work Schedule of Calaca Coal-Fired Thermal Power Plant Unit No. 1

2-1-5 Economic and Financial Evaluation

(1) Method of Evaluation

The Calaca No. 1 Upgrading Plan is aimed at maximum utilization of the local coal by reducing the consumption of the imported coal. In view of the economy of this project from the stand point of the Republic of the Philippines (Economic Evaluation), the implementation of the project will bring about an economic merit of saving of the important foreign exchange to be spent for the purchase of coal from abroad.

On the other hand, if NAPOCOR, operating the sale of electricity generated by Calaca Power Plant, looks at this upgrading plan (Financial Evaluation), the implementation of the plan will increase the generating cost since the plan is intended to increase the consumption of the domestic coal, the unit cost per calorific value of which is higher than the imported coal.

In view of the above aspects, first the economic internal rate of return (EIRR) of each case of the upgrading plan was calculated with the 'Benefit" of foreign exchange saving derived from the increase in the blend ratio and plant reliability and performance improvement of local coal as a preliminary economic evaluation. With reference to the results, the technically feasible and practical upgrading plans were put together as the upgrading project.

With respect to the upgrading project, the economic and financial feasibility were evaluated by the internal rate of return method. However, because the upgrading project will give an adverse effect to the financial feasibility, the financial feasibility was tested if the investment and rise of generating cost by the upgrading project could be absorbed in the cash flow of the original project. Further, financial effects of With and Without the upgrading project were compared.

(2) Assumptions

The power plant was being operated with a blending ratio of 50:50 (weight) when this upgrading plan was formulated. The blending ratio was considered as the base. And other plant operating condition and fuels were assumed as follows:

a. Calaca power plant

Output:	300 MW
Capacity factor:	70 %
Efficiency:	35.4%

b. Fuel

	Calorific Value (kcal/kg)	Unit Cost (₱/t)
Australian coal	6,090	648 (C&F)
Semirara coal (SSC)	4,390	750
Oil	10,000	2,642 (20 $/bbl)

c. Economic life and depreciation

The economic life of the plant is 25 years from October 1984 to 2009. And the depreciation was made by the sum-of-the-year digit method without residual value. The original project was constructed with a 1985 price of ₱2 billion. But that is not realistic at the current price. The revalued price of the power plant was estimated at about ₱6 billion by the 1986 depreciation cost of ₱430 million.

d. Finance procurement and repayment schedule

The original project was constructed with several loans but mainly by the loan from the Export Import Bank of Japan (EXIM Bank). Thus, for the re-evaluation of the original project, the terms and conditions of the EXIM Bank was applied. Although the interest rate of the EXIM Bank is relatively high as compared to those in these days, the same terms and conditions were used for the upgrading project from the conservative point of view.

e. Exchange Rate

US$1 = ₱21 = ¥140

(2) Economic Evaluation of Upgrading Project

a. Cost

As a result of preliminary economic and technical evaluations, the following items of works were selected for the upgrading project. And the cost of the upgrading works are broken down as follows.

Table 2-4 Cost Breakdown of the Upgrading Works

No.	Item	Cost (Thousand US$)
A.1	Continuation of present operation with improvement of operation and maintenance	0
B.1	Modification of silos and coal feeders	4,500
B.2	Addition of 4 sootblowers	500
B.3	Modification of ABC system	500
B.4	Installation of a new blending facility	5,143
D.1	Other improvement works	7,836
	(Improvement of instruments)	(429)
	(Automation of consumed coal sampler)	(686)
	(Improvement of coal handling equipment)	(6,721)
	Total (incl. supply, transportation and installation)	18,479
	Consultant fee	571
	Total cost	19,050
	Contingency	1,850
	Total project cost	20,900