RECOMMENDATIONS

Recommendations

Some items necessary for the smooth and swift completion of the project has been summarized in the form of recommendations.

1. The range of overseas coal for possible procurement is extremely extensive. In procurement, attention should be paid to economy, as well as reliability and security, and to diversification of procurement sources. The establishment of an organization to study procurement strategies and implement them within NAPOCOR is desirable for a systematic procurement of imported coal.

2. The preliminary design of the power plant facilities has been prepared on the assumption of split use of indigenous and imported coal. Australia's Lemington coal (6,524 kcal/kg) has been employed for the design. Sources of procurement are extensive in variety, and policy of the procuring party can be reflected strongly in the contract. When procuring overseas coal in the future, it is desirable that coal of quality comparable to or better than Lemington coal be studied based on the standards of coal quality evaluation.

3. Taking into consideration the energy policy of the Philippine Government, the plant has been designed to use indigenous and overseas coal on a split basis. However, the result of the study has revealed that the potential supply capacity of indigenous coal, at the starting time of this project, might be less than 50% of the demand. Therefore, from an economic view point, one boiler should be designed to burn imported coal only, and the other boiler for mixed burning of indigenous and overseas coal.

4. The construction schedule is 43-months from contract award to taking over of the first unit. It is a standard schedule based on similar projects. It is important that all possible measures be taken to start operation as early as possible. Hence, efforts for smooth contract award procedure are necessary. For this purpose the following actions should be taken:

   (1) NAPOCOR must start negotiations for financing as quickly as possible following receipt of this report.

(2) The tender documents should be prepared by NAPOCOR. The reason is that NAPOCOR has experience with Calaca in preparing standard tender documents for coal-fired thermal power plant. It is believed that necessary information for the preparation of the tender documents can be obtained from the report and past exchanges of views. Hence, NAPOCOR must start preparation of tender specifications after receipt of this report.

The period until the contract is awarded should be reduced to the shortest possible period.

5. There are many problems that require understanding and cooperation of the local community, such as acquisition of land, construction of large-scale port, adjustment with existing navigation routes, and acquisition of ash disposal area. For this reason, discussion with the local community on the project should be started immediately.

6. It is important to precisely grasp the natural conditions at the planned site in order to smoothly carry out the detailed design and construction of the project. It is necessary to carry out observation of wind, sea water temperature, runoff of the Masinloc river, etc. as well as topographic survey of sea-bottom and topography, and additional geological survey will be required systematically around the planned site.

CHAPTER 1

INTRODUCTION

Chapter 1 Introduction

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CHAPTER 1 INTRODUCTION

1.1 General

(1) National Power Corporation (NAPOCOR) requested the Japanese Government in 1988 to have a feasibility study performed for a coal-fired thermal power project of 2 x 300 MW for the purpose of promoting the electric power development plan in Luzon Island. Japan International Cooperation Agency (JICA) concluded an Implementing Arrangement with NAPOCOR to perform this request of NAPOCOR, and started the local work from March, 1989. The first stage of this study is site selection from among the three (3) predetermined sites. The second stage consisted of estimation of the construction cost and construction schedule including preliminary design of the plant facilities as well as performing economic evaluation and financial analysis.

(2) This study is divided into the local work in the Philippines and the work analysis performed in Japan. The local work is undertaken mainly with the cooperation of persons concerned in NAPOCOR.

1.2 Scope of Study

The main objectives of the Study are to formulate an optimum plan for "Coal-Fired Thermal Electric Power Development Project in Luzon Island" and to assess its technical, economic and financial feasibility.

(1) Pre-selected Sites for Study

(Site-A) Masinloc, Zambales
(Site-B) San Juan, Batangas
(Site-C) Limay, Bataan

(2) First Stage

The Study is carried out in two (2) stages and the detailed scope of work at the respective stages is itemized as follows:

i) Collection and review of existing data and information related to the study.

ii) Fuel selection.

iii) Power survey

- Review and analysis of existing and planned power supply and transmission facilities in Luzon Island.

- Review and analysis of information on power consumption growth and characteristics of power consumption pattern in Luzon Island.

- Review and analysis of electric power demand and peak demand from year 1989 to year 2000.

iv) Site selection study

Site selection study carried out for the aforementioned three (3) candidate project sites. After the study the most suitable project site is recommended.

(3) Second Stage

In accordance with the results of the first stage, following studies and investigations shall be carried out for the selected project site.

i). Detailed site survey of the selected project site to investigate the following items:

- Topographic survey
- Marine topographic survey
- Geological survey including drilling
- Geophysical investigation, if necessary

ii) Formulation of optimum plan

iii) Preliminary design

iv) Cost estimation

v) Construction schedule

vi) Environmental assessment

vii) Compensation

viii) Economic analysis

ix) Financial analysis

1.3 Overall Social Conditions of the Philippines

(1) Territory

The Philippines is situated in the southern part of the Eurasia plate and is an archipelagic country consisting of 7,107 islands. The total land area of the country is approximately 300,000 km^2, and its location is from 4 degree to 21.5 degree north latitude and from 116 degree to 127 degree east longitude. The topography of the Philippine Islands is extremely complex and the geographical feature of the Luzon island is one of alluvial plain with narrow valleys and gently rolling hills and high mountains.

(2) Weather Conditions

The climate of the Philippines is tropical with rainfall frequently exceeding a monthly average of 500 mm during the northeasterly seasonal wind season and the trade wind season on the eastern shores of Luzon, and the maximum precipitation is during the east west seasonal wind season for the major part of western Luzon. The maximum average temperature during the day is between 29°C to 33°C while the minimum temperature during the day is between 18°C to 24°C.

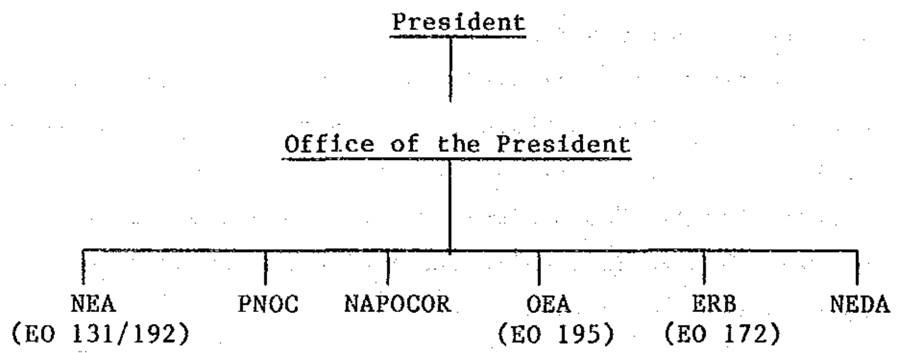
Month	1	2	3	4	5	6	7	8	9	10	11	12
Average Temperature (°C)	25.3	26.0	27.4	28.9	29.4	28.4	27.7	27.3	27.5	27.2	26.5	25.7
Precipitation (mm)	14.3	5.0	6.6	14.8	122	250	344	434	317	191	127	60.2

1.4 Related Organizations

1.4.1 Government and Related Agencies

In 1987, the Aquino government abolished the Department of Energy and reorganized the energy related organization. The controlling function of this department was transferred to the Energy Regulatory Board (ERB). This was based on Executive Order No. 172. ERB undertakes formulating and coordinating policies and plans related to energy. The government organization chart responsible for energy is shown in Fig. 1.4-1.

Fig. 1.4-1 Government Organizations Responsible for Energy



Note: NEA : National Electrification Administration
NEDA: National Economic and Development Authority
NEDA coordinates energy policies and energy-related projects from the point of view of the Philippines economy as a whole.
PNOC: Philippine National Oil Company
OEA : Office of Energy Affairs

1.4.2 Electricity Enterprises in the Philippines

The electricity enterprises in the Philippines consist of the National Power Corporation (NAPOCOR), a governmental organization, which performs development of power sources including transmission line, and the main private enterprise that supplies electricity in and around Metro Manila is the Manila Electric Company (MERALCO). The remote area where the power transmission system of NAPOCOR cannot serve, electric power is supplied by public and private power generating plants which total 800.

(1) National Power Corporation (NAPOCOR)

The National Power Corporation was established in 1936 with the government contributing the total amount of capital for the purpose of generating hydro-electricity and electric power undertakings with other natural resources. This was based on Commonwealth Act No. 120 of 1935. The role of NAPOCOR was substantially enlarged by virtue of the NAPOCOR Charter and Presidential Decree 40 of 1972. At present NAPOCOR is engaged in performing surveys and development of all resources for electric power sources as well as maintaining a power transmission network throughout the country to supply electric power, it generates and wholesales to the electric cooperative associations throughout the country and to Manila Electric Company in accordance with the socio economic development policies of the country.

All deliberations and decisions related to the business policies of NAPOCOR are performed by the National Power Board. Each member of the board is nominated by the President. The organization chart of NAPOCOR is shown in Figure 1.4-2.

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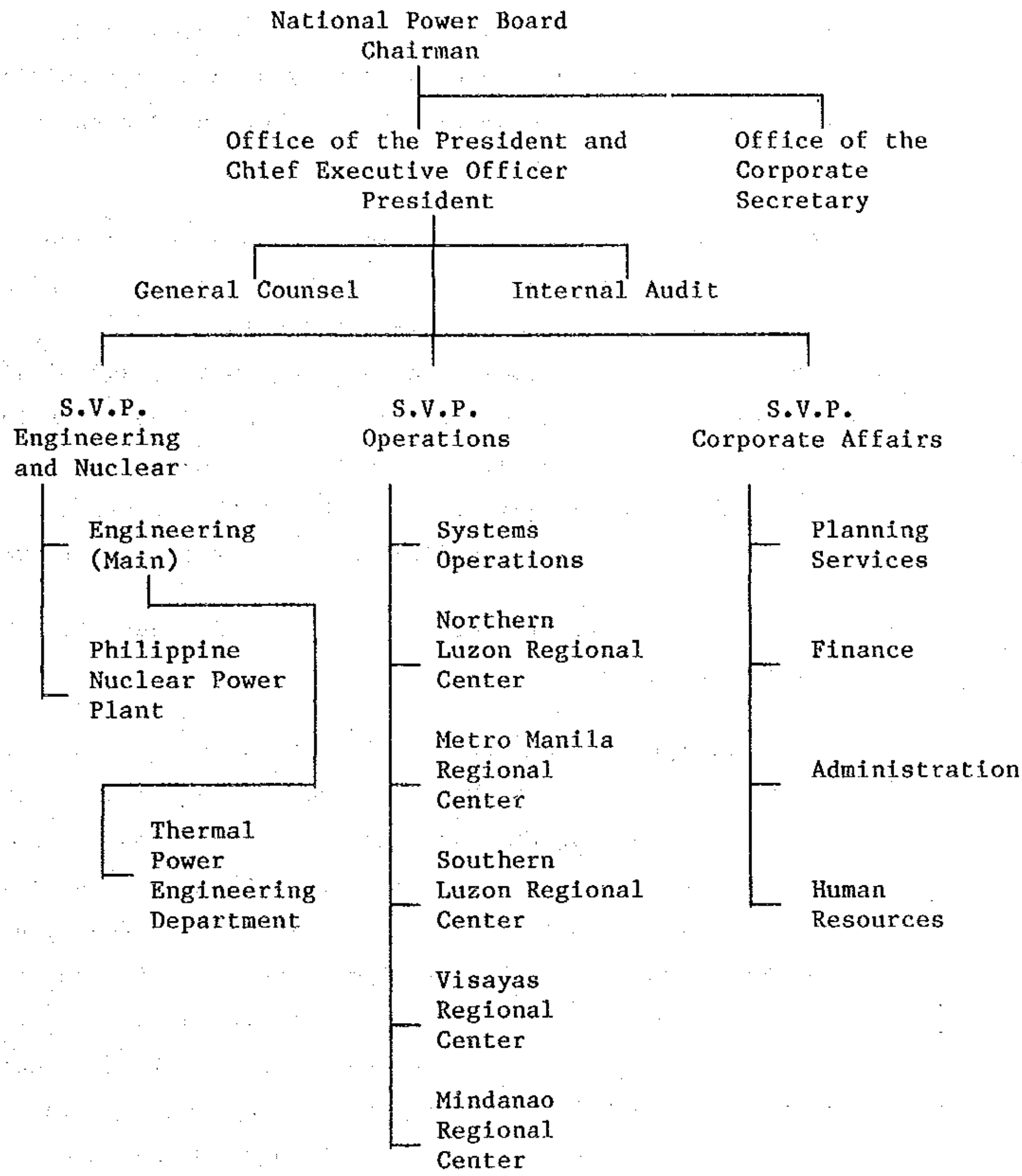
All deliberations and decisions related to the business policies of NAPOCOR are performed by the National Power Board. Each member of the board is nominated by the President. The organization chart of NAPOCOR is shown in Figure 1.4-2.

Fig. 1.4-2 Organization of NAPOCOR



The facilities in the possession of NAPOCOR are 5,782 MW and the number of employees is 11,294 as of the end of 1988.

(2) Manila Electric Company (MERALCO)

Manila Electric Company was established by the amalgamation of 3 companies, in 1919, namely: Manila Electric Railroad & Lighting Co., Manila Suburban Railway Co. and La Electricista.

Later, the bus division was separated and in the meantime the electric division steadily enlarged as a result of the increasing demand for power. The entire shares of Manila Electric Company had been possessed by an American holding company, General Public Utilities Corp., but in 1962 the shares were bought by MERALCO Securities Corp.

MERALCO currently distributes electric power to an area totalling 8,813 km^2 (approximately 3% of the total land area) covering Manila and the outskirt of Manila. Electric power is purchased from NAPOCOR on a wholesale basis, and of significance interest is that of the total electric energy wholesaled by NAPOCOR which amounted to 17,645 MWh, MERALCO has purchased 10,160 MWh which is equivalent to 58% of the electric energy wholesaled by NAPOCOR according to actual records for 1986.

(3) National Electrification Administration and Electrification Cooperative Associations

In the Philippines, electrification of the rural community has been taken up as one of the most important policies of the government from some time ago, and for this purpose the National Electrification Administration (NEA) was established in 1969 as its promotional organ. NEA procures funds, prepares tender documents, purchases equipment and material and sells the constructed power distribution facilities to electric cooperative associations. Therefore, NEA itself does not possess any electric power facilities, but NEA organizes electric cooperative associations throughout the country and promotes electrification of the urban districts through such associations.

There were electric cooperative associations established in 118 places in 73 provinces and 2 sub-provinces throughout the entire country by 1984. The electric cooperative associations purchase on a wholesale basis electric power supplied from NAPOCOR and sells it to urban users within their respective regions through their distribution facilities.

1.4.3 Persons Related to the Study

For this project feasibility study, cooperation has been obtained from various sources including NAPOCOR, and listed below are the names and the respective position of those who have cooperated in this endeavor.

(NATIONAL POWER CORPORATION)

Mr. Ernest M. ABOITIZ	President and Chief Executive Officer
Mr. Francisco T. DELGADO	Senior Vice President/ Engineering and Nuclear
Mr. Marciano C. AVENDAÑO	Vice President/Engineering (Main)

<u>Thermal Power Engineering Dept.</u>

Mr. Gilberto A. PASTORAL	Manager/Thermal Power Eng'g Dept.
Mr. Dennis P. PEDRON	Manager/Thermal Projects Development Div.
Mr. Bienvenido A. BABILONIA	Principal Engineer A
Mr. Conrado B. MARAMAG	Principal Engineer A

<u>Environmental Management Dept.</u>

Dr. Gonzalo A. BANTUGAN	Vice President Corporate Specialist/EMD
Mr. Nestor E. TAMONDONG	Manager/Environmental Impact & Assessment Div.
Mrs. Humbelina M. CASTRO	Chief/Physico-Chemical Environ. Section

<u>Engineering Resources Service Dept.</u>

Mr. Ronaldo A. ALMERO	Manager/Eng'g Resource Sves. Dept.
Mr. Zosimo P. SANTOS Jr.	Manager/Eng'g Survey & Invest. Div.
Mr. Romeo M. PULANCO	Manager/Geology & Geotechnics Div.
Mr. Adelo I. DERILLO	Chief/Geophysics Section
Mr. Fernando Y. ROXAS	Chief/Eng'g Geology Section
Mr. Petronilo E. PANA	Chief/Geotechnical Section

Mr. Artemio A. LAGARAMA	Principal Engr. B. Eng'g Survey Section

Settlement & Land Management Dept.

Mr. Arturo V. GRIMAREZ	Manager/Settlement Services Div.

(Semirara Coal Corporation)

Mr. Clarence A. FAJARDO	Manager/Marketing & Administration

(JICA Study Team)

Hiroshi ISAKA	Team Leader
Shigeo MATSUZAKI	Project Plan
Hiroshi NAMBA	Mechanical Facility
Masahiro UEDA	Coal Handling Facility
Masashi HATANO	Electrical Facility
Yasuo ONDA	System Analysis
Haruo KUBO	Civil Design
Kuniaki YOSHIOKA	Port Plan
Takao CHAISHI	Geology
Akira MAMIYA	Environment
Hozumi AWATA	Economy
Hidenori FUJISHIMA	Architecture

CHAPTER 2

BACKGROUND OF THE PROJECT

Chapter 2 Background of the Project

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CHAPTER 2 BACKGROUND OF THE PROJECT

2.1 General

(1) The economic environment of the Philippines has been rapidly recovering since 1987 and the growth of gross domestic product has reached 6.6% in 1988. The power demand of the Luzon grid has also been rapidly growing since 1987 and has miraculously expanded to 9.2% in 1988. On the other hand, the installed capacity of the Luzon grid is 4,100 MW as of 1988, but the dependable capacity is only about 3,200 MW. Therefore, even if the projects as formulated by NAPOCOR in the Power Development Program (June, 1988) were to be completed as scheduled, electric power shortage of approximately 125 MW is expected in 1995. It would therefore be necessary to urgently plan for an expansion of the power source.

(2) In 1986, the Philippine government decided to mothball the nuclear power plant. This decision has accelerated the electric power shortage condition and NAPOCOR had implemented an emergency measure of employing gas turbines to cope with this predicament. On the other hand, in order to undertake a full scale development of electric power source in accordance with the energy policy, coal-fired power project development was planned in the outskirt of Manila in 1987 and a preliminary study was conducted on several possible sites. As a result, a request was made to the Japanese government to select an optimum site from the three (3) proposed sites located in Masinloc Zambales, San Juan Batangas and Limay Bataan, and similarly to conduct a feasibility study of the development including preliminary design.

(3) The energy policy of the Philippines is directed towards the

i) Promotion of energy diversification.

ii) Development of domestic energy resources.

This policy aims to reduce the dependency on oil. Upon the receipt of such policy target, the development plan for the coal-fired thermal power project was aggressively examined in the electric power development plan. It is planned to develop 3,000 MW by coal-fired power project up to the year 2000 in the Luzon grid.

(4) It is generally said that the economic effects that the electric power development creates extends to up approximately 2.5 times through its interaction with other industries such as electric machinery, basic metals, mining on construction. In this project, the policy is to use indigenous coal, and the impact that this would have on the coal industry is expected to be enormous. At the same time it is intended to use overseas coal to supplement the shortage of indigenous coal. This is expected to stimulate the development of the domestic coal industry.

Also, the huge size of the vessels to be used in the ocean transportation of the overseas coal will also have an influential effect on the local economics. Hence, adjacent to Masinloc where this project is proposed to be located the Coto chromite mine is presently operating and is contributing to the promotion of local industries. Selecting this site for the power plant will require maintaining infrastructure including habor facilities, especially for Masinloc. This is expected to contribute to the stabilization of the social foundation of the community.

2.2 Particulars of the Study

2.2.1 Improvement of the Economic Environment

The economic situation in the Philippines has remarkably improved during these past 2 to 3 years. The Philippine economy has freed itself from the previous slow growth rate and the real economic growth since 1987 can be said to be miraculous. The actual GNP growth since 1983 is shown in Table 2.2-1. The electricity demand that supports these vigorous economic activities has also shown a remarkable growth of about 9% as it can be noted in Table 2.2-2.

Table 2.2-1 Changes in Actual GNP Growth Rate

Year	1983	1984	1985	1986	1987	1988
GNP Growth (%)	1.1	-7.1	-4.3	1.5	5.7	6.7

Table 2.2-2 Changes in Electricity Demand

(Unit: 10^6 kWh)

	1983	1984	1985	1986	1987	1988
Entire Philippines	18,682 (7.3)	18,666 (0)	18,757 (0.5)	19,263 (2.7)	20,995 (9.0)	22,944 (9.3)
Luzon Grid	15,294 (6.2)	14,655 (-4.2)	14,449 (-1.4)	14,756 (2.1)	16,030 (8.6)	17,439 (8.8)
Visayas Grid	1,057 (36)	1,177 (11.4)	1,343 (14.1)	1,467 (9.2)	1,693 (15.4)	1,876 (10.8)
Mindanao Grid	2,331 (4.2)	2,834 (21.6)	2,965 (4.6)	3,040 (2.5)	3,272 (7.6)	3,629 (10.9)

Figures in parentheses are the rates of growth in comparison to the previous year in percentage

Table 2.2-3 Changes in Peak Demand

(Unit: MW)

	1983	1984	1985	1986	1987	1988
Luzon	2,478 (4.8)	2,374 (-4.2)	2,311 (-2.7)	2,435 (5.4)	2,592 (6.4)	2,780 (7.3)
Visayas	229 (41.4)	242 (5.7)	256 (5.8)	284 (10.9)	307 (8.1)	333 (8.5)
Mindanao	410 (5.9)	433 (5.6)	470 (8.5)	484 (3.0)	533 (10.1)	571 (7.1)

2.2.2 Urgency for Expansion of Electric Power Source

The total installed capacity in the Philippines is approximately 5,800 MW as it can be seen in Tables 2.2-4 and 2.2-5, but the Luzon grid accounts for 4,100 MW which is equivalent to 70% of the total electric power generating capacity.

Of these facilities, 30% is contributed by hydro-electric power plants which cannot avoid output reduction during the dry season. Also, oil-fired power plants that are more than 15 years old amount to 1,025 MW. The loss of electric power system exceeds 10% and measures for the prevention of such loss is a major issue.

Taking these circumstances into consideration, it is reasonable to consider that the dependable capacity of the grid is approximately 3,200 MW. If the annual demand for electricity were to continue to grow in the range of 8%, the electricity demand of the Luzon grid will reach approximately 25,000 GWh and the maximum electric power will come up to approximately 4,000 MW by 1993, and therefore, electric power development of approximately 1,600 MW will be required when the reserve rate, etc. are taken into consideration. Under these circumstances, the preliminary study of the new coal-fired power project for the Luzon grid was conducted in 1987 by NAPOCOR for the purpose of urgently repleting the power source. In 1988 NAPOCOR requested a full scale feasibility study to be conducted by the Japanese Government based on the results of the preliminary study.

Table 2.2-4 Installed Capacity

(Unit: MW)

	Oil-based	Hydro	Geothermal	Coal	Total
Entire Philippines	2,359.6	2,123.8	894.8	405.0	5,782.4
Luzon Grid	1,925.0	1,226.2	660.0	300.0	4,111.2
Visayas Grid	254.0	2.0	234.0	105.0	595.0
Mindanao Grid	180.6	895.6	-	-	1,076.2

(As of June, 1988)

Table 2.2-5 Existing Generating Plants in Luzon Grid

(As of June 1988)

Plant Name	Type	Unit No.	Unit Capacity (MW)	Comm. Year	Year of Retire-ment	Location
1. BOTOCAN	Hydro	1	8.00	1946	1988	Majayiay,
		2	8.00	1948	1988	Laguna
		3	0.96	1945	1995	
2. CALIRAYA	Hydro	1	8.00	10/45	1992	Lumban,
		2	8.00	11/45	1992	Laguna
		3	8.00	10/47	1997	
		4	8.00	2/57	2000	
3. AMBUKLAO	Hydro	1	25.00	12/56	2006	Bokod, Benguet
		2	25.00	12/56	2006	
		3	25.00	9/57	2007	
4. Buhi-Barit	Hydro	1	1.80	9/57	2007	Buhi, Camarines Sur
5. CAWAYAN	Hydro	1	0.40	10/59	2009	Sorsogon, Sorsogon
6. BINGA	Hydro	1	25.00	1/60	2010	Itogon,
		2	25.00	1/60	2010	Benguet
		3	25.00	3/60	2010	
		4	25.00	3/60	2010	
7. ANGAT, MAIN	Hydro	1	50.00	10/67	2017	Norzagaray,
		2	50.00	10/67	2017	Bulacan
		3	50.00	8/68	2018	
		4	50.00	8/68	2018	
8. ANGAT, AUX	Hydro	1	6.00	7/67	2017	Norzagaray,
		2	6.00	7/67	2017	Bulacan
		3	6.00	10/78	2018	
		4	10.00	6/68	2018	
9. PANTABANGAN	Hydro	1	50.00	4/77	2027	Pantabangan,
		2	50.00	5/77	2027	Nueva Ecija
10. MASIWAY	Hydro	1	12.00	12/80	2030	Pantabangan, Nueva Ecija
11. KALAYAAN	Hydro	1	150.00	5/82	2032	Kalayaan,
		2	150.00	8/82	2032	Laguna
12. MAGAT	Hydro	1	90.00	8/83	2033	Raman, Isabela
		2	90.00	9/83	2033	
		3	90.00	11/83	2032	
		4	90.00	8/84	2034	

(As of June 1988)

Plant Name	Type	Unit No.	Unit Capacity (MW)	Comm. Year	Year of Retire-ment	Location
13. TIWI	Geo	1	55.00	1/79	2009	Tiwi, Albay
		2	55.00	5/79	2009	
		3	55.00	1/80	2010	
		4	55.00	4/80	2010	
		5	55.00	12/81	2011	
		6	55.00	3/82	2012	
14. MAK-BAN	Geo	1	55.00	4/79	2009	Bay, Laguna
		2	55.00	7/79	2009	
		3	55.00	4/80	2010	
		4	55.00	6/80	2010	
15. MAK-BAN	Geo	5	55.00	7/84	2014	Bay, Laguna
		6	55.00	9/84	2014	
16. CALACA	Coal	1	300.00	1984	2014	Batangas
17. MANILA	Oil	1	100.00	9/65	1995	Isla de Provisor Metro Manila
		2	100.00	10/65	1995	
18. SUCAT 1 & 2 (GARDNER)	Oil	1	150.00	10/68	1998	Sucat, Muntinlupa, Metro Manila
		2	200.00	1/70	2000	
19. SUCAT 3 & 4 (SNYDER)	Oil	3	200.00	7/71	2001	Sucat, Muntinlupa, Metro Manila
		4	200.00	9/72	2002	
20. BATAAN	Oil	1	75.00	9/72	2002	Limay, Bataan
		2	150.00	2/77	2007	
21. MALAYA	Oil	1	300.00	9/75	2005	Pililla, Rizal
		2	350.00	3/79	2009	

2.3 Current Economic Situation and Economic Development Plan

2.3.1 Current Economic Situation

(1) The Philippine economy recorded minus growth for years 1984 and 1985 when the GNP growth rates were -7.1% and -4.2% respectively for these years, but for the years 1986, 1987 and 1988, domestic demand such as private consumption expenditures and private investment in plants and equipment have increased supported by stabilization of inflation and in interest rates, and the GNP growth rates during these three years acceleratingly recovered to 1.5%, 5.7% and 6.7%, respectively.

(2) The characteristics of the economic structure in the Philippines lie in the primary industries with agriculture, forestry and fishery still occupying 30% of the gross domestic product and industrial and service industries being a little over 30%. In respect to trade structure, the main products of export are agricultural products such as copra, sugar, banana, wood, coconuts, etc. and other primary products. Although the currency exchange rate has been consistently depreciating there has been almost no increase in its export.

(3) Import of finished goods from the U.S.A. is the major bulk of imports into the Philippines and payment of imported oil still remains a heavy burden on the Philippine economy. Resolving the cumulative deficit in the balance of trade payment is a vital matter for the growth of its economy.

Foreign debt balance/GNP has reached the stage of occupying 95% and remains even recently at a rate of over 80%. The total debt service relative to export of goods and services (TDS/XGS) was at a high 35.4% for 1987 and 33.7% for 1988, and the situation remains severe.

(4) Recently, the Philippine economy has been rapidly recovering and in a state of being able to continue the high growth rate, but is suffering from the accumulated foreign debts and shortage of foreign exchange which is a pre-requisite for economic growth. The severity facing Philippine economy is more than its outward appearance.

Table 2.3-1 Current Situation of the Philippine Economy

	1985	1986	1987	1988
Actual GNP Growth Rate (%)	-4.3	1.5	5.7	6.7
Increase Rate in Consumer Prices (%)	23.1	0.8	3.8	8.8
Ordinary Expenditure Balance/GNP (%)	-0.3	3.3	-1.6	-1.1
Export/GNP (%)	25.4	24.7	26.8	29.4
Foreign Currency Reserve including Gold (100 Million Dollars)	10.9	26.1	23.1	
Balance of Foreign Debts/GNP (%)	81.9	95.0	86.5	

Table 2.3-2 Structure by GDP Industries

(Real: 1972 prices, Unit: Million Peso, %)

	1984	1985	1986		
	Amount	Amount	Amount	Distribution Ratio	Rate of Growth
Agriculture, Forestry and Fishing Industries	25,409	25,409	27,233	30.0	3.7
Mining and Manufacturing	32,282	29,000	28,204	31.1	2.7
Mining	1,755	1,768	1,558	1.7	11.9
Manufacturing	23,319	21,541	21,717	23.9	0.8
Construction	5,866	4,258	3,382	3.7	20.6
Electricity, Gas and Water	1,342	1,433	1,547	1.7	8.0
Service Industry	36,236	34,551	35,333	38.9	2.3
Transportation, Communication and Warehousing	5,032	4,953	5,084	5.6	2.6
Commerce	14,073	14,066	14,337	15.8	1.9
Bank and Others	17,131	15,532	15,912	17.5	2.4
GDP	93,927	89,803	90,770	100.0	1.1

Source: NEDA, "Philippine Statistical Yearbook" 1987

2.3.2 Outline of the Economic Development Plan

The Philippines is in a precarious situation of becoming short of foreign currency if this present condition were to persist due to foreign debts which have reached approximately 30,000 million dollars. Under these circumstances the medium term economic plan (from 1989 to 1992) of the Philippine government has been drawn up in March, 1989 after deliberation with IMF. Under the new medium term economic plan, the Philippine government aims to attain a continuous annual economic growth rate of 6.5% for this year which is a high rate of growth through aggressive fiscal policy and by promoting private enterprises as well as by effectively combining it with the strengthened tax collection efforts.

Summary of the medium term economic plan (1989 - 1992) of the government.

(1) Aim of development: Correct poverty, create jobs and realize social fairness

(2) Basic duty: To attain continuous growth

(3) Major targets of the economic development of the society

i) To attain an actual GNP average growth rate of 6.5%

ii) To increase the investment ratio of GNP from 18% in 1988 to 24.5% in 1992

iii) In particular, to increase the government investment amount from 3% in 1988 to more than 5.5% from 1991 to 1992 in GNP ratio

iv) However, there will be a shortage of funds totalling US$3,000 million during the period 1989 to 1992. In order to cope with this shortage, new loans will be sought from foreign private banks, and a request for re-extension of debt repayment will be made to the Paris Club (official bond conference)

v) Under the new taxation system which has the value added tax (VAT) as the backbone and which was introduced in

1988, efforts will be made to strengthen tax collection, and at the same time rationalization of government departments will be strengthened. As a result of these efforts, the government current account balance of 13.9% in 1988 will be reduced to 12% in 1992

Table 2.3-3 Main Target of the Medium Term Economic Plan in the Philippines (1989 to 1992)

(Unit: %)

	1987	1988	1989	1990	1991	1992
GNP (Growth rate)	5.7	6.7	6.5	6.5	6.5	6.5
Consumer Price (Growth rate)	3.8	3.8	8.0	6 - 7	5 - 6	5 - 6
Public Investment/GNP	3.6	3.4	4.2	4.7	5.6	5.8
Debt Service Ratio*	35.4	33.7	33.8	32.2	31.0	29.4

* Debt Service Ratio (TDS/XGS): Total debt service relative to export of goods and services

2.4 Energy Policy

2.4.1 Basic Target

During the first oil crisis of 1973, the primary energy supply volume of the Philippines was 92% dependent upon imported oil, and the amount of imported oil to the total import amount was 13%. From that time up to the first half of the 1980's the price of oil has been increasing and payment for imported oil continued to increase until the amount reached 25.6% of the total import in 1982.

In order for the Philippine economy to realize an economic growth in this situation of high oil prices and at the same time to reduce its foreign debts while holding the energy consumption at a high level, it is necessary to convert the source of energy from the previously imported energy to domestic energy. In order to cope with this situation, the Philippine government made an economic forecast in 1979 and formulated a policy in regards to energy development.

As a result of progressing along this plan to develop domestic energy, the ratio of domestic energy became 42% and the imported oil ratio was 56% of the total energy supply which indicated that reliance on imported oil has been favorably decreasing.

The basic targets of the government in regards to energy development are as follows:

(1) To guarantee energy supply at economical prices and to suppress hindrances in the supply of electricity

(2) To promote efficiency and to rationalize the use of energy

(3) To control the effects on the environment that accompany energy development

2.4.2 Policy and Strategy of the Power Development Plan

The contents of the policy and the strategy in regards to the power development plan of the Philippines are as follows:

(1) To complete each project within the term of the plan

(2) To perform rehabilitation on the existing oil-fired plants with the aim of increasing the power generation capacity and to promote reliability

(3) To reassess and arrange the Power Development Plan in order to promote efficiency at each stage of the energy department

  i) To increase the rate of utilization and load factor of the facilities

  ii) To reduce the plant cost and control the power generation cost

(4) To promote energy saving plan

(5) To restructure electric power consumption unit from the economic view point

(6) To promote efficiency and improve the system operation in order to reduce loss of load probabilities

(7) To allow the participation of the private sectors in the new power development under the BOT/BOO scheme and the control of public investment

(8) To assess and to implement measures for environmental control and at the same time to develop all types of energy

The Philippine government has instructed NAPOCOR to effectively utilize indigenous energy, other than imported oil, in order to meet the increasing demand for electric power.

Although the mothballing of the nuclear power plant in 1986 by the Aquino administration was based on safety reasons and a political decision, this has become a big impact on the electric power shortage when the demand for electric power was rapidly increasing. The nuclear power plant was scheduled to supply 620 MW electric power to the Luzon grid. In order to cope with this electric power shortage, NAPOCOR had to install gas turbine plants capable of generating 200 MW to 700 MW to meet the emergency situation. The gas turbine plants, however, cannot be said to be favorable from the economic stand point. It is therefore considered that an early promotion of the coal-fired thermal power plant has become indispensable as a result of this development.

The power development plan as formulated by NAPOCOR in June, 1988 is shown in Table 2.4-1.

Table 2.4-1

Power Development Program (June 1988)

Year	Luzon		Visayas		Mindanao	
	Plant Additions	Cap (MW)	Plant Additions	Cap (MW)	Plant Additions	Cap (MW)
1988					DLPCO DSL	46
1989	Gas Turbine Rehab Sucat I	500	Leyte-Samar Interconnection	—	Agus I	80
1990	Mak-Ban 7 Geo Small Luzon Geo Rehab. Sucat 4	55 40	Janopol Hydro *1 (Power Barge 2) Negros-Panay Interconnection	5 (32) —	Gas Turbine A (Power Barge 2)	150 (32)
1991	Bac-Man I Geo Gas Turbine	110 200	——	—	Gas Turbine B	50
1992	Calaca II Coal Bac-Man II Geo Luzon-Mindoro Interconnection	300 110	(Power Barge 2) Palimpinon Geo 4 Cebu-Negros-Panay Interconnection	(32) 37.5 —	Power Barge 2	32
1993	Coal III	300			Apo Geo 1 & 2	110
1994	Luzon Geo	330	Palimpinon Geo 5*2	37.5	Apo Geo 3	55
1995	Tongonan Geo A HVDC-II 350kV	440	——	—	Apo Geo 4	55
1996	Tongonan Geo B HVDC-II 350kV	440	Palimpinon Geo 6	37.5	Agus III	225
1997	Coal A	600				
1998	Coal B	600	(Power Barge 2) Bohol DSL	(5.5)	(Power Barge 2)	(32)
1999	Coal C	600			Coal A	100
2000	Coal D	600	Jalaur Hydro	24	Coal B	100

*1 : NEA project

*2 : Entry reset to 1992 due to uncertainties associated with non-NAPOCOR plants.
NOTE: Parenthesis indicate pull of Power Barge.

*3 : Bac-Man stands for Bacon-Manito.

2.5 Economic Influences of Coal-fired Thermal Power Development Project

The economic effect of the coal-fired thermal power development project is basically evaluated through economic and financial analyses of the willingness to pay of those who benefit from the additional power supplied by the project. On the other hand, the power project of such a large scale will inevitably have a strong impact on the energy and power policies; also, its secondary effects through various industries will affect the general economic growth. This section deals with indirect economic effects of the thermal power project and its significance in the energy policy, both of which are not included in the cost-benefit analysis in economic evaluation and financial analyses in Chapters 10 and 11.

2.5.1 Energy Policy and the Role of Coal-fired Thermal Power Project

The steady and sustained economic growth is a central requirement in the Philippine economic policy. A sustained economic growth will be achieved only through efficient utilization and stable supply of power. Development of petroleum-substituting power source, in particular, will reduce the need for foreign currency needed to import oil, thus enhancing the energy self-sufficiency through exploitation of the country's own energy source and diversification thereof; all these will contribute to the stable power supply.

The development of a coal-fired thermal power plant is crucial for the country to cope with expected rapid growth in power demand and to fill the power deficiency caused by the mothballing of the nuclear power project, etc.

The development of a coal-fired thermal power plant will enhance the overall capacity of power generation as well as the reliability of power supply systems; it will thus establish a long-term prospect of stable power supply.

(1) Coal-fired Thermal Power Project and Stable Power Supply

i) Coal-fired power plant is a major source of substitution for oil-fired power plant. NAPOCOR plans to develop

3,200 MW of coal-fired power plant up to the year 2000. As a result, the percentage of oil-fired power plant in the year 2000 will decrease from the current 35% or more to 16%, whereas that of coal-fired power plant will increase from 10% to 25%, thus helping substitute oil together with the geothermal power project.

ii) Electric power development in the Philippines grew at an average annual rate of higher than 7% between 1973 and 1988, with significant increases in geothermal and hydroelectric power generation. The Philippine government, however, has the diversification of power as its goal. Therefore, the development of large-scale coal-fired power plants has strategic importance as oil-substituting base-load power plant in the Philippines' long-term power policy.

iii) Luzon power grid, in particular, is the largest system of the Philippines, corresponding to 76% of the national demand; major goals of prospective growth in power demand in the metropolitan area, rural electrification, and development of the power system require a systematic strategy of developing coal-fired power plant as a large-scale base-load power source and reduction in the power cost or improvements in economic efficiency, both through pursuing scale economy in power generation and system operations.

iv) Important economic factors for steam power plants are scale merit and learning effects. In a growing stage of power demand, the scale merit is the major factor through scaling-up of plants with possible technical improvements; doubling of scale with coal-fired plant usually results to some 20% cost reduction. In addition, continuous construction of coal-fired plants and accumulation of operating experience are expected to result in cost reduction through learning effects, thus supporting prospects of long-term cost reductions by scaling up of power plants owned by NAPOCOR.

(2) Raising Self-sufficiency in Energy

Dependence of the Philippine commercial energy on petroleum was 94% to 96% before the second oil crisis (1978). In the 1980s, however, dependence on oil rapidly declined through energy-saving efforts in industries such as electric and cement industries. Reduction in foreign currency spending for importing oil will continue to be an important political requirement, thus necessitating to raise the self-sufficiency of energy by introducing large-scale coal-fired plants.

Commercial Energy Imports

(Thousand tons of oil equivalent)

	1973	1980	1983	1985	1987
Oil	9,221	9,114	8,064	6,539	8,185
Petrol Products	416	1,832	2,034	588	1,307
Coal/Coke	5	163	131	609	298
Total	9,642	11,108	10,229	7,736	9,790
Net Oil Import Dependence (%)*	95.5	85.8	76.9	63.1	74.8

* N.O.I.D = (Oil + Petrol products - Exports)/Primary Energy Requirement

The coal demand in the Philippines in 1987 was 1.85 million tons, of which 0.83 million tons (45%) was purchased by NAPOCOR.

According to our coal demand estimation, as stated in Chapter 5, the total coal demand will grow to about 13 million tons by the year 2000, NAPOCOR will share the demand with 11 million tons. Coal demand in Luzon grid will probably increase to more than 10 million tons up to the year 2000, this means 76% of total coal demand in the Philippines.

The creation of such a large coal demand through the development of a coal-fired power project is a major means of promoting self-sufficiency in energy.

2.5.2 Coal-fired Power Project and its Secondary Industrial Effects

(1) Indirect Economic Effects of a Coal-fired Power Project

The power generation has enormous industrial impact through its interaction with other industries such as electric machinery, basic metals, mining or construction. This applies also to Philippine economy. The constituent ratio of the coal-fired power plants is about 10%; production of one peso (₱1.00) of electric power creates ₱2.32 of additional production in the whole industry through its secondary effects.

The development of a large-scale coal-fired power project as a substitution for an oil-fired power project will change the country's energy scheme by replacing imported oil with its own coal. Also, construction of power plant facilities and equipments will affect the economic growth through strong impact on power schemes for domestic coal industry, machinery or construction. In particular, the multiplicative effects of capital investments for coal-fired power project will significantly affect the overall economic growth. These effects will be enhanced as the development of coal-fired power projects will promote domestic production of coal and machinery.

Through the plant construction and development of related infrastructure such as harbors, the large-scale coal-fired power project will contribute to activation of the local economy, creation of employment stabilization of people's life in neighboring areas, thus stimulating the local economy.

(2) Increased Production of Indigenous Coal and Improving Productivity

The coal-fired power project will increase the country's self-sufficiency in energy through an increase in demand for indigenous coal and is expected to have the following economic effects.

The current price of indigenous coal is some 20% higher than imported coal; it is strongly required for the industry to modernize its operations and lower the price through improvements in productivity to compete with overseas coal. The creation of enhanced demand for indigenous coal meets this purpose, since it will induce investments on infrastructure for the development of new coal mines and modernization of coal industry to achieve higher productivity; it will also enhance production and bring the scale-merit effect.

The secondary industrial effect of the coal industry is as important as that of the power industry. The multiplicative production effect is estimated at 2.14, and this means additional secondary industrial effects in the process of substitution of oil with coal for power generation.

These indirect secondary effects will help the coal industry to be competitive against imported coal. The resulting low price of indigenous coal will benefit the power industry.

2.5.3 Coal-fired Power Project and Import-substitution Project

A major long-term challenge for the Philippine economy is to modernize itself from the present consumer-good-oriented structure based on products such as textile, appliance or machinery to a capital-good-oriented economy based on petrochemicals including fertilizer, pulp & paper and steel manufacturing/shipbuilding; all these would mean a large-scale substitution of imported goods. All these capital-oriented industries are typical power-consumers, which require reliable power supply. Previous experiences by other countries show the effectiveness of the chain scheme of "Coal-fired power project - Reliable supply of power and energy - Development of material industry". Therefore, it is believed that the change in the power supply structure by coal-fired power plant has an enormous impact on economic growth and renovation of industrial structure through among the effects of scale merit, substitution of oil, or interactions with other industries.

Fig 2.5-1 Economic Effect of a Coal-Fired Thermal Power Project in Luzon

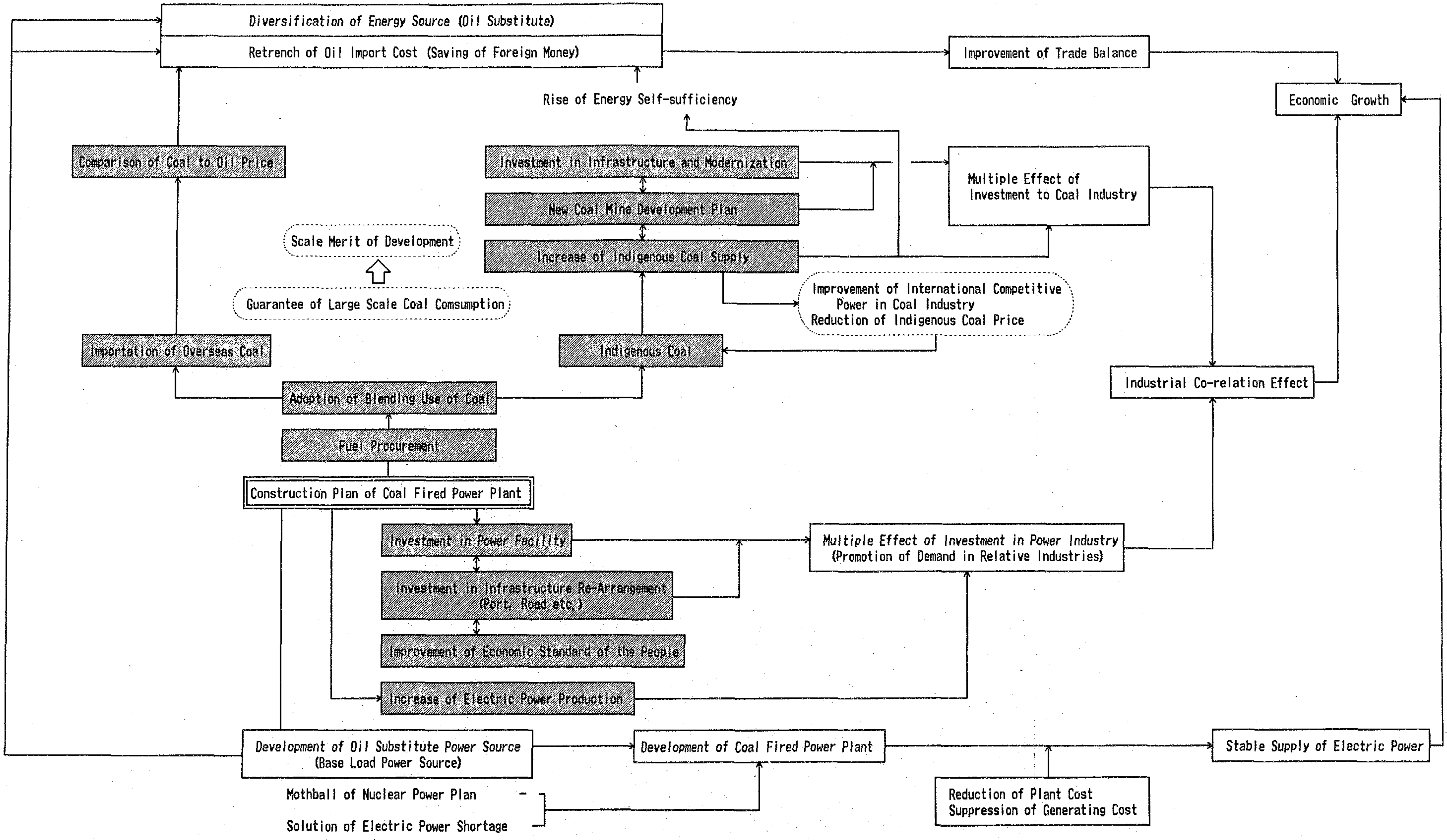

Table 2.5-1 Power Generation and its Secondary Industrial Effects

Unit: Million Peso

Industry	Industrial Effects
Mining and Quarrying	40,913
Electrical Machinery, Basic Metal Industries, Chemicals and Other Manufacturing Industries	345,498
Construction	1,203
Electricity, Gas and Water	410,678
Transportation, Communication and Storage	21,150
Trade	58,912
Banking, Insurance and Real Estate	5,741
Other Industries	40,501
Total	924,596 (2.327)

* 600 (MW) x 6,132 (hour) x 1.08 (₱/kWh) = ₱397,354 (Million Pesos)

Table 2.5-2 Technical Coefficients of Input

Industries	Technical Coefficients
Forestry and Logging	0.00735
Electrical Machinery, Basic Metal Industries, Chemicals and Other Manufactureing Industries	0.51994
Construction	0.00066
Electricity, Gas and Water	0.03321
Transportation, Communication and Storage	0.01801
Trade	0.06644
Banking, Insurance and Real Estate	0.00096
Other Services	0.01009
Intermediate Input	0.65667
Wage and Salaries	0.11594
Operating Surplus	0.22739
Total Primary Inputs	0.34333
Total Input	1.00000

* Technical Coefficients = Input/Electric Output

CHAPTER 3

POWER LOAD FORECASTING

AND SYSTEM ANALYSIS

Chapter 3 Power Load Forecasting and System Analysis

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CHAPTER 3 POWER LOAD FORECASTING AND SYSTEM ANALYSIS

3.1 General

NAPOCOR announced in June 1988 its basic policy up to the year 2000 concerning power development plan for electric power systems (Table 3.2-3). We have forecasted electric power load up to the year 2000 using linear regression method based on the basic policy mentioned above.

Load forecasting was carried out based on the assumption that commercial operation of Calaca II (300 MW), now under construction, will be operated in 1992 as scheduled and that all of the plans shown in Table 3.2-3 will be completed as planned. Even in this case, however, electric power supply will become short by about 42 GWh in 1993 and it will be necessary in 1996 to construct new power sources with an output of 713 GWh (equivalent to 160 MW).

As stated in the construction schedule (Chapter 8), operation of this project is expected to be started around 1996, but implementation of the project should be started as soon as possible as a serious power supply shortage is anticipated. Under these circumstances unit No. 2 should be started up with an interval of only half a year after unit No. 1.

Power system analysis was carried out based on the assumption that electric power development up to 1996 is implemented as planned and two 300 MW units are constructed at the Masinloc site. As a result of this analysis, 600 MW can be transmitted by a transmission line now being considered by NAPOCOR. From the viewpoint of thermal capacity of conductors of the transmission line, however, it is considered advisable to provide more allowance in the conductors.

3.2 Power Load Forecasting

3.2.1 Method for Power Load Forecasting

Generally speaking, strong correlations can be seen between the income level of users indicated in the form of GDP and the growth of electric power demand. Load forecasting can be carried out based on such correlations.

The growth trends of GDP and power demand between 1975 and 1983 can be shown in straight lines as shown in Fig. 3.2-1.

In view of such trends, load forecasting was performed using the linear regression method which is well-known.

If relations between GDP and power demand can be expressed in a linear form, the following formula can be established:

$$yi = a + bxi + ei$$

where, yi : Power demand (GWh)
xi : GDP (Million Pesos)
a, b: Regression factors
ei : Deflection from regression

Now, if the regression factors a and b are to be found through the least squares method so that ei will become small as a whole and $(yi - a - bxi)^2$ will be minimum,

$$b = \frac{S\ (xy)}{S\ (xx)} = \frac{(xi - x)\ (yi - y)}{(xi - x)^2}$$

$$= \frac{xiyi - (\ \ X)(\ \ yi)/n}{xi^2 - (\ \ xi)^2/n}$$

(n: the number of data)

$$a - \bar{y} - b\bar{x}$$

The final formula will be as follows:

$$y = a + bx$$

The basic data used to find regression factors a and b are shown in Table 3.2-1. Namely, it is the data concerning GDP (on a 1972 basis) and power demand volume in the 14 years between 1975 and 1988.

The regression factors can be easily found through the use of a computer, and the result is as follows:

$a = -6{,}771$
$b = 0.2124$

Accordingly, the final regression formula is:

$$y = -6{,}771 + 0.2124x$$

where, y = Forecast load volume (GWh)
X = Forecast GDP value (Million Pesos)

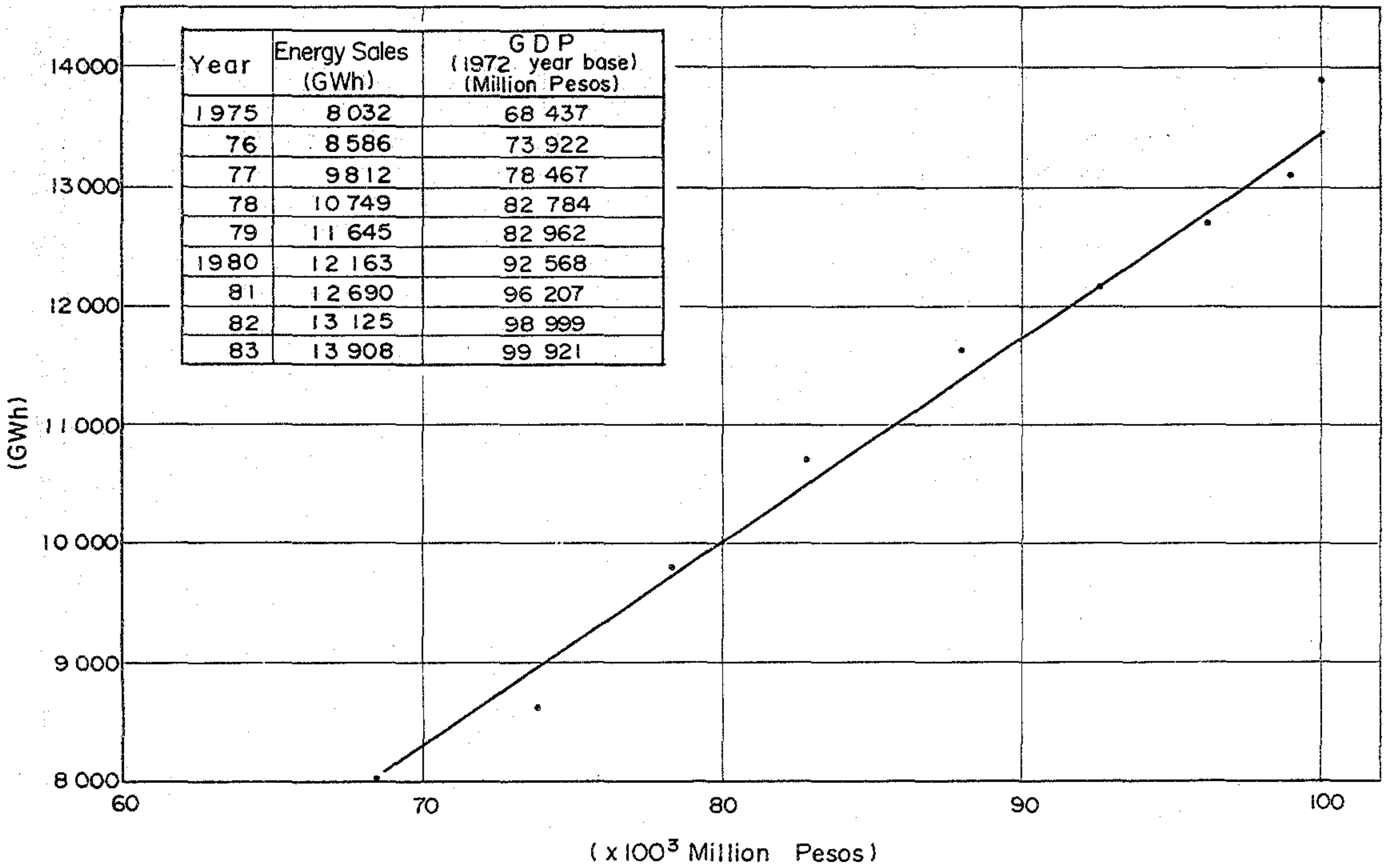
3.2.2 Results of Load Forecasting

Results of load forecasting for the period from 1989 to 2000 are shown in Fig. 3.2-2 and Table 3.2-2, and the power development plan is indicated in Table 3.2-3.

The estimated GDP value (x) employed for the calculation is one obtained when the growth of 6.5% was added to the actual GDP value of 1987.

As can be seen in Table 3.2-3, shortage of supply is anticipated after 1993 even if the power development program progresses as planned. This being the case, new power facilities will be required. The kW balance is shown in Fig. 3.2-3.

Fig. 3.2-1 Trend between GDP and Energy Sales (1975 ~ 1983)



Year	Energy Sales (GWh)	GDP (1972 year base) (Million Pesos)
1975	8 032	68 437
76	8 586	73 922
77	9 812	78 467
78	10 749	82 784
79	11 645	82 962
1980	12 163	92 568
81	12 690	96 207
82	13 125	98 999
83	13 908	99 921

Fig. 3.2-2 Luzon Grid Energy Balance (kWh Balance)

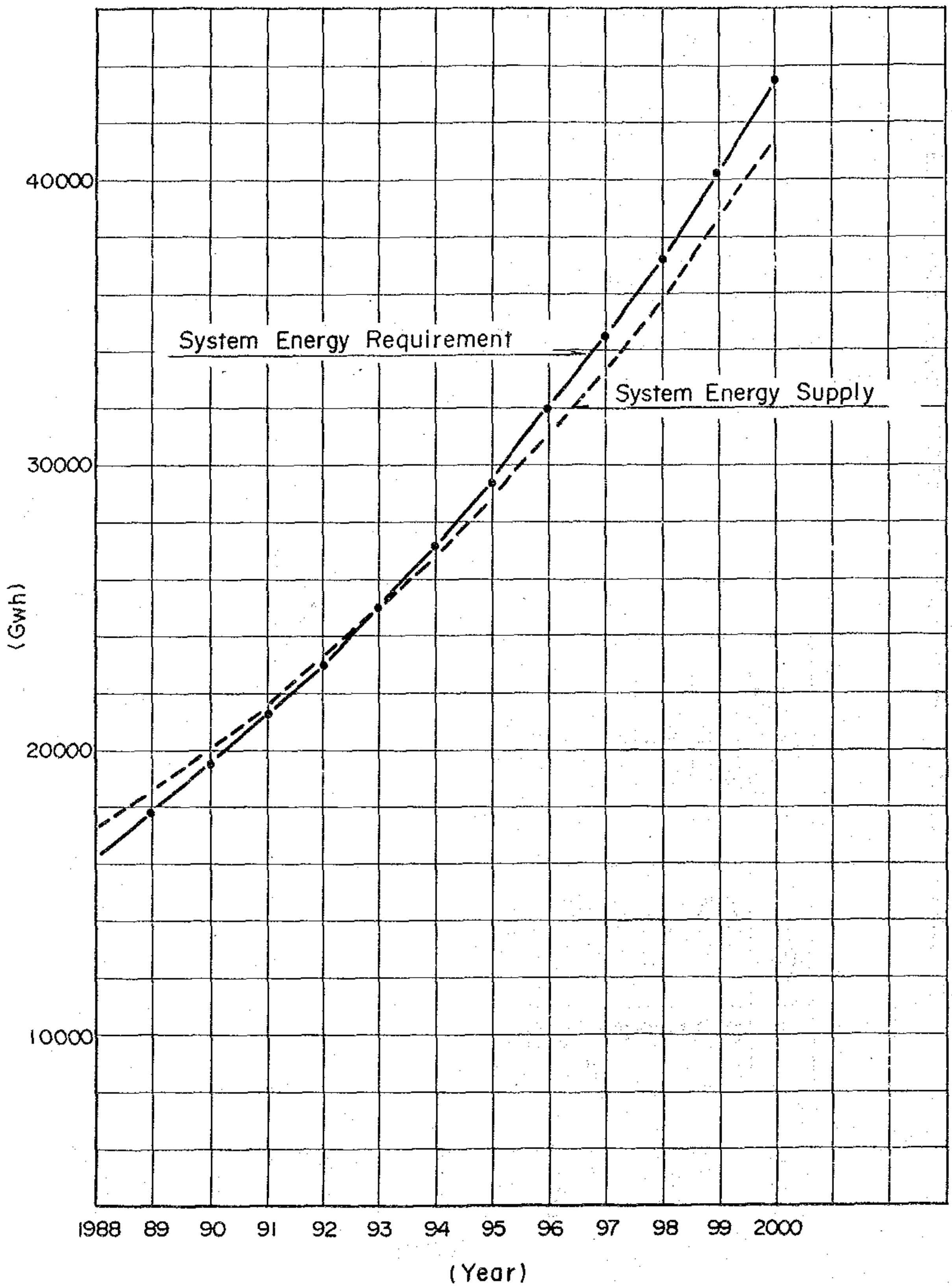


Fig. 3.2-3 Luzon Grid Power Balance (kW Balance)

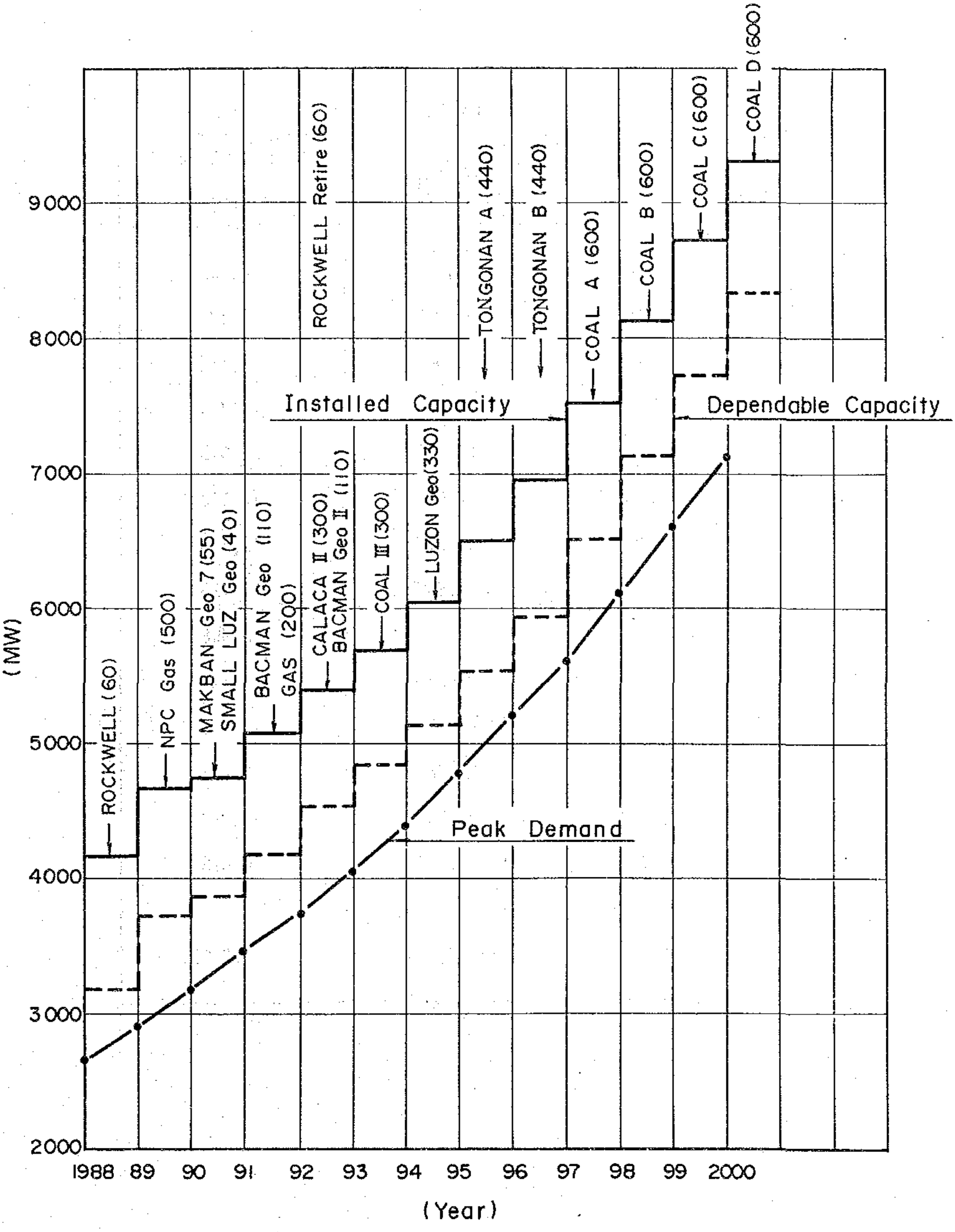


Table 3.2-1 **Base Data**

No. of Data	Year	GDP 1972 Base (Million Pesos) (x i)	Energy Sales (GWh) (y i)
1	1975	68,437	8,032
2	1976	73,922	8,586
3	1977	78,467	9,812
4	1978	82,784	10,749
5	1979	87,962	11,045
6	1980	92,568	12,163
7	1981	96,207	12,690
8	1982	98,999	13,125
9	1983	99,921	13,908
10	1984	93,927	13,245
11	1985	89,904	13,135
12	1986	91,287	13,461
13	1987	95,948	14,722
14	1988	102,200	16,078
Mean Value		$\overline{X}$ = 89,466	$\overline{Y}$ = 12,239

Table 3.2-2 System Energy Supply & System Energy Requirement (Forecast)

Year	Energy Consumption (Sales Level) (GWh)	System Loss (%)	System Energy Requirment (GWh)	Load Factor (%)	Peak Demand (MW)	Installed Capacity (MW)	Plant Factor (%)	System Energy Supply (GWh)	Balance (GWh)
			(1)					(2)	(2)−(1)
1989	16,347	9	17,818	70	2,906	4,671	45.5	18,618	800
1990	17,856	9	19,463	70	3,174	4,766	48.0	20,040	577
1991	19,449	9	21,199	70	3,457	5,076	48.6	21,610	411
1992	21,149	9	23,052	70	3,759	5,426	48.9	23,243	191
1993	22,956	9	25,022	70	4,081	5,726	49.8	24,980	- 42
1994	24,889	9	27,129	70	4,424	6,056	50.6	26,844	- 285
1995	26,950	9	29,376	70	4,791	6,496	50.7	28,851	- 525
1996	29,139	9	31,761	70	5,180	6,936	51.1	31,048	- 713
1997	31,476	9	34,309	70	5,595	7,536	50.5	33,338	- 971
1998	33,963	9	37,020	70	6,037	8,136	50.3	35,849	- 1,171
1999	36,619	9	39,915	70	6,509	8,736	50.4	38,570	- 1,345
2000	39,445	9	42,995	70	7,012	9,336	50.7	41,464	- 1,531

Table 3.2-3 Luzon Grid Power Development Program (1) (As of June, 1988)

Year	Plant Additions	Plant Cap. (MW)	Installed Capacity (MW)					Total	Depen. Cap. (MW)	
			Hydro	Geo.	Coal.	Oil				
						NAPOCOR	Other			
1987			1,226	660	300	1,925	—	4,111	—	
1988	ROCK WELL	60	〃	〃	〃	〃	60	4,171	3,185	
1989	NPC Gas. A	200	〃	〃	〃	2,425	60	4,671	3,735	
	〃 B	300								
1990	MAK BAN Geo. 7	55	〃	755	〃	〃	〃	4,766	3,875	
	SMALL Luz. Geo.	40								
1991	BAC MAN Geo. I	110	〃	865	〃	2,625	〃	5,076	4,175	
	GAS	200								
1992	CALACA II	300	〃	975	600	〃	0	5,426	4,535	
	BAC MAN Geo. II	110								
	Retire ROCK WELL	(60)								
1993	COAL III	300	〃	〃	900	〃	〃	5,726	4,835	
1994	LUZON Geo.	330	〃	1,305	〃	〃	〃	6,056	5,135	
1995	TONGONAN Geo. A	440	〃	1,745	〃	〃	〃	6,496	5,535	
1996	TONGONAN Geo. B	440	〃	2,185	〃	〃	〃	6,936	5,935	
1997	COAL A	600	〃	〃	1,500	〃	〃	7,536	6,535	
1998	〃 B	〃	〃	〃	2,100	〃	〃	8,136	7,135	
1999	C	〃	〃	〃	2,700	〃	〃	8,736	7,735	
2000	D	〃	1,226	2,185	3,300	2,625	0	9,336	8,335	

3.3 Power System Analysis

3.3.1 Study Conditions

The power system analysis (transient stability calculation, power flow calculation) of the Luzon Grid was carried out under the following conditions:

(1) Studied year: 1996

(2) The data prepared by NAPOCOR was used concerning system composition and system impedance. The system composition and the system impedance are indicated in Fig. 3.3-1.

(3) The capacity of generators of this project was assumed to be 600 MW.

(4) A new two-circuit 230 kV transmission line with total length of 129 km will be constructed between the project site and the Hermosa Substation.

(5) The fault point assumed for calculation of transient stability is the bus-line faults at the Botolan and Dolores Substations. The kind of the faults was assumed to be three-phase ground fault (3LG-0).

(6) No consideration was given to AVR of generators.

3.3.2 Study Results

(1) Results of the power flow calculation (at peak time) for the peak in 1996 are shown in Fig. 3.3-2, but no problem can be seen in the bus-line voltage and power flow in the transmission line of each substation.

Since capacity of transmission line reaches the upper limit when output of this project reaches 600 MW, addition of at least one-circuit transmission line will be required.

(2) The stability calculation results in the case that short circuit ratio of generators of this project which is assumed to be

0.58 are shown in Fig. 3.3-3, and those when the ratio is assumed to be 0.64 are shown in Fig. 3.3-4.

As a consequence, it can be said that no problem will arise in terms of stability by using either ratio, but the short circuit ratio of 0.58 is considered rather better.

(3) In the current study, AVR of the generators is not included. However, all generators are provided with AVR. Such being the case, stability will be further increased.

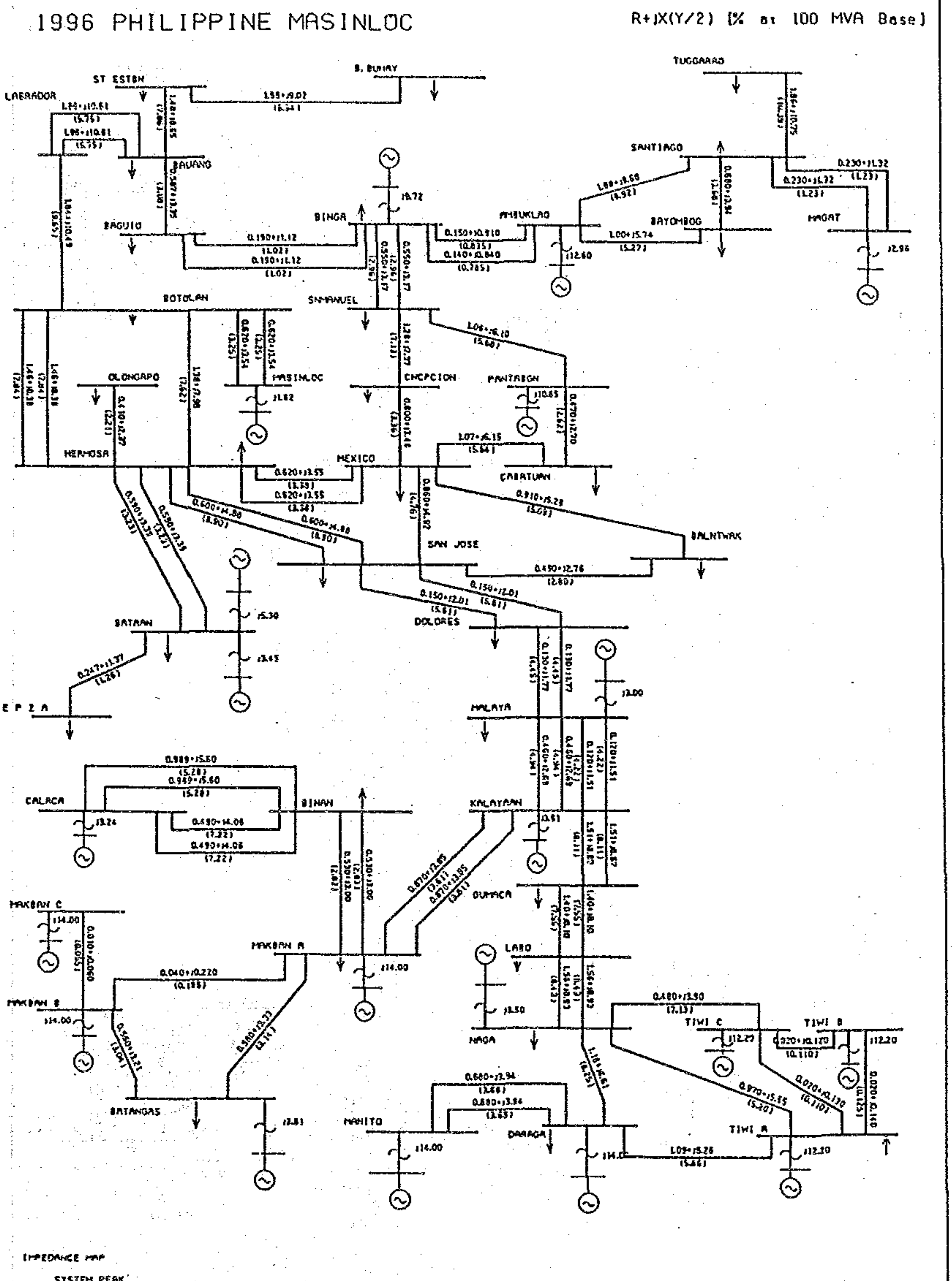


Fig. 3.3-1 Luzon Grid Impedance Map in 1996

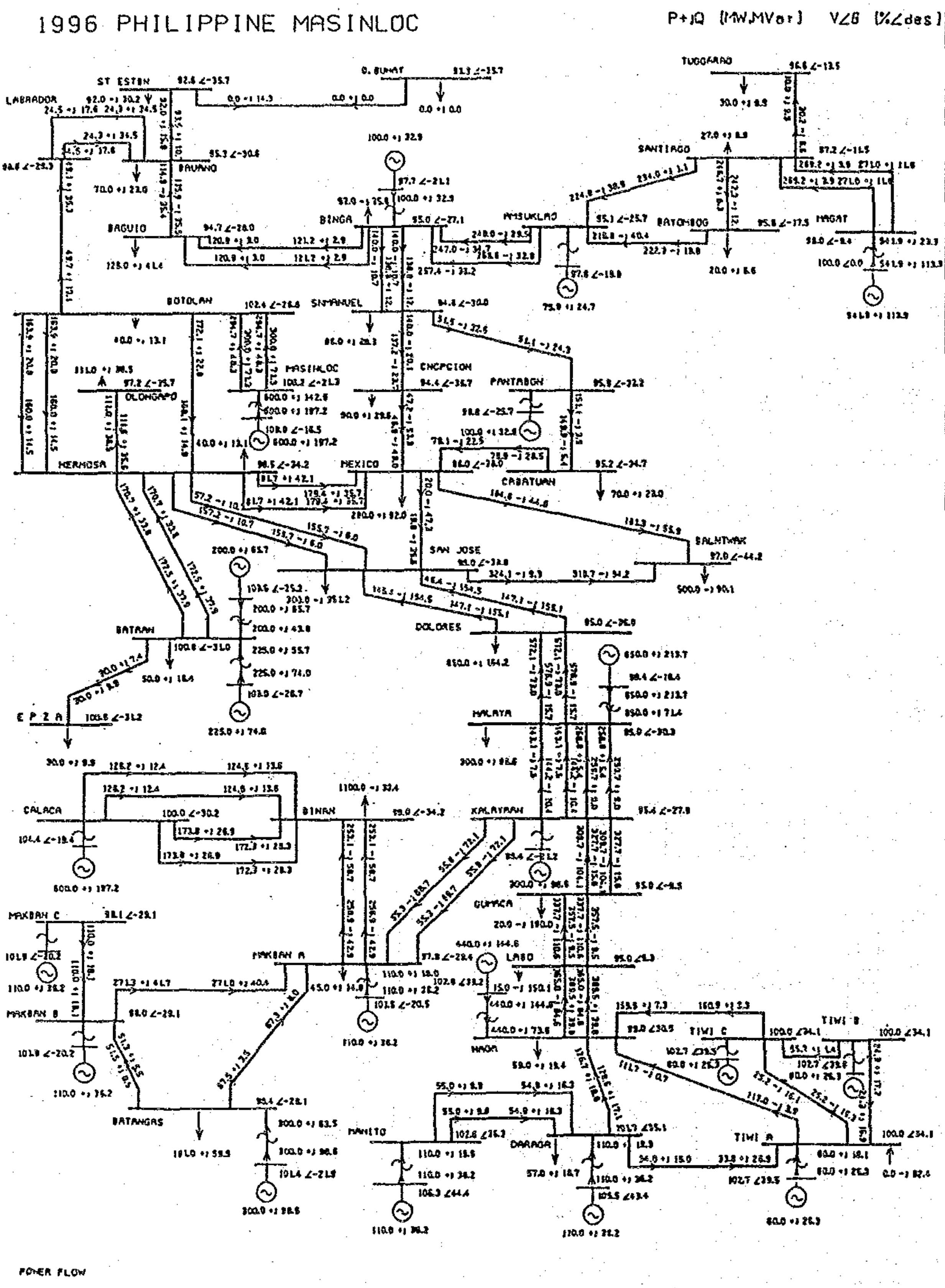
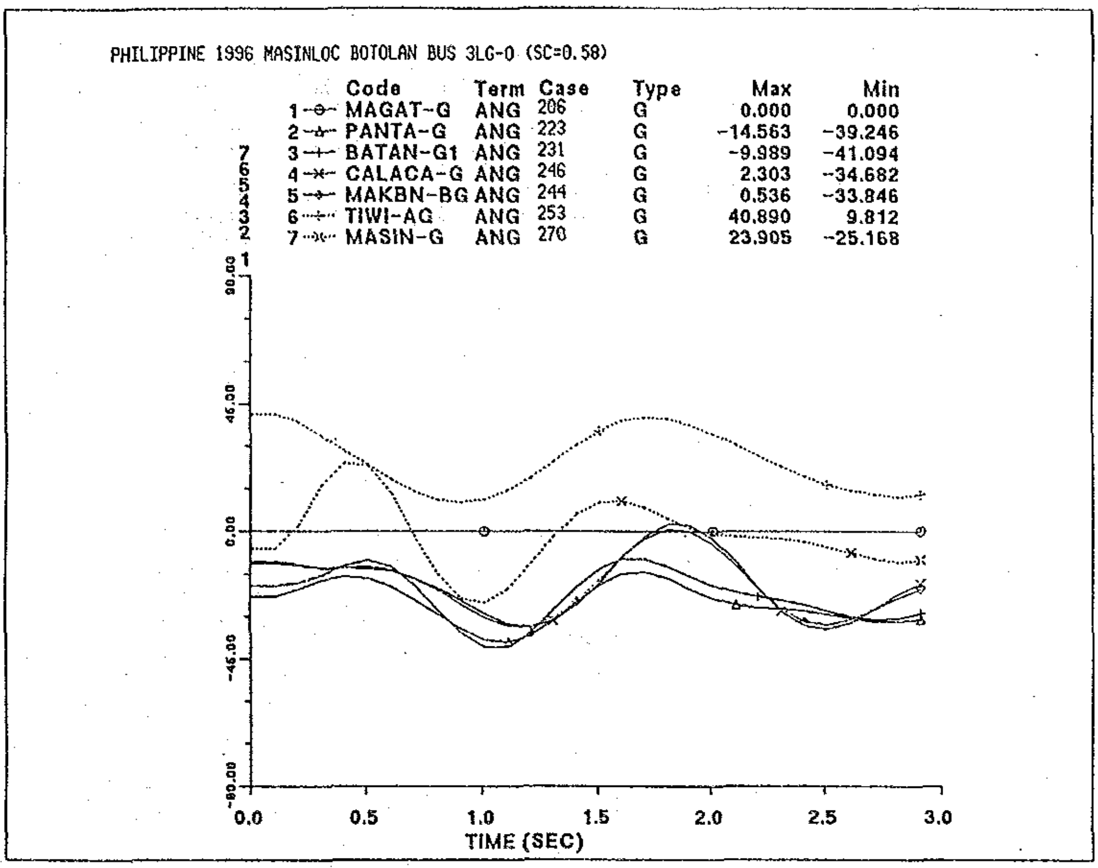


Fig. 3.3-2 Luzon Grid Power Flow in 1996 (peak time)



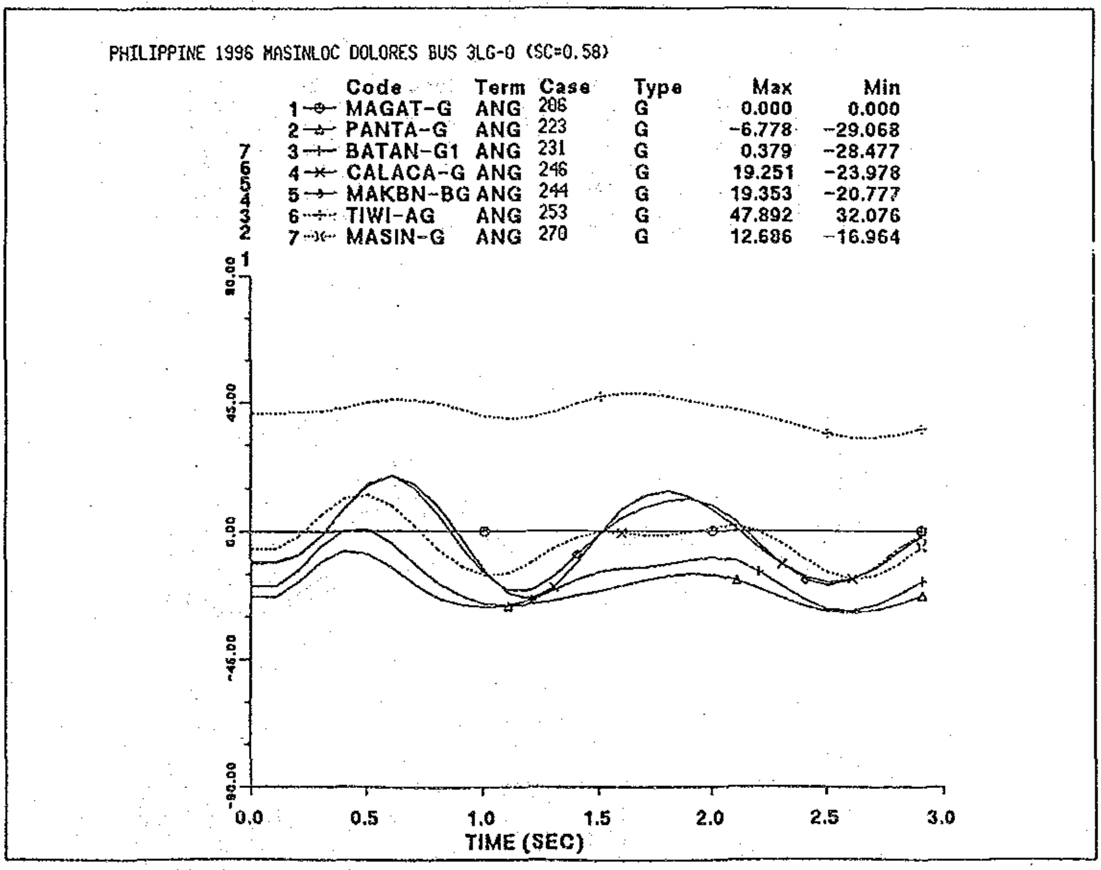
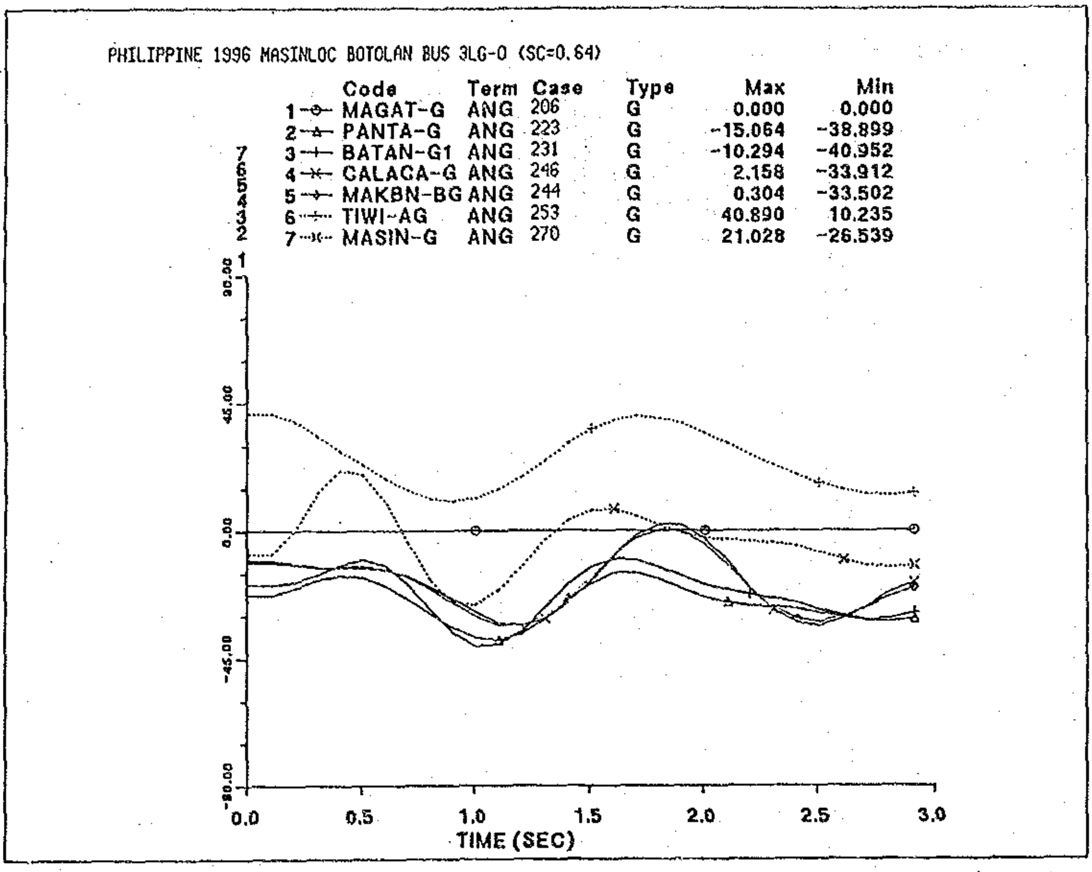


Fig. 3.3-3 Luzon Grid Stability Study in 1996 (Short Circuit Ratio = 0.58)



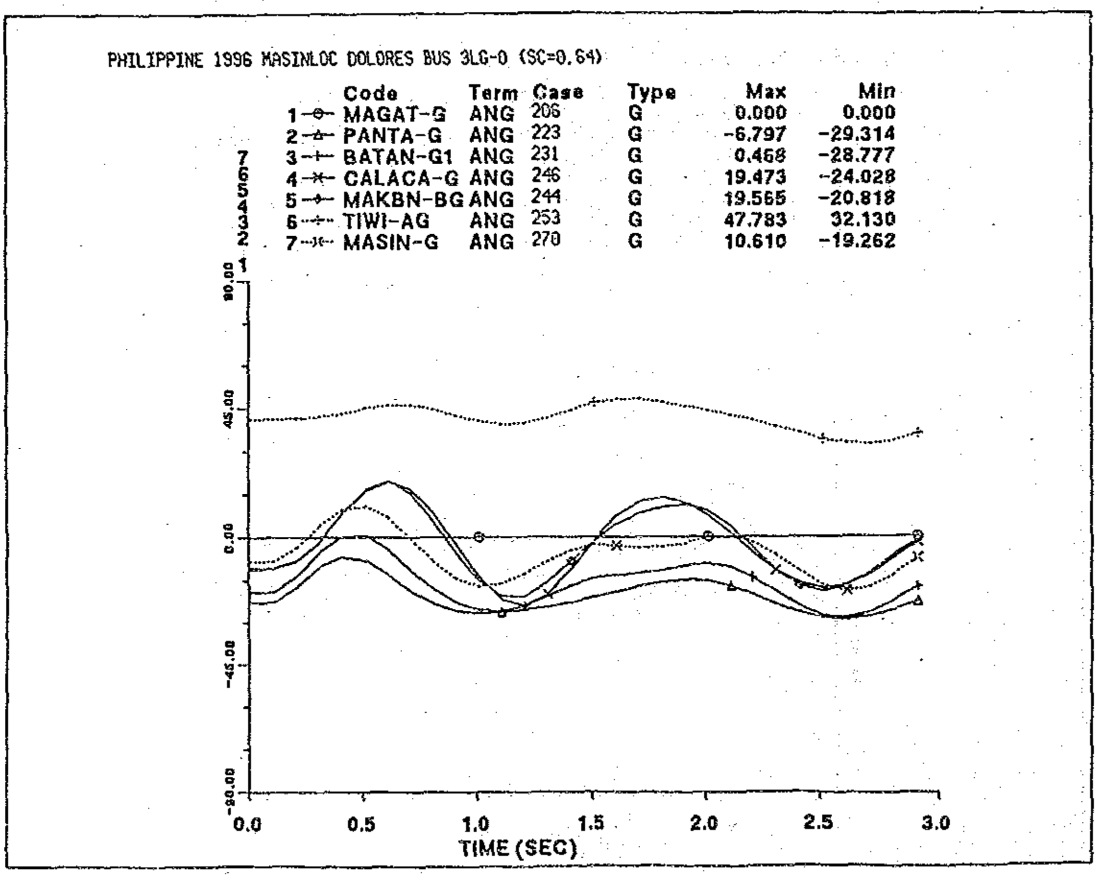


Fig. 3.3-4 Luzon Grid Stability Study in 1996 (Short Circuit Ratio = 0.64)

CHAPTER 4

SITE SELECTION STUDY

Chapter 4 Site Selection Study

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CHAPTER 4 SITE SELECTION STUDY

4.1 General

Many points must be considered in evaluating the suitability of each site for a coal-fired power plant. These are the main items:

1) Sufficient area should be available.

2) Good harbor is required for safe navigation and berthing of coal vessels and ease in unloading coal.

3) Area must be available for large-volume of ash disposal.

4) Fresh water must be available.

5) Area must have minimum environmental problems.

6) Power-consuming area must be as near as possible.

These items were examined in the first stage of evaluation of candidate sites, which led to a general conclusion with regard to the three sites. After this evaluation, Masinloc site is recommended for the study of the second stage.

(1) Masinloc Site

1) The advantages of the Masinloc site is the availability of sufficient power plant area, good geologic condition, and calmness of the harbor area. The largest problem is an extensive coral reef, which might be an obstacle to the port plan. Other problems include the availability of fresh water and the distance of transmission line; these are not, however, critical to the feasibility of the project.

2) The chief problem in the port plan is that it is inevitable that many winding sea channels will need to be planned. This raises such issues as the following:

   i) Safe operation of vessels must be secured.

   ii) Sea casualty would until its complete settlement completely interrupt coal delivery.

   The following measures are indispensable in meeting these problems:

   a) Deployment of tugboats (of 2,000 PS class, about three (3))

   b) Providing sufficient navigation signals

   c) Preparing good sea channels

   d) Assuring sufficient coal-storage capacity

3) The ash disposal system can be built either on land or offshore. The site has sufficient space for future expansion, making the construction of a large-scale plant feasible.

(2) San Juan Site

1) The obstacles expected at this site were availability of fresh water and ash disposal area. Our site reconnaissance revealed that fresh water can be taken from the Maraquin Ilog river 14 km away and that the geological condition has adequate bearing strength to support the loads of power plant facilities. Also, a large-capacity ash disposal area seems to be available on land. Thus, the only large problem is the port plan.

2) This candidate site faces a vast offshore area, which means that even a weak wind of 5 to 8 m/s can cause high waves if it blows continuously. Also, this site is very likely to have many characteristic swells caused by typhoons and tropi-

cal low pressure. The building of a breakwater is thus included in the project. However, the construction of a breakwater for large vessels at such a location will inevitably increase the cost of the project. In conclusion, it is important to pursue an economically favorable planning through careful studies about related vessels and harbor size, based on the data of winds and waves.

(3) Limay Site

1) The Limay site has sufficient area for a power plant. But the most serious problem is lack of inland ash disposal area. This necessitates the building of an ash disposal in offshore areas which will increase the construction cost. Such ash disposal area would also spoil the scenic beauty of the area.

2) An oil-fired thermal plant and an oil refinery are located in this area. To meet environmental regulations and standards with the planned quantity of emission, a coal-fired power plant in this area should desirably have desulfurization equipment.

3) The harbor conditions, however, are more favorable than at the other two sites. Thus it is a good site for a thermal power plant. Its construction is highly feasible by careful selection of fuel and development capacity.

(4) Recommendation of Masinloc Site

The result of rough cost estimation of the three candidate sites are shown in the following table in the form of comparison with Masinloc site with in-land ash disposal system. The calculation takes into account the difference only in characteristics and conditions of the sites.

(Unit: 1,000$)

Site	Masinloc	San Juan	Limay
In-land ash disposal system	Base	Base +23,200	(impossible)
Off-shore ash disposal system	Base +36,900	Base +78,400	Base +41,000

The present study dealt with the feasibility of 2 x 300 MW coal-fired power plants. Though not satisfactory in every aspect, Masinloc is the best site from an economic point of view.

Thus we recommend it for the second-stage survey. At this site, which is remote from the power consumption areas, a large-scale development should be pursued to achieve economic advantage.

The other two sites are also suited for power plant construction. Further examinations on fuel, harbor, and environmental problems are necessary for establishing power development plans suited for the sites.

4.2 Evaluation of Candidate Sites

4.2.1 Candidate Sites

The site selection study for a power plant is performed in two stages. First, the three candidate sites were evaluated for feasibility of construction of coal-fired power plants. Second, the appropriate site for plant construction was selected on the basis of evaluation in the first stage, followed by preliminary planning of power plant facilities.

The three candidate sites were confirmed in the Implementing Arrangement agreed between JICA and NAPOCOR in November 1988. The sites are as follows:

Sites for Study and Their Locations

Site A: Masinloc, Zambales
Site B: San Juan, Batangas
Site C: Limay, Bataan

4.2.2 Evaluation Criteria

Numerous evaluation criteria must be considered when studying feasibility of power plant construction at a selected site. The plan of development suited to each site must also be examined. The plant size (2 x 300 MW) and the kind of fuel (coal) have already been decided. Therefore, candidate sites should be evaluated for feasibility using the following 12 criteria. None of these sites however, seems to satisfy all of the criteria at once. Therefore, the final conclusion must be made by assessing how each problem can be technically solved and at what cost. The construction cost was estimated for each major criteria as follows, in a comparative way for each site.

(1) Accessibility to plant site.

(2) Suitable topographical and geological conditions.

(3) Availability of sufficient areas for power plant, coal storage and ash disposal.

(4) Availability of room for future expansion.

(5) Good harbor for safe accommodation of coal vessels and easy unloading.

(6) Stable availability of sufficient condenser cooling water and no recirculation problems of thermal effluent.

(7) Availability of good-quality and abundant fresh water in the vicinity of the plant site.

(8) Availability of electric power for construction works.

(9) Capability to unload and transport heavy machines.

(10) Availability of construction materials and aggregate.

(11) Closeness to power consumption areas.

(12) Little environmental impact on the environment caused by plant construction.

4.2.3 Method of Evaluation

To evaluate the feasibility of the selected plant sites by the same standards, major factors were selected, as follows, through discussions with NAPOCOR.

(1) Size of plant 2 x 300 MW

(2) Maximum size of coal vessels 60,000 DWT

(3) Quality of fuel

An indigenous coal (Semirara ROM Coal) was used as the tentative fuel for evaluation. Its properties are as follows:

Heating value (Hh) : 3,760 kCal/kg (6,770 Btu/lb)
Surface moisture (Wl) : 17.6% (As-received basis)*1

Inherent moisture (W2)	:	15.1% (Air-dried basis)*2
Total moisture (W)	:	30.0%
Ash content (As)	:	15.0%

(4) Annual average heat rate(p): 9,500 Btu/kWh (p = 36%) (at generating end)

(5) Annual plant factor : 70%

(6) Maximum coal storage Capacity : 500,000 tons*3 (Corresponds to 45 days)

(7) Ash disposal capacity : 13,000,000 m^3*4 (Corresponds to 30 years)

Note *1 and *2: Surface and inherent moisture content were estimated from "As received" and "Air dried" data in CALACA II FS Report.

*3: Maximum coal storage capacity is 300,000 tons at second stage study.

*4: Ash disposal capacity is 6,200,000 m^3 at second stage study.

4.2.4 Masinloc, Zambales (Site - A)

(1) Location

The site is located at Barangay Bani, Masinloc, Zambales, about 250 km northwest of Manila.

(2) Access road

The site is linked to a national road by a provincial road approximately 2.3 km long, which is rugged and needs widening and pavement for transporting construction machines and materials.

(3) Topography and geology

There are gently sloping hills in the northwest of the site, with rice paddies along the shore line. There is a large flatland on the side of the Lawis river. The off-shore area slopes gently and the shallow area have much coral reefs.

The geology around the site is composed of an alternation of sandstone and shale, which are parts of the Zambales formation. The lowland is covered with thin alluvium. The shallow seabed probably consists of bedrock covered with reef limestone. The bedrock provides sufficient bearing strength for a power plant.

(4) Required plant area

The required plant area (26 ha) can be obtained by excavating a part of a hill and by reclaiming land in the off-shore area with the excavated soil.

(Note: The required plant area has been examined at the second stage study.)

(5) Approach channel and port facilities

1) Location of unloading jetty

The unloading jetty should be built 700 m off Oyon Bay to provide sufficient turning basin (15 m deep) for 60,000 DWT coal vessels and to minimize the length of coal conveyer.

2) Approach channel

Coal vessel has to travel 5.5 km through coral reef area from the bay mouth to the unloading jetty. The vessel has to sharply change direction three times. Thus, the following measures are necessary for the safe navigation of large vessels to the berth:

i) The long approach channel with many curves requires approximately 1.5 L (L: overall length of vessel) route width and a sea depth of more than 16.5 m, thus necessitating several dredging operations.

ii) Deployment of tugboats.

iii) Highly experienced pilots.

iv) Provision of navigation aids.

3) Turning basin

A turning basin of 2 L in diameter and 15 m deep can be obtained with some dredging.

4) Breakwater

Because of the small size of Oyon Bay's port area, wind waves are not significant. Also, waves caused by southwest/west wind from the South China Sea is partially attenuated by the shoals. Thus, the sea surface in the bay is sufficiently calm, requiring no breakwaters.

(6) Condenser cooling water

1) Intake

Condenser cooling water can be taken from a deep position at the mouth of Oyon Bay. This design provides water intake in stable amounts without temperature rise.

2) Water discharge

Condenser cooling water is discharged into the west side of the coral reef shoals to prevent the possible warming effects of water intake.

(7) Ash disposal area

Either of the following options for ash disposal can be used for about 30 years. The selection should be made only after considering construction cost, ash disposal cost and compensation cost.

1) In-land ash disposal

A rice field on the north side of the plant can be used. The required area is 152 ha.

(Note: The required area has been estimated as 73 ha at the second stage study.)

2) Offshore ash disposal

An ash disposal area can be built in Oyon Bay, on the west side of the plant. The required area is 132 ha.

(8) Fresh Water

Of the two possible fresh water sources - the Lawis river (pipeline length of 4 km) on the east of plant site and the Masinloc river on the south (pipeline length of 10 km) - the latter is recommended for the following reasons:

1) Because of the wide riverbed of the Lawis river, its flow channel is likely to vary significantly between the dry season and rainy season. Therefore, building intake facilities that would ensure stable supply of fresh water would be expensive. On the other hand, the Masinloc river is narrow and intake facilities can be readily built.

2) The Lawis river has the Coto chromite mine upstream, which may cause water pollution. Our water analysis did not indicate pollution, but a long-term examination would be needed for confirmation. Thus, the Lawis river is not recommended for our present purpose.

(9) Electricity for Construction

There is a 69 kV transmission line for the Acoje mine, passing approximately 5 km away from the site. Power can be tapped from this line.

(10) Unloading facilities for construction materials

The existing port was investigated for this purpose. The problems found were:

1) It belongs to a private corporation.
2) The wharf has to be improved.
3) It is 6 km away from the site and the road needs to be upgraded.

Thus, it is recommended to build new unloading facilities in the vicinity of the plant site.

(11) Transmission line

Generated power will be transmitted to Hermosa S/S via Botolan S/S. A new transmission line can be built from Masinloc to Hermosa S/S (129 km long).

(12) Environmental protection and compensations

Since there is no other industry in the area, a thermal power plant seems unlikely to cause any environmental problems. The plant site, however, must be obtained through conversion of rice field and fruit farms, which may require compensation.

(13) Potentiality for future expansion

The ash disposal area has a large capacity as stated above (7) and the plant site can be readily expanded. Also, the calm harbor has a potential for larger capacity of coal unloading. Thus, the site can accommodate two more generator units.

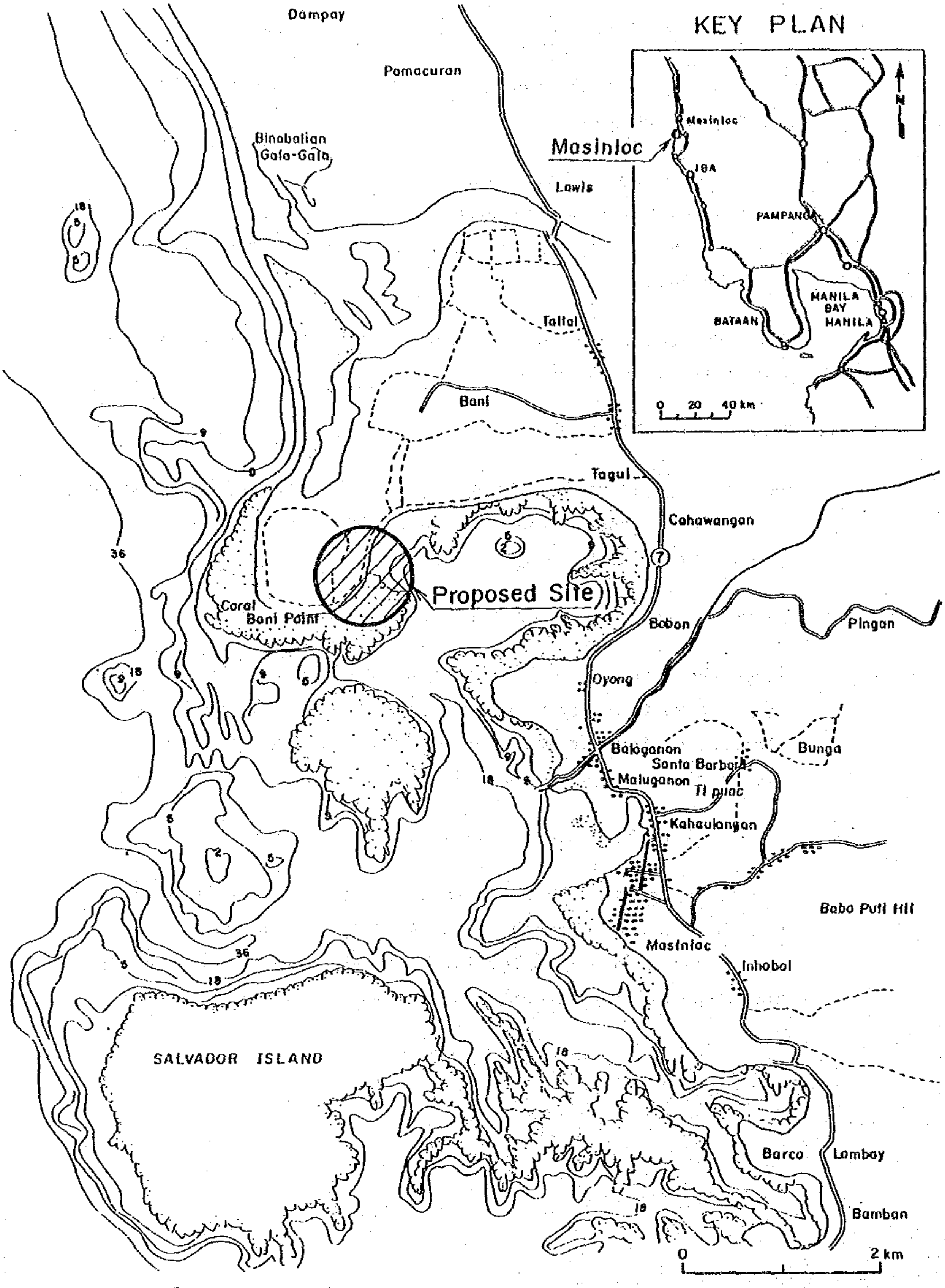
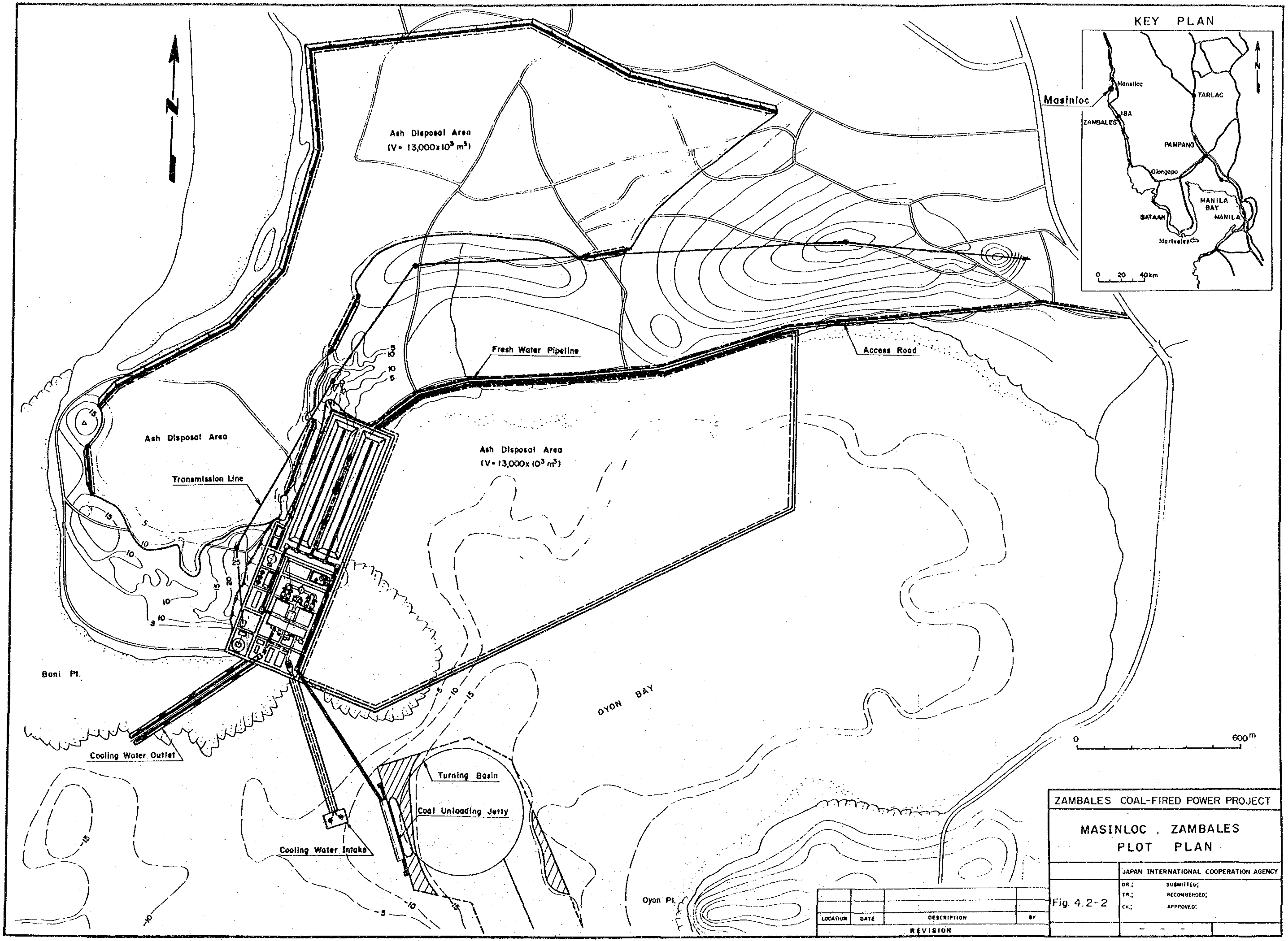
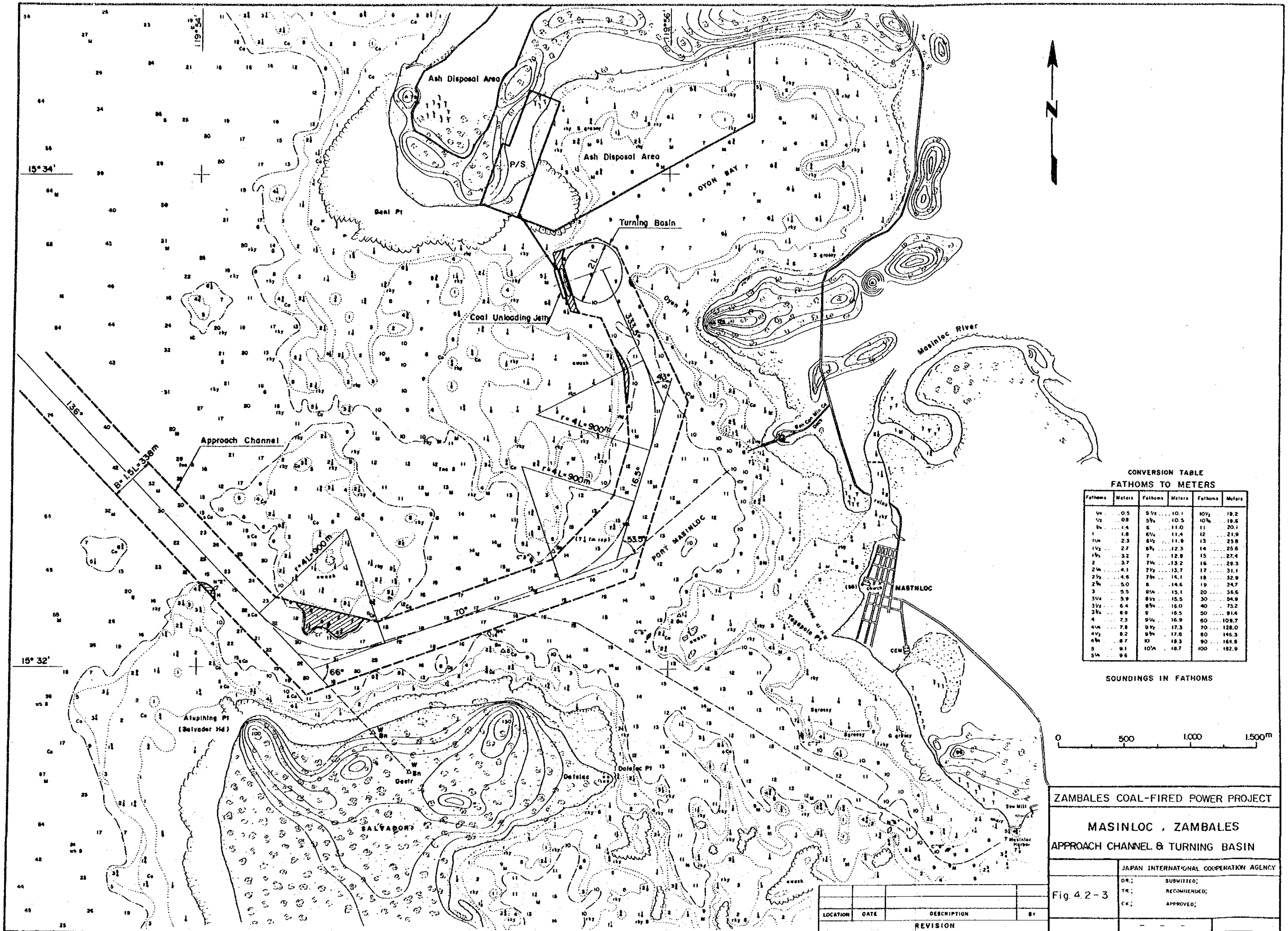


Fig.4.2-1 Site Location (Masinloc, Zambales)


KEY PLAN
Masinloc
Masinloc
IBA
ZAMBALES
TARLAC
PAMPANGA
Olongapo
MANILA BAY
MANILA
BATAAN
Mariveles
0 20 40km
N
Ash Disposal Area
(V= 13,000x10³ m³)
Ash Disposal Area
Ash Disposal Area
(V= 13,000x10³ m³)
Fresh Water Pipeline
Access Road
Transmission Line
Bani Pt.
OYON BAY
Oyon Pt.
Cooling Water Outlet
Cooling Water Intake
Turning Basin
Coal Unloading Jetty
0
600m
ZAMBALES COAL-FIRED POWER PROJECT
MASINLOC , ZAMBALES
PLOT PLAN
JAPAN INTERNATIONAL COOPERATION AGENCY
Fig. 4.2-2
DR.;
TR.;
CK.;
SUBMITTED;
RECOMMENDED;
APPROVED;
LOCATION
DATE
DESCRIPTION
BY
REVISION



CONVERSION TABLE

FATHOMS TO METERS

Fathoms	Meters	Fathoms	Meters	Fathoms	Meters
¼	0.5	5½	10.1	10½	19.2
½	0.9	5¾	10.5	10¾	19.6
¾	1.4	6	11.0	11	20.1
1	1.8	6¼	11.4	12	21.9
1¼	2.3	6½	11.9	13	23.8
1½	2.7	6¾	12.3	14	25.6
1¾	3.2	7	12.8	15	27.4
2	3.7	7¼	13.2	16	29.3
2¼	4.1	7½	13.7	17	31.1
2½	4.6	7¾	14.1	18	32.9
2¾	5.0	8	14.6	19	34.7
3	5.5	8¼	15.1	20	36.6
3¼	5.9	8½	15.5	30	54.9
3½	6.4	8¾	16.0	40	73.2
3¾	6.9	9	16.5	50	91.4
4	7.3	9¼	16.9	60	109.7
4¼	7.8	9½	17.3	70	128.0
4½	8.2	9¾	17.8	80	146.3
4¾	8.7	10	18.3	90	164.6
5	9.1	10¼	18.7	100	182.9
5¼	9.6				

SOUNDINGS IN FATHOMS

LOCATION	DATE	DESCRIPTION	BY
REVISION			

ZAMBALES COAL-FIRED POWER PROJECT

MASINLOC , ZAMBALES

APPROACH CHANNEL & TURNING BASIN

JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 4.2-3

DR; SUBMITTED;
TR; RECOMMENDED;
CK; APPROVED;

4.2.5 San Juan, Batangas (Site B)

(1) Location

The site is located at Barangay Subukin and Nagsaulay, San Juan, Batangas, about 140 km southwest of Manila.

(2) Access road

The site is linked to San Juan by a national road approximately 12 km long, which is rugged and needs widening and paving for transporting construction machines and materials.

(3) Topography and geology

The land of the site area is nearly flat and gently sloped toward the shoreline, the elevation changing from about 15 m to 5 m. There are much coral reefs extending to about 400 m offshore. The shoreline is covered with reef limestone more than 3 m thick, which is also distributed widely to the plant site. The reef limestone covers the taal tuff in varying and unknown thicknesses. There is some question as to whether the reef limestone has sufficient bearing strength to stably support power plant facilities.

(4) Required plant area

The required plant area (26 ha) can be obtained by leveling the palm forest behind Subukin point.

(5) Approach channel and harbor facilities

1) Location of unloading jetty

The unloading jetty should be built approximately 1.2 km off the coast of Subukin point, which is located on the west of Tayabas Bay, to provide sufficient turning basin for 60,000 DWT coal vessels.

2) Approach channel

Tayabas Bay is a large body of water with sufficient width and depth of approach channels. With some improvement by navigation aids, large coal vessels can readily be accommodated.

3) Turning basin

A turning basin can be built in front of the unloading berth.

4) Breakwater

This candidate site faces a vast offshore area. This means that even an ordinary wind of 5 - 8 m/s can cause high waves if it blows continuously. Also, this site is likely to have many characteristic swells caused by typhoons and tropical low pressure. Building of a breakwater is included in the project, because the calmness in the port is considered to be secured.

The construction of breakwater for large vessels at such a location will inevitably increase the cost of the project.

(6) Condenser cooling water

1) Intake

Condenser cooling water is taken from a deep position on the east side of the site. This design provides water intake in stable amounts without temperature rise.

2) Water discharge

Condenser cooling water is discharged at the shore on the east of the plant site. The effects of thermal effluent is not likely to become significant, since Tayabas Bay is open to the outside.

(7) Ash disposal area

Either of the following options for ash disposal can be used for about 30 years. The more economical option should therefore be chosen.

1) In-land ash disposal

The site is surrounded by a gentle hill area, which has no large flat land suited for in-land ash disposal. There is a coconut farm at Calubucub, about 5 km north of the site, and another coconut farm and a swampland at Bataan, about 4 km south of the site, both of which are suited for ash disposal. These areas are 148 ha and 250 ha, respectively.

2) Offshore ash disposal

An ash disposal area can be built on the south shoreline of the site, with the construction of revetment. The area is 151 ha. This option requires changing the course of a small river.

(8) Fresh Water

Our water analysis indicated contamination of underground water around the site with seawater. Therefore, it is recommended to take fresh water from the Malaquing Ilog river on the north of the site, through a pipeline (14 km).

(9) Electricity for Construction

A 69 kV transmission line from Batangas S/S can be tapped, by building a branch transmission line to the site.

(10) Unloading facilities for construction materials

There are no existing unloading facilities in the vicinity of the site. New unloading facilities must be built in the area of the plant site.

(11) Transmission line

The transmission line from San Juan to Batangas S/S will be 48 km long, and its route is occupied mostly by private houses or cultivated lands. There is enough space in Batangas S/S for additional switching facilities.

(12) Environmental protection and compensation

The power plant area must be obtained through conversion of coconut farm, which may require compensation.

(13) Potential for future expansion

In terms of the space of site area, supply of fresh water, and ash disposal capacity, the site can accommodate up to four generator units. In that case, however, the calmness of the port area should be examined more precisely.

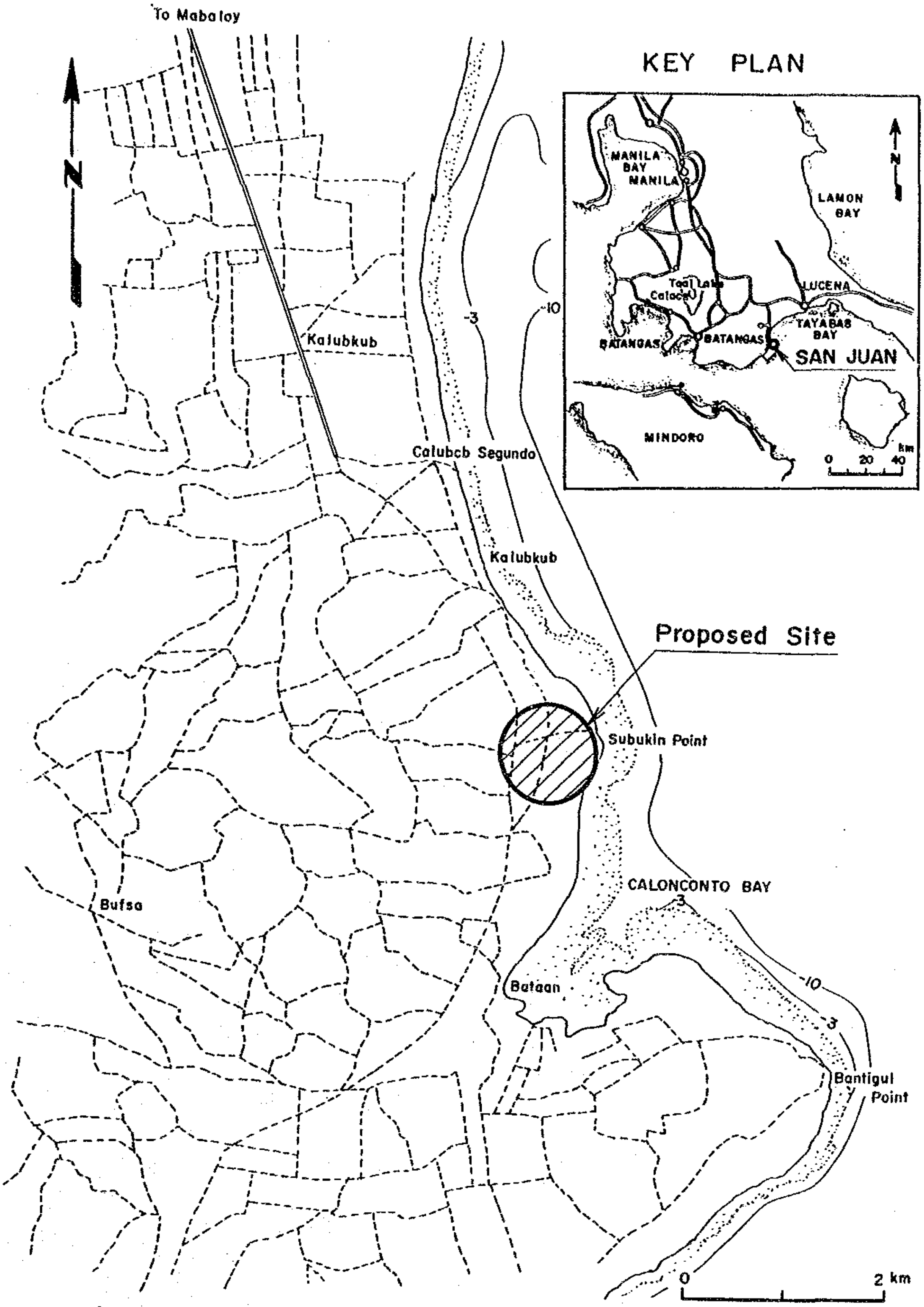
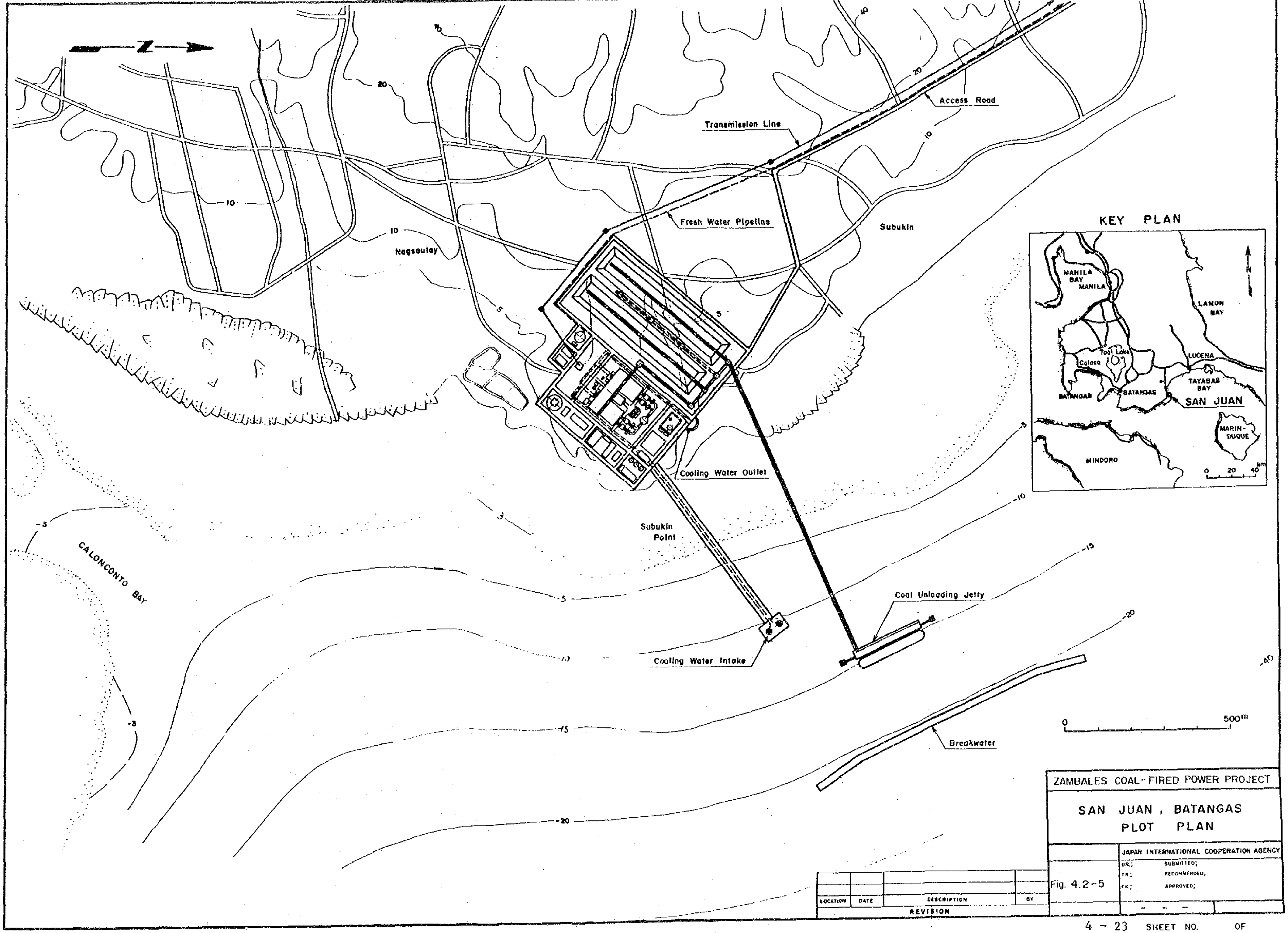


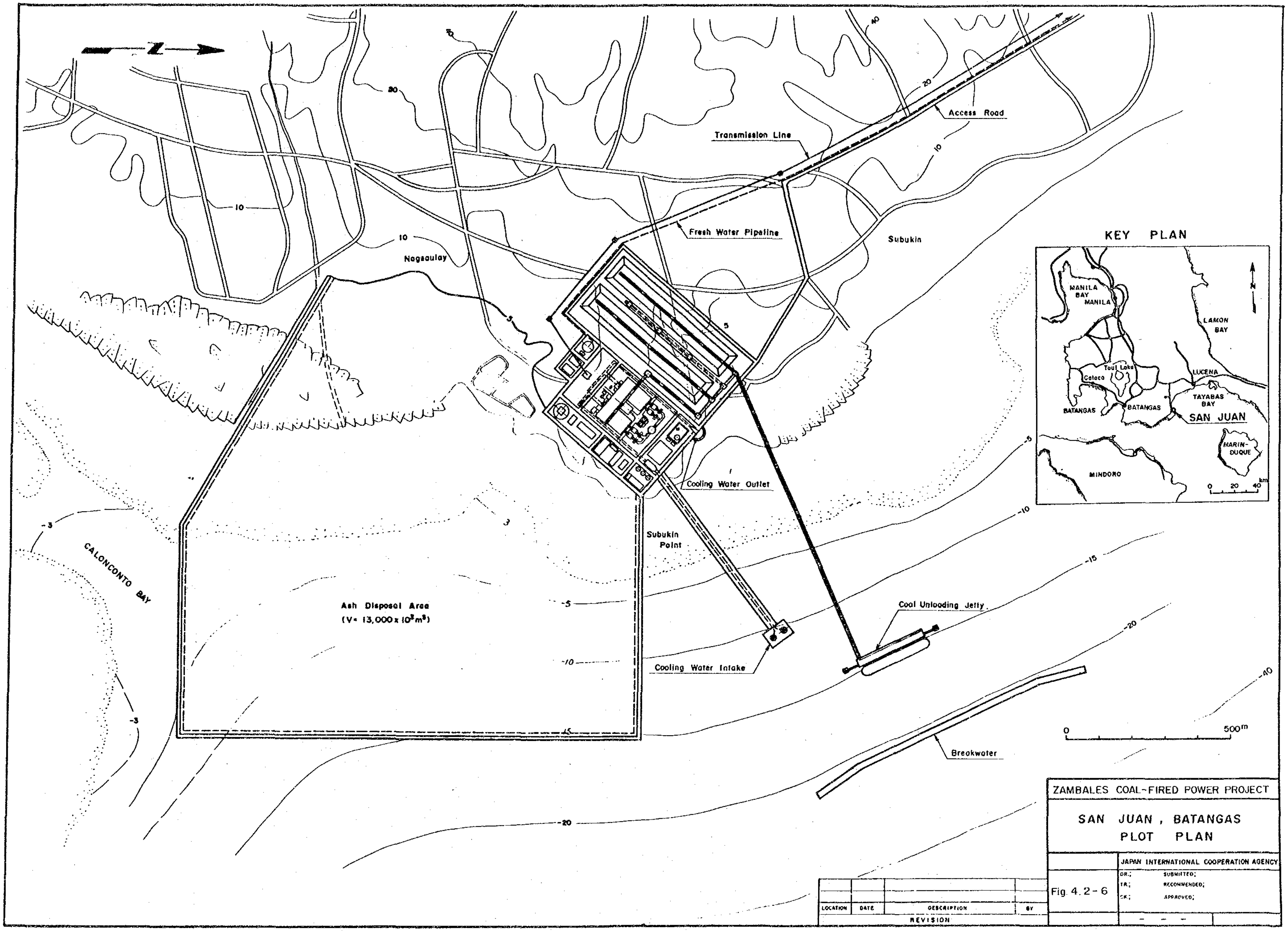
Fig. 4.2-4 Site Location (San Juan, Batangas)



ZAMBALES COAL-FIRED POWER PROJECT

SAN JUAN, BATANGAS
PLOT PLAN

Fig. 4.2-5



ZAMBALES COAL-FIRED POWER PROJECT

SAN JUAN , BATANGAS
PLOT PLAN

JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 4.2-6

LOCATION	DATE	DESCRIPTION	BY	
REVISION				

DR.; SUBMITTED;
TR.; RECOMMENDED;
CK.; APPROVED;

ZAMBALES COAL-FIRED POWER PROJECT

SAN JUAN , BATANGAS
ASH DISPOSAL AREA

JAPAN INTERNATIONAL COOPERATION AGENCY

DR.;	SUBMITTED;
TR.;	RECOMMENDED;
CK.;	APPROVED;

Fig. 4.2-7

LOCATION	DATE	DESCRIPTION	BY
REVISION			

4.2.6 Limay, Bataan (Site - C)

(1) Location

The site is located at Barangay Luz, Limay, Bataan, 130 km west of Manila.

(2) Access Road

The site is linked to a national road by a provincial asphalt road approximately 250 m long.

(3) Topography and geology

The site is located on the east side of Mt. Mariveles, facing Manila Bay. The area has been partly leveled to 12 m above sea level. The seashore slope is gentle, with no coral reefs.

The baserock of the area mainly consists of tuff and tuff breccia. This rock provides sufficient bearing strength for a power plant. There is some fill material mainly containing clay and gravel, in the central part of the site. The sea area consists of soft alluvium, 5 to 10 m thick, based on refinery data.

(4) Required plant area

The required plant area can be obtained by leveling the former estate of the National Steel Corporation. To accommodate 2 x 300 MW facilities, however, the aquisition of additional area and a partial change in the route of the access road for Bataan thermal P/S may be required.

(5) Approach channel and port facilities

1) Location of unloading jetty

The unloading jetty should be built 1.3 km off Quitang point, to provide sufficient turning basin for 60,000 DWT coal vessels.

2) Approach channel

It is 30 km between the mouth of Manila Bay and the unloading berth. There is no difficulty in approach channel, depth, turning basin and others. Installation of unloading berth and navigation signals, however, must be done with care in consideration of existing tanker-mooring facilities.

3) Breakwater

Judging from wave conditions in Manila bay and effective attenuation of waves from the South China Sea by Bataan Peninsula, there is no need for breakwaters.

(6) Condenser cooling water

There is already a thermal power plant of 225 MW in this area. Thermal effluent from this plant must be carefully taken into account.

1) Intake

Condenser cooling water is taken from a deep position at about 1 km offshore of Bataan Thermal Power Station. Water must be taken from as deep as possible to avoid the possible influence of thermal effluent.

2) Water discharge

Condenser cooling water is discharged into the sea on the south side of the site.

3) Countermeasures for thermal effluent

The shore protection works for ash disposal may cause stagnation of thermal effluent from the existing power plant. This is likely to result in the problem of recirculation of thermal effluent in the existing power plant, unless the new water intake site is changed. This problem needs to be closely examined in the course of construction of a coal power plant in this area.

(7) Ash disposal area

Thirty years offshore ash disposal is possible if a disposal site is built with a revetment on the east of the plant site and its area is about 106 ha. In-land ash disposal is not feasible at this site for the following reasons:

1) A candidate site for in-land disposal downstream of the Alangan river is small in capacity (1.5 million m^3, corresponding to 3.5 years of operation) and requires changing the course of the Alangan river and purchasing a shrimp farm and rice field.

2) The surrounding area is mostly hills, offering no suitable site for a large-capacity ash disposal arera.

(8) Fresh Water

Fresh water can be taken from the Alangan river, on the south side of the site, by building a pipeline about 1.3 km long.

(9) Electricity for construction

Power can be tapped from a spare metalclad switch gear (4.16 kV) of Bataan thermal power plant adjacent to the site.

(10) Unloading facilities for construction materials

The existing pier in the site is available for this purpose but requires some repairs.

(11) Transmission line

The generated power will be transmitted to Hermosa S/S. The transmission line from Limay to Hermosa is approximately 43 km long.

(12) Environmental protection and compensation

Because of the infuences from the existing oil thermal power plant, gas turbine plant and other manufacturing plants in the neighborhood, there seems to be little margin to be within the level of atmospheric SO2 under NPCC regulation (850 g/scm). This situation necessitates installation of environmental protection facilities.

(13) Potential for future expansion

Because of environmental factors, availability of fresh water and ash disposal capacity, the potential for expansion is very little. For these reasons, the understanding of inhabitants is indispensable for the construction of a 2 x 300 MW power plant.

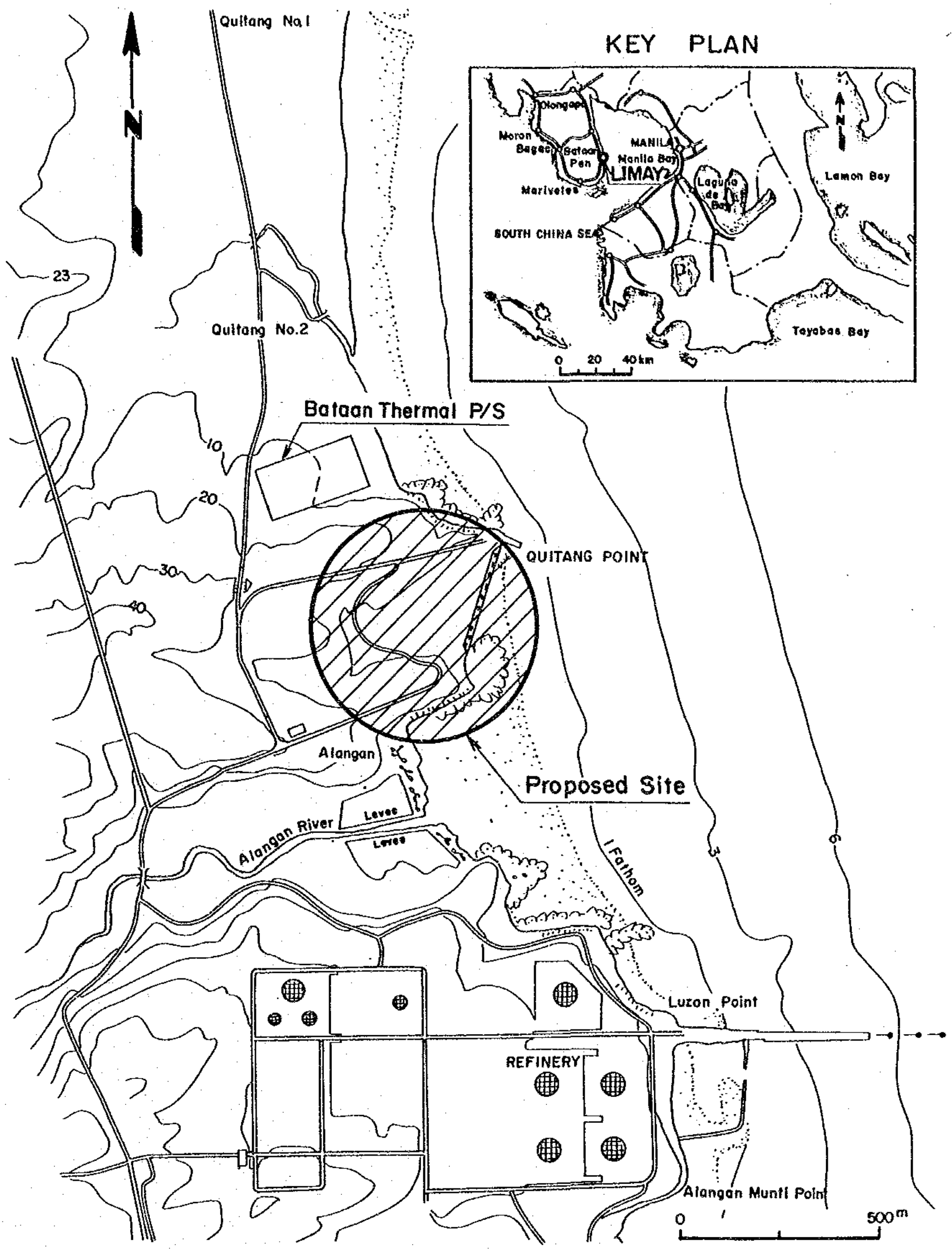
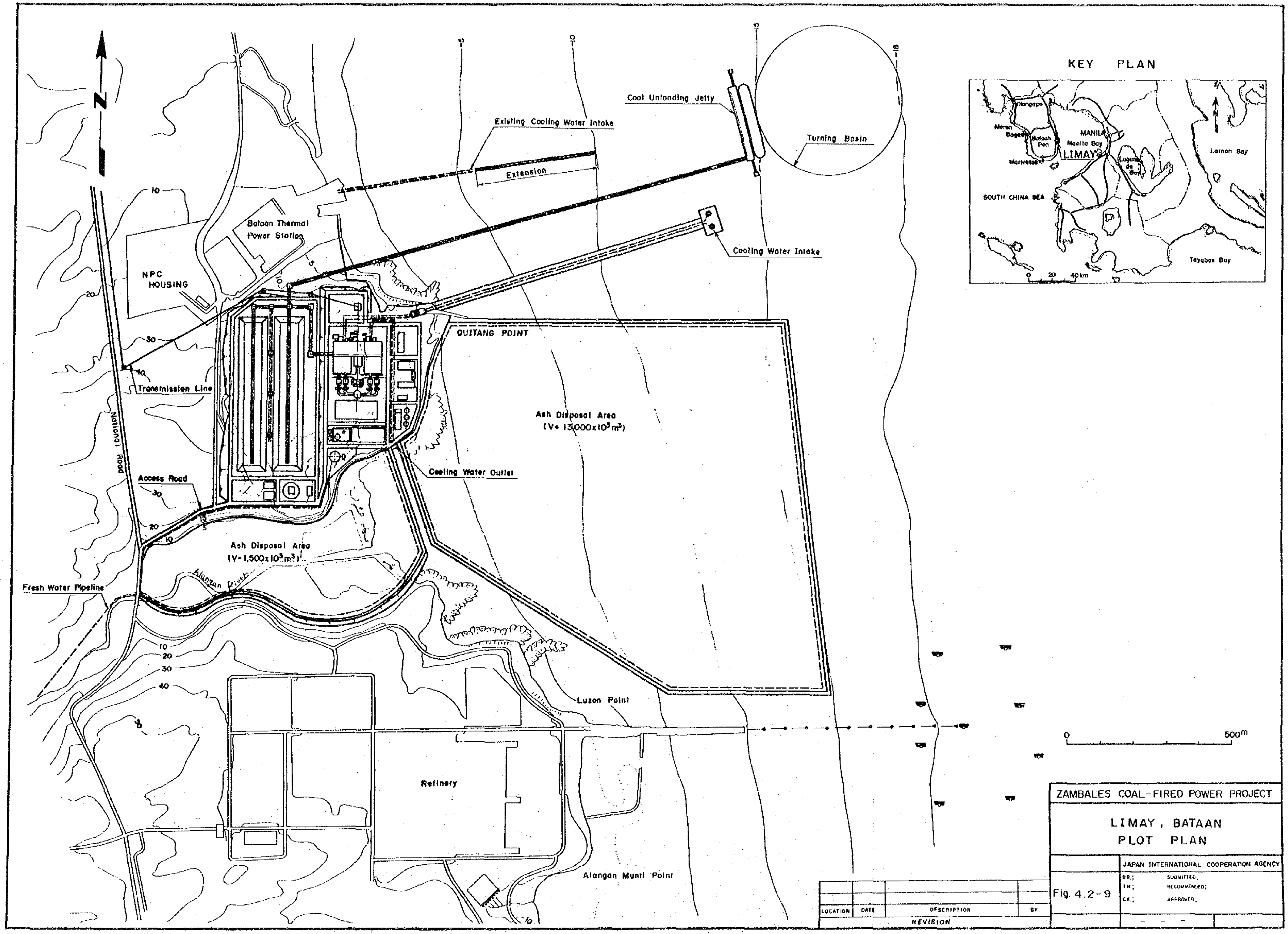


Fig.4.2-8 Site Location (Limay, Bataan)


KEY PLAN
Olongapo
Moron
Bagac
Bataan Pen
MANILA
Manila Bay
LIMAY
Mariveles
Laguna de Bay
Lamon Bay
SOUTH CHINA SEA
Tayabas Bay
0 20 40km
Coal Unloading Jetty
Existing Cooling Water Intake
Turning Basin
Extension
Bataan Thermal Power Station
NPC HOUSING
Cooling Water Intake
QUITANG POINT
Transmission Line
Ash Disposal Area
(V= 13,000x10³m³)
National Road
Access Road
Cooling Water Outlet
Ash Disposal Area
(V=1,500x10³m³)
Alangan River
Fresh Water Pipeline
Luzon Point
Refinery
Alangan Munti Point
0 500m
ZAMBALES COAL-FIRED POWER PROJECT
LIMAY, BATAAN
PLOT PLAN
JAPAN INTERNATIONAL COOPERATION AGENCY
Fig. 4.2-9
DR.; SUBMITTED;
TR.; RECOMMENDED;
CK.; APPROVED;
LOCATION DATE DESCRIPTION BY
REVISION

4.2.7 Evaluation on Environment

Environmental evaluation of the three sites -- Masinloc, San Juan and Limay -- was carried out taking into account the investigation results of NAPOCOR. As for Masinloc site and San Juan site, there are no problems requiring attention since there are no industrial zones nearby. After selection of the site, harmony with the present natural condition will be considered.

The surroundings around the Limay site have already become an industrial area. Adjacent to the area, a thermal power plant and an oil refinery are in operation.

For this reason, the problem of air pollution at the Limay site has been studied in case two new thermal plants of 300 MW each be constructed there.

As a result of diffusion calculation of SOx in relation to the tolerance for the limit value set by NPCC (National Pollution Control Commission), it is desirable that flue-gas desulfurization facilities should be installed in order to reduce SOx as shown in Table 4.2-1 "Results of Diffusion Predictive Calculation (Limay Site)".

Table 4.2-1 Results of Diffusion Predictive Calculation (Limay Site)

		Calculation formula	Meteorological conditions	Smoke source	Calculation results	Evaluation
Short-term diffusion calculation	Manual	Bosanquet-Sutton	Wind speed 5 m/s Stability of atmosphere D ※ Temperature 28 ℃	Power plant Coal, 1st and 2nd units (without flue gas desulfuration equipment) Heavy Oil, 1st and 2nd units Gas turbines, 1st-4th units	If ground-level concentrations of all smoke sources of the power plant are simply added, the maximum ground-level concentration will be about 0.144 ppm (hourly value) and 0.085 ppm (daily avarage value).	It represents about 50% and 60%, respectively, of ambient limits of the National Pollution Control Commission (NPCC) 0.3 ppm (hourly value and 0.14 ppm (daily average value).
Short-term diffusion calculation	Personal computer	Bosanquet-Sutton	Wind speed 5 m/s Stability of atmosphere D ※ Temperature 15 ℃ Wind direction voluntary	Power plant	The maximum ground level concentration will be 0.718 ppm (3 minute value).	If the figure is multiplied by 0.15, the coefficient for time dilution from the 3-minute value to the hourly value, 0.718 ppm × 0.15 = 0.11 ppm, will result, representing about 40% of the ambient limit of NPCC.
				Power plant + Refinery	The maximum ground level concentration will be 1.70 ppm (3 minute value).	If multiplied by 0.15, the coefficient for time dilution from the 3 minute value to the hourly value, 1.70 ppm× 0.15 = 0.26 ppm will result, representing about 85% of NPCC's ambient limit.
Long-term diffusion calculation	Personal computer	(Plume rise formula) Moses, Carson, Concawe, Briggs	Annual meteorological data for NPC Napot site	Power plant	Maximum ground level concentration will be 0.018 ppm.	If the utilization factor of the power plant is assumed to be 70 %, 0.018 ppm × 0.7 = 0.013 ppm will result.
		(Diffusion formula) Plume, Puff		Power plant + Refinery	Maximum ground-level concentration will be 0.029.	If the utilization factor of both the power plant and the refinery is assumed to be 70 %, 0.029 × 0.7 = 0.020 will result.

※ Meteorological Conditions Defining Pasquil Turbulence Types D (Neutral Conditions)

4.3 Selection of Optimal Site

4.3.1 Items for Comparison

In order to select the most appropriate site, the specification is determined for items which are caused by the difference in the specific feature of site and the construction cost is estimated based on the number of work items. Details are as follows:

(1) Access road

Width expansion and pavement work costs for the road to be constructed from the main national road to the site.

(2) Reclamation of plant area

Excavation, banking and dike embankment work costs to reclaim the power station and coal storage yard.

(3) Port and unloading facilities

1) Construction cost for 60,000 DWT class unloading jetty

The construction cost for unloading jetty differs between the sites depending on their geologic conditions.

2) Construction cost for offshore conveyer

The difference in conveyer length and in foundation costs are taken into account.

3) Dredging cost for approach channel (specific to Masinloc site)

4) Breakwater construction cost (specific to San Juan site)

(4) Condenser cooling water equipment

1) Difference arising from difference in the sea depth at water intake

2) Construction costs for cooling water intake, pipes and discharge channel

(5) Ash Disposal Area

1) For inland ash disposal area, the construction costs are calculated based on costs that arise from differences in structure and length of embankment work, and the amount of overburden. The road for truck transport of dry ash, cost for dumptrucks, bulldozers, flyash silos and differences in distance from power plant to ash disposal are also considered.

2) For offshore ash disposal, the construction costs are calculated based on costs that arise from differences in the length of revetment and the volume of overburden. The costs for slurry transport facilities and flyash silos are included. Differences in distance from power plant to ash disposal are also considered.

(6) Fresh water

Included as construction costs are those that arise from differences in the structure of fresh water intake and the length of pipelines.

(7) Belt conveyer

The construction costs are those that arise from differences in length of inland belt conveyer and in structures of foundations.

(8) Foundations

The construction costs are those that arise from differences in depth of bedrock and foundation of main buildings such as power house and stack.

(9) Lighters, wherry for construction

The construction costs of quay for unloading construction machinery and access road to plant site are included.

(10) Temporary transmission line

The construction costs include those that arise from differences in length of temporary transmission lines to power plant.

(11) Transmission line

The construction costs include those that arise from differences in length of transmission line from power plant to neighboring substations.

(12) Miscellaneous

An embankment for offshore ash disposal area is to be built in Limay site. Because this might cause recirculation of thermal effluent from Bataan thermal power plant, the cost for extension of existing water intake pipeline is included. The cost for partial re-routing of the access road of Bataan power plant is included.

4.3.2 Conditions of Approximate Calculation of Construction Cost

(1) Only direct construction cost is included.

(2) The cost for Masinloc site is presented as the base for comparison. The differences from this value are shown for the other sites.

(3) The cost is shown in US dollars. The exchange rates are: 1 US dollar equal to 20.75 pesos and 132 yen. (This rate is applied for site comparison study only.)

(4) Base prices were taken from "1989 Price Level" and "Batangas Coal-Fired Thermal Power Plant, 1981 Price Level", which were received from NAPOCOR in March, 1989. Influence of escalation was also included.

Table 4.3-1 shows the comparison of approximate construction costs based on the above mentioned items and calculation conditions.

4.3.3 Result of Site Selection

Major factors for economic feasibility of three sites are dredging of sea channel, construction of breakwater and offshore ash disposal area. Characteristic features of three sites are as follows:

(1) Limay site necessitates an offshore ash disposal. This makes the site less advantageous compared to the other two sites. It also has problems of air pollution and thermal effluent.

(2) San Juan site is economically inferior to Masinloc site because it needs a breakwater for securing calmness of port, and long offshore belt conveyers and water intake/discharge pipelines.

The site is inferior to Masinloc site with regard to construction and maintenance works for port facilities.

(3) Masinloc site has the following advantages:

1) The site is most economically favorable in spite of costs which are rather high for dredging and transmission line.

2) An area for inland ash disposal is available close to the plant site.

3) Bedrock is near to the ground surface compared to the other sites, thus making the foundation costs somewhat lower than for others. It also has the shortest offshore conveyer and water intake/discharge pipelines.

4) It has room for future expansion with potential ash disposal area both inland and offshore. The plant can be easily expanded.

On the other hand, this site has the disadvantage of having long and winding sea channels. This necessitates improvements in approach channel, deployment of tubgoats and highly experienced pilots. It is thus needed to sound the approach channel to prepare a more detailed harbor scheme in the next stage.

Consequently, the conclusion is that Masinloc is the most favorable site.

Table 4.3-1 Rough Comparison of Construction Cost (1/2)

Unit : $ × 10^3

Items	SITE - A MASINLOC, ZAMBALES		SITE - B SUAN JUAN, BATANGAS		SITE - C LIMAY, BATAAN		Remarks
	Quantity	Cost	Quantity	Cost	Quantity	Cost	
1. Access Road							
Pavement	L = 2.3 km		k = 12 km	1,200	L = 0.25 km	▲ 600	
2. Site Grading	V = 660,000 m³						
Excavation, Banking, Revetment			V = 390,000 m³	▲ 5,400	V = 750,000 m³	▲ 3,600	
3. Harbour, Unloading Facilities							
· Unloading Jetty	h = 14 m		h = 14 m	▲ 800	h = 14 m	▲ 1,500	
· Offshore Conveyer	L = 540 m		L = 940 m	3,000	L = 1,260 m	3,200	
· Dredging	V = 750,000 m³		—	▲ 15,300	—	▲ 15,300	
· Breakwater	—		L = 900 m	38,300	—	0	
4. Condenser Cooling Water Facilities		Base					
· Intake	h = 10 m		h = 10 m	0	h = 13 m	200	
· Off-shore Inlet Channel	L = 530 m		L = 600 m	600	L = 870 m	1,000	
· Inlet-Outlet pipe	L = 290 m		L = 860 m	5,000	L = 780 m	5,100	
· Outlet	L = 510 m		L = 80 m	▲ 600	—	▲ 1,000	
5. Ash Disposal Area							
(1) In-land							
· Embankment	L = 2,600 m		L = 2,050 m	200			
· Overlay Soil	V = 760,000 m³		V = 740,000 m³	0			
· Ash Disposal facilities	L = 1,800 m		L = 5,300 m	4,000			
(Transpotation Distance)							
(2) Offshore							
· Revetment	L = 4,210 m	41,000	L = 3,640 m	63,300	L = 3,790 m	62,600	
· Overlay Soil	V = 660,000 m³	▲ 300	V = 760,000 m³	▲ 100	V = 530,000 m³	▲ 600	
· Ash Disposal facilities	L = 1,000 m	▲ 3,800	L = 1,100 m	▲ 3,800	L = 1,300 m	▲ 800	
6. Fresh Water							
· Intake, Pipeline	L = 10 km	Base	L = 14 km	500	L = 1.3 km	▲ 1,000	

Table 4.3-1 Rough Comparison of Construction Cost (2/2)

Unit : $ × 10^3

Items	SITE - A MASINLOC, ZAMBALES		SITE - B SAN JUAN, BATANGAS		SITE - C LIMAY, BATAAN		Remarks
	Quantity	Cost	Quantity	Cost	Quantity	Cost	
7. Belt Comveyer							
・Onshore Conveyer	L = 880 m		L = 430 m	▲ 2,300	L = 630 m	▲ 1,100	
8. Foundations							
・Power House, Stack, etc.				1,100		2,900	
9. Temporary Lighter's wharf							
・Wharf, Road				300		▲ 1,300	
		BASE					
10. Provisional Electricity							
Transmission Line (69kV)	L = 5 km		L = 35 km	800	—	▲ 100	
11. Transmission Line							
Transmission Line (230kV)	L = 129 km		L = 48 km	▲ 7,400	L = 43 km	▲ 9,000	
12. Others				0	Bataan p/s	2,000	
					Extension of Inlet channel		
					Bataan p/s		
					Shifting of Access Road		
Total							
(1) In-land Ash Disposal Area		BASE		23,200			
(2) Offshore Ash Disposal Area		36,900		78,400		41,100	
Recommended Plan for Ash Disposal Area	In-land	BASE	In-land	23,200	Off-shore	41,100	
Rank		1		2		3	

CHAPTER 5

SELECTION AND PROCUREMENT

STUDY OF COAL

Chapter 5 Selection and Procurement Study of Coal

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CHAPTER 5 SELECTION AND PROCUREMENT STUDY OF COAL

5.1 General

(1) Some Quantitative Issues on the Indigenous Coal

Demand and supply forecast of indigenous coal was examined based on the thermal power development plan in the Luzon grid which was stated in the Chapter 3. The results show that:

i) After checking the balance of demand and supply of indigenous coal in the Philippines, the self-sufficiency ratio of indigenous coal is assumed at 67% in 1993, 79% in 1995 and less than 40% after 1997.

ii) Any other coal resources for Zambales project could not be found except the Semirara coal at this moment.

iii) The self-sufficiency ratio will be maintained at approximately 50% until the commissioning of this project.

The above mentioned circumstances show that the plan of thermal power plants to use only indigenous coal is not realistic.

(2) Quality Issues on the Indigenous Coal

NAPOCOR requested the study on the boiler which could burn both 100% indigenous and 100% overseas coal. The results of the study based on the Semirara Coal and Lemington Coal show that such kind of boiler is not realistic to burn both coal satisfactorily from a technical and an economical view point. The reasons are as follows:

i) In case of exclusively using only indigenous coal in the boiler that is designed based on high bituminous coal, the boiler will not be able to attain the rated output due to some troubles such as slagging of furnace, contamination of heat transfer surface, lacking of pulverizer capacity, decline of inlet temperature of pulverizer, etc. The maximum output would be decreased to about 75% of the rated capacity.

ii) In case of using only imported coal in the boiler that is designed based on lignitic coal exclusively, the boiler will not be able to attain the rated output due to the following reasons:

- decline of main steam temperature and reheat steam temperature by tens degrees Celsius.

- inability to use the pulverizer properly.

iii) The characteristic data of Semirara Coal provided by NAPOCOR have a very wide range of values. Using these data as design basis would result to an un-economical and over-designed steam generating facilities. Therefore, to prevent such matters, analytical data of coal should be obtained from the analyses of various coal sample data taken from different area within the mines.

(3) Selection of Design Coal

By considering availability of indigenous coal and effectiveness of boiler design, 50/50 blending of indigenous and overseas coals for this project should be recommendable.

Australian Lemington coal as overseas coal and Semirara's Himalian coal as indigenous one are adopted as the design coal.

(4) Procurement Strategy of Overseas Coal

i) Coal consumption in the Philippines was approximately 2.48 million tons in 1988. Production of indigenous coal, on the other hand, was only about 1.34 million tons. NAPOCOR plans to develop 3,200 MW of coal-fired plants in total up to 2000. The self-sufficiency ratio of indigenous coal is projected to decline under 40% after 1997. Therefore, the deficiency must be procured with overseas coal. The annual import will reach about 1.3 million tons until 1997 and 9 million tons in 2000. Based on these circumstances, the most important factors in establishing a procurement strategy are:

- Security and reliability
- Flexibility
- Economy

In the procurement of overseas coal it is recommended to have some long-term contract with a spot purchase contract as supplement. The source of overseas coal should be diversified to meet the actual demand.

ii) The procurement of large amounts of coal necessitates careful research on coal market, maritime market, etc., which will help in the establishment of the appropriate procurement plan for a consumer. For achieving this purpose, setting up of the fuel unit in NAPOCOR, as soon as possible, is indispensable.

5.2 Demand and Supply of Indigenous Coal

JICA conducted a master plan survey in 1988 on the coal industry of the Philippines. The demand and supply of indigenous coal was examined based on this study report. The major point of the present report is an examination of the production system of each coal mine, referring to the OEA supply forecast, and an estimation of supply in the year 2000, based on former results. It therefore seems to provide practical figures of forecast.

5.2.1 Supply Forecast

(1) Projection of Long-term Production by OEA

In February 1988 OEA published a projection of coal supply up to the year 2000.

The report forecast the production of 2.0 million tons at the Iguig mine and 2 million at the Isabela mine, both in northern Luzon Island. The production in the Semirara mine is forecasted to be 3.0 million tons in 1995 and 3.6 million tons in 2000.

Coal Supply Forecast (1988 to 2000)

(Unit: 10^3 ton)

	Actual			Forecast			
	80	83	87	88	93	95	2000
(Run of Mine Basis)							
Semirara	33	326	595	875	2,000	3,000	3,600
PNOC Areas	42	275	204	310	350	350	350
Cebu	201	323	1,226	374	654	804	1,104
Batan	12	34	55				
Others	41	62	89	284	681	982	5,322
Total	329	1,020	1,169	1,843	3,658	5,136	10,376
(10,000 Btu Basis)							
Semirara			429	630	1,440	2,160	2,592
PNOC Areas			210	353	402	402	402
Cebu			233	374	654	825	1,132
Batan			52	75	142	142	142
Others			88	164	464	719	2,800
Total			1,012	1,596	3,102	4,248	7,068

Source: OEA, Feb. 1988

(2) The Report on Master Plan Survey for Coal Mining Technology Development by JICA

The report of August 1988 by the JICA Study Mission corrected the previous forecast to smaller figures, providing a more realistic forecast, shown below.

Basic Concept of Supply Forecast by JICA (Aug., 1988)

(Unit: 10^3 ton)

	88	93	95	2000
(Run of Mine Basis)				
U/G	607	915	1,107	1,782
O/C	615	1,230	1,845	1,845
Total	1,222	2,145	2,952	3,627
(10,000 Btu Basis)				
U/G	607	915	1,107	1,782
O/C	461	923	1,384	1,384
Total	1,068	1,838	2,491	3,166

This forecast expected the production by underground mines to increase by 10% each year and that the increase in production by open cut mines would be derived from Semirara mine. The resulting figures were made more realistic. The production at the northern Luzon mine would be added to the figure in case production was commissioned.

(3) Recent Forecast of Coal Supply

In early 1989, the OEA prepared a medium-term schedule covering the next five years, the sum total of forecasted productions for each mine was estimated as 2,996,000 tons for the year 1993. When based on coal production in 1988, this figure corresponds to an average annual growth of 10.5% for mines besides Semirara. This rate is very close to JICA's projection.

Therefore, 10% of annual growth rate was adopted as a basic assumption, and the contribution of newly developed large scale mines was added to the coal supply forecast. With regard to the newly developed mines, production at the Semirara mine, PNOC Lalat mine, and PNOC Bislig III mine, all being national mines, was forecasted. The contribution of developments at other private mines was included in the 10% growth. The summary is given below.

<u>Semirara New Mine</u>

Attached Appendix should be referred.

<u>PNOC-CC's Lalat Mine</u> (Zamboanga, Mindanao Island)

The minable quantity is 11 million tons and the planned annual production is 300,000 t/y (as clean coal). New mines are developed according to demand. The proper level of production would be approximately 200,000 t/y.

Bislig Mine, District No. 3 (Bislig, Mindanao Island)

The minable reserve is about 24 million tons. The selected clean coal has 15% moisture content, 5 to 9.5% ash content and 10,000 - 10,700 Btu/lb heating value. The commissioning of production for the Mindanao Thermal Power Plant is scheduled for 1999.

Coal Supply Forecast

(Unit: 10^3 ton)

	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
ROM Basis													
Semirara(U)	670	700	700	700	700	700	700	700	700	700	700	700	700
" (others)					900	1200	1200	1200	1200	1200	1200	1200	1200
PNOC Lalat						100	150	200	200	200	200	200	200
Bislig III												150	250
Others	666	733	806	886	975	1073	1180	1298	1428	1570	1727	1900	2090
Total	1336	1433	1506	1586	2575	3073	3230	3398	3528	3670	3827	4150	4440

	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
10,000 Btu Basis													
Semirara(U)	583	609	609	609	609	609	609	609	609	609	609	609	609
" (others)					648	864	864	864	864	864	864	864	864
PNOC Lalat						105	158	210	210	210	210	210	210
Bislig III												131	218
Others	666	733	806	886	975	1073	1180	1298	1428	1570	1727	1900	2090
Total	1249	1342	1415	1495	2232	2651	2811	2981	3111	3253	3410	3714	3991

* Remark: Semirara (U) means Unong mine.