THE COOPERATIVE REPUBLIC OF GUYANA

THE MASTER PLAN STUDY
ON
ELECTRIC POWER DEVELOPMENT PROJECT
IN
THE COASTAL AREA

FINAL REPORT

MAY 1989

JAPAN INTERNATIONAL COOPERATION AGENCY

PREFACE

In response to a request from the Government of the Cooperative Republic of Guyana, the Japanese Government decided to conduct a survey on Electric Power Development Project in the Coastal Area of Guyana and entrusted the survey to the Japan International Cooperation Agency (JICA).

JICA sent to Guyana a survey team headed by Mr. Masashi Koike, EPDC International Ltd., from July, 1988 to March 1989.

The team exchanged views with the officials concerned of the Government of Guyana and conducted field surveys in the Coastal Area of Guyana. After the team returned to Japan, further studies were made and the present report was prepared.

I hope that this report will contribute to the development of the Project and to the promotion of friendly relations between our two countries.

I wish to express my sincerest appreciation to the officials concerned of the Government of the Cooperative Republic of Guyana for their close cooperation extended to the team.

May, 1989

Kensuke Yanagiya

Kensuke Yanagiya
President
Japan International Cooperation Agency

LETTER OF TRANSMITTAL

Mr. Kensuke Yanagiya
President
Japan International Cooperation Agency

Dear Sir,

We take pleasure to submit herewith the report on Master Plan Study on Electric Power Development Project in the Coastal Area of the Cooperative Republic of Guyana which was prepared by a study team of EPDC International, Ltd. under assignment from the Japan International Cooperation Agency.

The study team conducted field investigations with the cooperation of Guyana Electricity Cooporation from July to September, 1988, following which studies in the home office were performed up to March, 1989 to complete this report.

The highlights of this report are as follows:

i) In order to mitigate the present shortage of supply capability, emergency power supply enhancement measures that should be implemented promptly is the installation of diesel engine generators at 2 existing power stations.

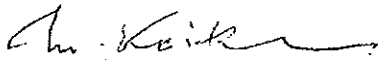
ii) Taking into consideration growth of demand and phased decommissioning of existing power generating units, the most optimum medium range electric power development program which covers the next 10 years comprising among others construction of major thermal power stations that were considered to be the best approach were studied and are presented in the report.

It is the wish of the study team that the projects recommended in this report are realized, thereby contributing to the improvement of supply and demand situation of electricity in Guyana.

In submitting this report, the study team wishes to record their deep appreciation to the government authorities concerned of Guyana and Guyana Electricity Corporation for their assistance and cooperation in the field investigations and making available all pertinent data and information, the Japanese Embassy in Venezuela, the Ministry of Foreign Affairs, the Ministry of International Trade and Industry, and Japan International Cooperation Agency for their guidance in performing the studies.

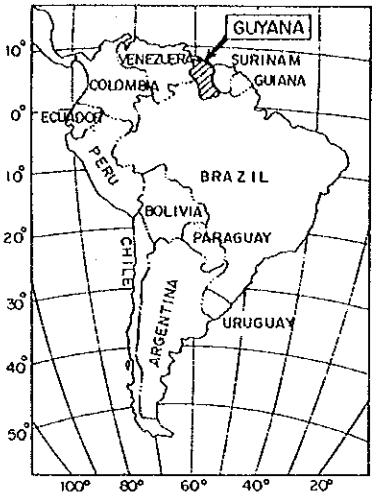
May 1989

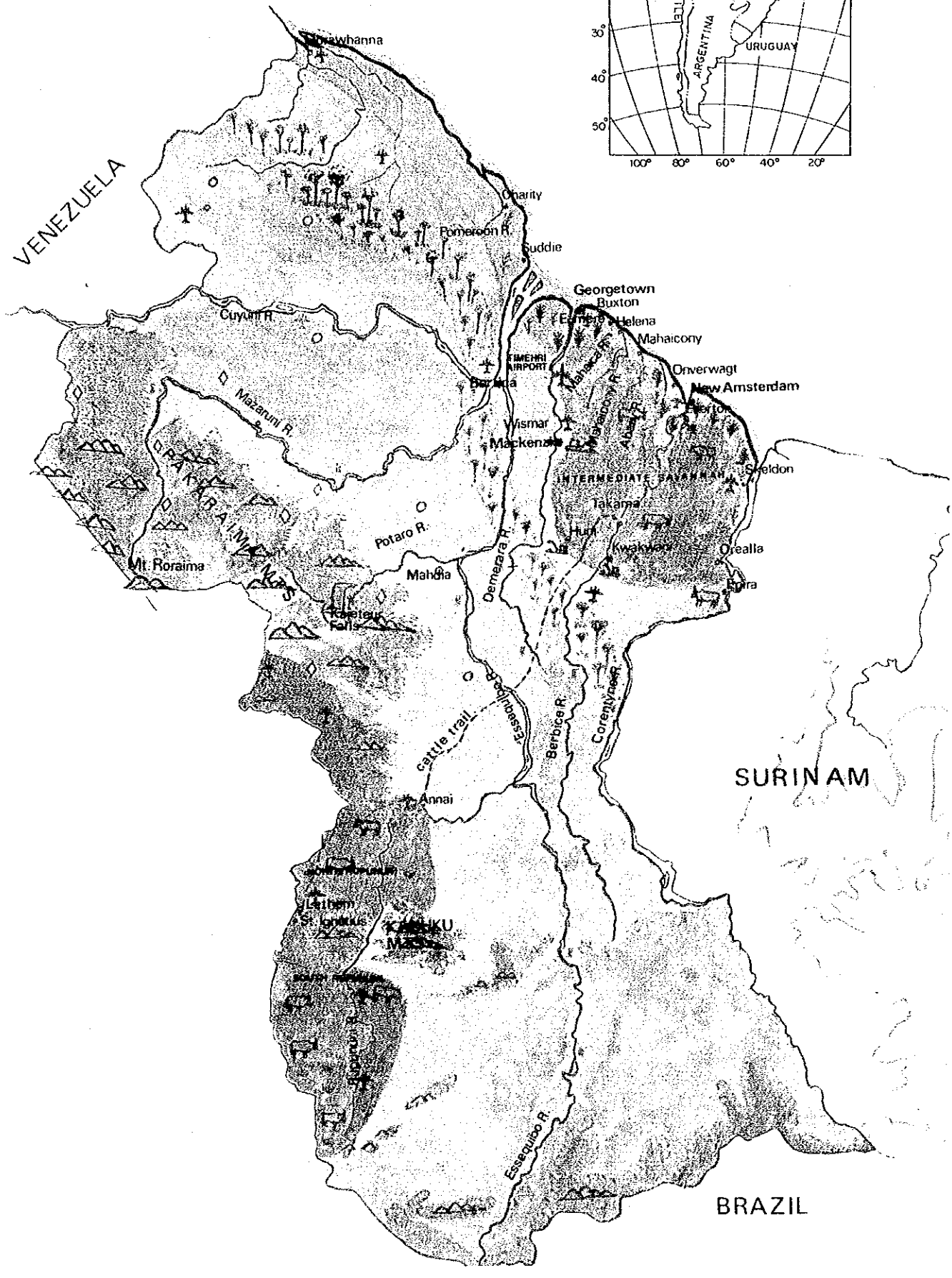
Respectfully submitted,

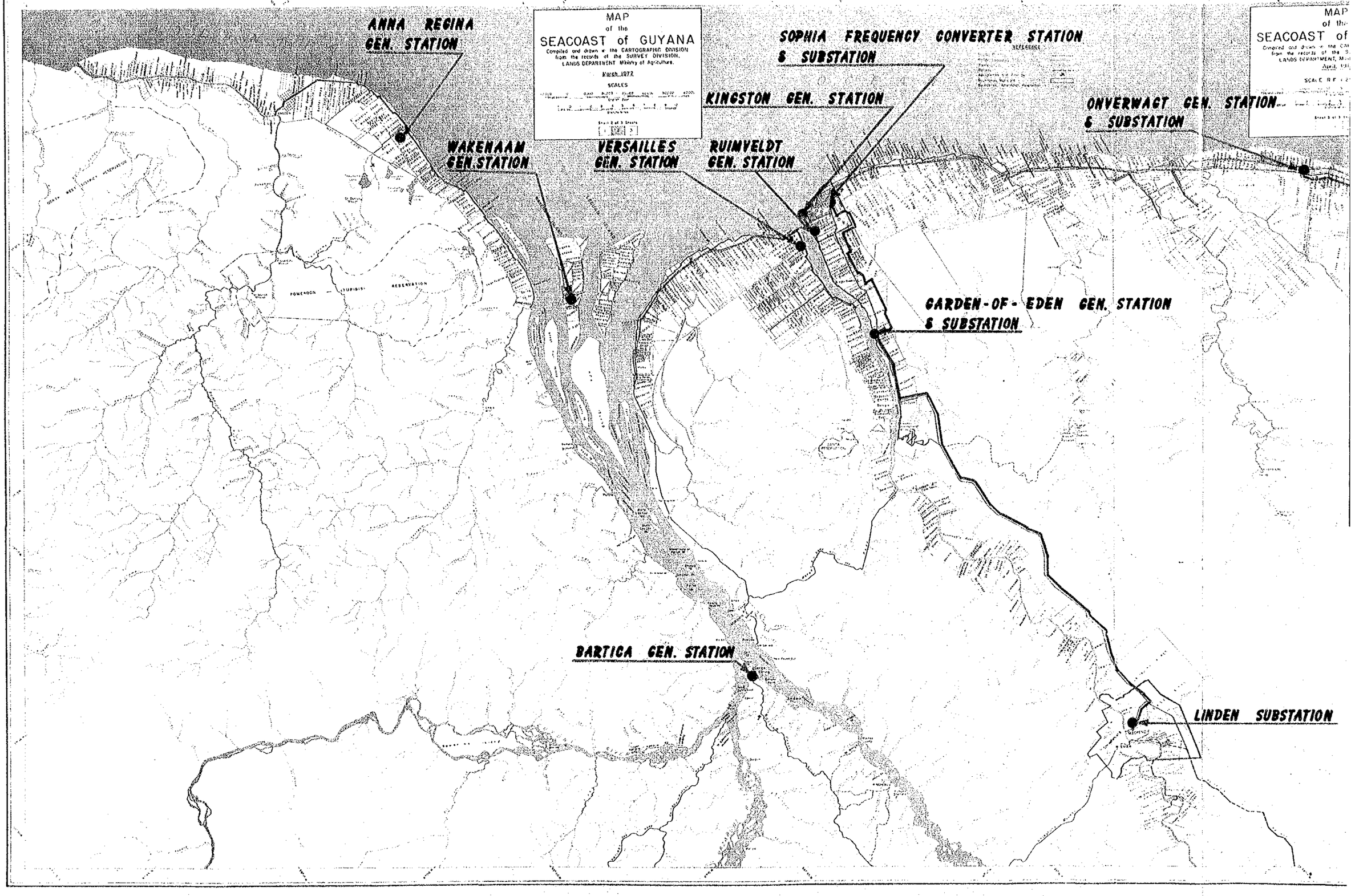


Masashi Koike
Team Leader
Study Team of Master Plan Study on
Electric Power Development Project
in the Coastal Area of Cooperative
Republic of Guyana

THE COOPERATIVE REPUBLIC OF GUYANA






ANNA REGINA GEN. STATION
MAP of the SEACOAST of GUYANA
Compiled and drawn at the CARTOGRAPHIC DIVISION from the records of the SURVEY DIVISION, LANDS DEPARTMENT Ministry of Agriculture.
March 1972
SCALES
SOPHIA FREQUENCY CONVERTER STATION & SUBSTATION
KINGSTON GEN. STATION
ONVERWACHT GEN. STATION & SUBSTATION
WAKENAAM GEN. STATION
VERSAILLES GEN. STATION
RUIMVELDT GEN. STATION
GARDEN-OF-EDEN GEN. STATION & SUBSTATION
BARTICA GEN. STATION
LINDEN SUBSTATION

FREQUENCY CONVERTER STATION

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MAP
of the
SEACOAST of GUYANA
Compiled and drawn in the CARTOGRAPHIC DIVISION
from the records of the SURVEY DIVISION,
LANDS DEPARTMENT, Ministry of Agriculture
April, 1971
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Sheet 3 of 3 Sheets

ONVERWACT GEN. STATION
& SUBSTATION

CANEFIELD GEN. STATION
& SUBSTATION

NO. 53 SUBSTATION

GARDEN-OF-EDEN GEN. STATION
& SUBSTATION

LINDEN SUBSTATION

REFERENCE

KEY

69 kV. TRANSMISSION LINE

13.8kV Distribution Line

11kV "

S U R I N A M

CONCLUSION AND RECOMMENDATION

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(1) Prompt Realization of Garden of Eden Unit Replacement Program

This program has been identified as the top priority project among Emergency Measures for supply capability enhancement. It is recommended that GEC will promptly accelerate the realization of this program.

Program Outline:

Installation of a new, 5.7 MW, medium speed diesel generator. (The fundation and building of existing power station will be utilized as such.)

Scheduled commissioning; end of 1990.
Total construction cost; approximately 700 million yen.

(2) Authorization of Onverwagt Power Station 3 Units Replacement

The supply capacity of Berbice System must be expanded by some 7 MW as the second step of Emergency Measures for supply capability enhancement. It is recommended that GEC reviews the plan proposed in this Report immediately, finalize the plan, forward the plan to the Government, and take necessary actions for realization of plan including procurement of funds.

Program Outline:

Installation of three, new, 2.6 MW, high speed diesel generators. (The foundation and building of existing power station will be utilized as such.)

Scheduled commissioning; end of 1991.
Total construction cost; approximately 800 million yen.

(3) Preparation of Construction of New Kingston Power Station

Construction of New Kingston Power Station is the key project in Power Development Plan of Guyana. Existing Kingston B Power Station is approaching the end of plant life. Since it is inevitable for GEC to construct a new power station, it is necessary to start planning right now. In this context, it is recommended that the feasibility study of this project should be started immediately.

Program Outline:

Installation of a new power station having low speed diesel generators with total capacity of 52 MW.

Unit capacity;	13 MW, 4 units
Location;	premise of old Kingston "A" Power Station
Scheduled commissioning;	Phase I, 13 MW x 2, 1993
	Phase II, 13 MW x 2, 1995
Total construction cost;	approximately 8 billion yen.

(4) Preparation of Hydroelectric Development Plan

Since the Republic of Guyana is blessed with abundant hydroelectric power resources, it is recommended that hydroelectric power plants are constructed as soon as practicable to secure energy self-sufficiency of the nation.

Although Tiger Hill Site has not been incorporated in this Master plan as a realistic power supply source which can improve supply shortage by 1998, this project has been verified as an excellent hydroelectric potential. Therefore, it is recommended that GEC authorizes its willingness to take up this project and start preparations which are recommended in this Report.

Recommended Project Plan:

Power Station capacity; 56 MW (to be expanded to 84 MW in future)
Rockfill dam with effective storage capacity of 4220 x $10^6 m^3$.
Effective head; 36 m, maximum discharge; 186 $m^{3/s}$
Generator capacity 28 MW x 2 (1 unit added in future)
Annual generation; 265 GWh.

(5) Improvement of Operation/Maintenance Management

Various recommendations presented in the main text of this Report are those that can be implemented immediately. It is advised that GEC examine these recommendations carefully.

(6) Accelerating 60 Hz Conversion of Georgetown Loads

As Kingston B Power Station, currently being operated at 50 Hz, will soon retire, and power will be supplied by 60 Hz New Kingston Power Station, all customers in Georgetown must be converted to 60 Hz. This could be a complicated task. Since this is inevitable, however, detailed studies must be started immediately to establish a realistic program as soon as possible.

CONTENTS

CHAPTER 1

INTRODUCTION

CHAPTER 1 INTRODUCTION

1.1 AUTHORIZATION

From several years ago, electricity supply capability of Guyana Electricity Corporation (GEC) has been in serious shortage to meet power demand due mainly to frequent troubles and deterioration of power plants, so that GEC has been forced to execute scheduled load shedding throughout the day. Under this circumstance, it is necessary to accelerate rehabilitation work for super-annuated power generating facilities and to construct new power plants corresponding to the growth in power demand, based on an optimum power development program.

The Government of Japan, in response to the request of the Government of the Cooperative Republic of Guyana, decided to conduct a Master Plan Study and the Japan International Cooperation Agency (JICA) dispatched a study team for a period of about 10 weeks from 14 July to 20 September 1988 to conduct field investigations.

1.2 SCOPE OF WORK

Scope of work of the field study and reconnaissance were:

a) Review of previous studies and data provided;

b) Study on the present power market including imminent problems of power plant rehabilitation;

c) Preparation of recommendations for improvement of operation and maintenance system of power plants;

d) Power demand forecast for the period of 10 years from 1989 to 1998 and preparation of demand and supply balance based on the above forecast;

e) Economic ranking study of various types of power plants to be included in the power development Master Plan for the above period;

f) Reconnaissance of Tiger Hill hydroelectric potential site, including surface geological investigation and preliminary topographic survey;

g) Preliminary hydrological study;

h) Optimization study to determine generating capacity and annual energy generation of power plant to be constructed at Tiger Hill site.

1.3 FIELD STUDY AND RECONNAISSANCE

Prior to field study and reconnaissance, a "Start Meeting" was held on 14 July at Department of International Economic Cooperation, Office of the President, between JICA team and representatives of:

- Department of International Economic Cooperation (DIEC).
- Guyana Natural Resources Agency (GNRA)
- Ministry of Public Utilities (MPU)
- Guyana Electricity Corporation (GEC)

Based on the mutual understanding reached at this meeting, the following field study was carried out:

(a) Investigation of the Demerara and Berbice systems

Field investigation was made by visiting the following facilities during the period from 15 to 26 July 1988:

. Power plants and frequency convertor station of GEC in the Demerara and Berbice areas.

. Captive power plants of GUYMINE in the above areas.

. Captive power plants of GUYSUCO in the above areas.

. Installations of bulk consumers in the west Demerara area.

(b) Preliminary visit to Tiger Hill site

On 27 July, a short visit to Tiger Hill hydroelectric potential site was made in order to make arrangement for site reconnaissance study to be conducted by civil engineering and geological investigation group.

(c) Joint general meeting

On 3 August, a "Joint General Meeting" was held at Department of International Economic Cooperation between JICA team and representatives of DIEC, GNRA, MPU and GEC, and results of field study and outlook of middle-term Master Plan were explained by JICA team.

After this meeting, a courtesy call was made to His Excellency, Robert H.O. Corbin, Deputy prime Minister (Public Utilities) at his office, together with GEC General Manager, and progress of study was reported.

(d) Investigation of Isolated Systems and Transmission and Distribution Facilities

During the period from 5 to 22 August 1988, the following installations of GEC were visited and current conditions of power generation were investigated:

- Power plants in the isolated systems of Anna Regina, Wakenaam and Bartica
- 69 kV, 13.8 kV and 11 kV transmission lines in the Demerara and Berbice areas
- Sophia frequency convertor station

(e) Tiger Hill site reconnaissance

Site reconnaissance was carried out during the period from 17 to 23 August 1988, accompanied by GNRA staff, to determine the general layout of main structures and to collect data needed for preliminary design.

(f) Data arrangement and analysis

During the period from 24 August to 20 September 1988, data arrangement and analysis were made at GEC head office.

(g) Submission of progress report

On 21 September 1988, the JICA study team, prior to its return to Japan, submitted to GEC the Progress Report which described in outline the middle-term Master Plan for optimum power development based on the field investigations.

(h) Submission of Interim Report

Upon return to Japan, the JICA study team conducted studies at Head Office of EPDC International Company based on the data collected in Guyana, and submitted to GEC the Interim Report on 23 January, 1989.

(i) Submission of Final Report (Draft)

The Final Report (draft) was prepared by the JICA study team reflecting the results of discussions held with the government authorities concerned of Guyana on the Interim Report.

This report was submitted to GEC on 22 March 1989.

1.4 STUDY TEAM

The JICA study team consisted of eight experts. Names and professions of the team members are as follows:

Masashi KOIKE	Team Leader
Tetsuro KOBAYASHI	Load forecast; Economic evaluation
Akio MASUKI	Thermal power plant planning & design
Noriyuki KOHORI	Power plant design (thermal & hydro)
Kunio KURODA	Power system planning
Minaichi TAKEOKA	Hydro power generating planning
Kaname SOBUE	Geological evaluation
Shozo YUZAWA	Hydro power generating planning (in Japan)

CHAPTER 2

BACKGROUND OF THE PROJECT

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2.1 ECONOMIC BACKGROUND

2.1.1 Geography

Guyana is situated in the north-east corner of South America facing the North Atlantic Ocean and has an area of about 215,000 sq km. It lies between latitude 1 degree North and latitude 8 degree North, and it is bounded on the West by Venezuela, on the East by Surinam and on the South by Brazil.

Along the North Atlantic Ocean, there are long coastal plains, partially covered by swamps interspersed with creeks and rivers. West and South of the coastal plains are successive belts of tropical rain forest with scattered hills, gradually rising up towards the boundaries with Venezuela and Brazil.

Four large rivers - Essequibo, Demerara, Berbice and Corentyne - flow from South to North and empty into the North Atlantic Ocean.

The climate is of typical tropical rain forest. The annual precipitation is about 2500 mm (1971-1985). The maximum shade temperature is about 30-31°C, and the minimum shade temperature is about 23-24°C (1974-1985).

The total population is estimated to be about 800 thousand in 1984. The annual population growth rate is about 2.1%.

Main cities are Georgetown, capital of the country, in the Demerara area and New Amsterdam in the Corentyne area. Linden in the hinterland is the center of bauxite production. In the Essequibo coast there are main towns of Anna Regina and Wakenaam.

2.1.2 Main industries

The national economy of Guyana is primarily dependent on the production of bauxite, sugar and rice. Needless to say, the availability of foreign exchange is indispensable to secure a steady growth of national economy. A statistic of IMF in 1987 shows that of the total export value in 1985, 48.2% was held by bauxite production, 32.2% by sugar production, 6.5% by rice production and 13.1% by other miscellaneous products as shown below:

	Export amount (US$ million)	Share (%)	Estimated production in 1986
Bauxite	421.6	48.2	1.47 million tons
Sugar	282.0	32.2	245.44 million tons
Rice	56.6	6.5	183.00 million tons
Other products	115.2	13.1	-
Total	875.4	100.0	

At the time of Guyana's independence in 1966, the bauxite and sugar sectors were controlled by foreign interests, with the indigenous private sector involved in local trading and distribution, agriculture and some small-scale manufacturing. In the early 1970s, the Government nationalized the bauxite and sugar sectors, and also has progessively become the main actor in the other economic sectors.

Most of the agricultural activity is concentrated along the coastal plains, and the mineral and timber resources remain largely unexploited in the hinterland because access is limited due to underdeveloped infrastracture.

2.1.3 Economic performance

Economic performance during the first half of the 1970s indicated real income growth at an average rate of about 4% per annum as a result of the rapid growth in Government expenditures and favorable prices for Guyana's major export commodities.

During the period from 1975 to 1980, on the other hand, there was an economic decline as a result of the fall in sugar price, the weakening in the demand of Guyana's main export products, and the reduced output in the two major sectors of bauxite and sugar.

Faced with the continuing economic crisis, in 1980 the Government began to formulate an economic program which aimed at recovering economic growth, generating employment and strengthening the balance of payments through the development and expansion of export-generating and efficient import substituting activities. However, in 1982 and 1983, real GDP contracted significantly with output in 1983 being approximately 16.5% lower than the level achieved in 1980. There were significant decreases in the bauxite and sugar production due to technical, labor and managerial problems, reducing drastically foreign exchange earnings.

The economy experienced some recovery in output in 1984 and thereafter, primarily as a result of improvements in bauxite production. It is estimated that GDP growth measured 2.1% in 1984, 0.9% in 1985 and 0.3% in 1986, representing a significant improvement over the economic decline registered in the early 1980s.

GDP registered during the period from 1974 to 1986 is as follows:

Year	Current price (G$ million)	Deflator	1980 prices (G$ million)	
1974	955.0	68	1,400.0	
1975	1,188.0	77	1,546.0	
1976	1,136.0	71	1,591.0	
1977	1,125.0	74	1,515.0	
1978	1,268.0	85	1,489.0	
1979	1,326.0	90	1,479.0	
1980	1,508.0	100	1,508.0	
1981	1,697.0	101	1,576.0	
1982	1,446.0	105	1,380.0	
1983	1,468.0	117	1,259.0	
1984	1,700.0	-	1,285.0	(Estimated)
1985	1,964.0	-	1,297.0	(Estimated)
1986	2,219.0	-	1,301.0	(Estimated)

Source: International Financial Statistics 1987 (IMF)

2.1.4 Balance of payments

The balance of payments during the period from 1980 up to present showed deficits every year with the exception of a moderate surplus of trade balance in 1984 as shown below:

(US$ million)

	1983	1984	1985
Exports	193.2	217.0	215.0
Imports	-248.3	-214.3	-262.2
Trade balance	-55.1	+2.7	-47.2
Services (Balance)	-100.5	-108.3	-112.3
Transfer (Balance)	1.0	6.2	6.5
Current account balance	-154.6	-99.4	-153.0
Capital (Balance)	-1.7	-7.8	-47.6
Net errors and omissions	-7.9	-10.3	-47.6
Balance of payments	-164.2	-117.5	-178.2

Source: Recent Economic Development (IMF)

2.2 POWER MARKET

2.2.1 Historical background

On December 28, 1960 the Guyana Electricity Corporation (GEC) was established by the Government purchasing the assets of the Demerara Electric Company, Ltd. At that time, the total installed capacity was 15.1 MW including Kingston "A" power station, Ruimveldt power station and two diesel generators installed in the Goods Yard of the Transport and Harbours Department. The distribution system consisted of a 4 kV primary network covering Georgetown, the East Coast Demerara as far as Better Hope, and the east bank of Demerara as far as Diamond, to supply electricity to about 31,000 consumers. All of these power stations have been retired from service.

During the period from 1962 to 1967, three steam turbine generators of each 10 MW were installed to constitute Kingston "B" power station. In 1978, two gas turbines of each 10 MW were installed in the compound of Kingston "B" power station, but they are out of service from several years ago.

In 1964, the Best area on the west bank of Demerara was electrified via a submarine cable from Kingston power station. In 1967 and 1972, five diesel generating units were installed at Versailles, but in 1985, they were

replaced by 3 units of each 2.0 MW obtained under a grant aid scheme from the Government of Japan.

In 1976 and 1977, four 5.7 MW diesel power station at Garden of Eden entered service.

In the West Berbice area, the first supply of electricity was made by GEC with the installation of three small-scale diesel generating units at Onverwagt. This power station was strengthened by the installation of four 1.0 MW diesel generators in 1973 and a 2.5 MW diesel generator in 1981. At present, it is only the last 2.5 MW unit which is operated for commercial service.

The first supply of electricity by GEC to the Corentyne area was made in 1972 with the construction of small-scale diesel power station at #53 Village and another station at Rose Hall in 1973. The New Amsterdam Electric Works was acquired by GEC in 1979 and currently GEC supplies New Amsterdam from two 5.8 MW Canefield power station.

For the isolated areas of Anna Regina, Wakenaam and Bartica, the first supply of electricity was made with the installation of small-scale diesel generating units in the following years:

Anna Regina	in 1964
Wakenaam	in 1981
Bartica	in 1970

2.2.2 Organization of Power Sector

GEC is governmental corporation. Its statutory duty is to develop and maintain an efficient and economical system of electricity supply for all parts of the country, but its financial position is precarious. GEC is also an operating subsidiary of the Guyana State Corporation (GUYSTAC), a government corporation which supervises and controls the state interest in public corporations.

The organization of the power sector is controlled by different agencies of the Government. The National Energy Authority (NEA) of the Ministry of Energy and Natural Resources, is responsible for formation of a national energy policy. The Ministry of Finance has jurisdiction over regulatory

matters (service areas, franchises, tariffs, and inspection of electrical facilities.)

The organization of GEC is as follows:

(1) Board of Directors

The supreme organ of GEC is the Board of Directors which is constituted of members representing related ministries, governmental corporations such as GEC, GUYMINE, GUYSUCO, etc., industrial trade-unions, professional experts, etc. The Board decides operational and financial policies, power development program, system expansion program and other important affairs.

(2) GEC Headquarter

The business affairs are managed by a General Manager, assisted by two Deputy General Managers (Technical and Financial). The daily business operations are carried out by the following 18 Departments or Units, each headed by Manager:

- Turbine Generation Department	Technical
- Diesel Generation Department	
- Transmission & Distribution Department	
- System Control Department	
- Transport Department	
- Electrical Services Department	
- Maintenance Department	
- Project Management Department	
- Personnel Department	
- Training Department	
- Strategic Planning Unit	
- Office of the IDB Coordinator	
- Financial Department	Financial
- Commercial Department	
- Contracts & Supplies Department	
- Data Processing Department	
- Internal Audit Department	
- Corporation Secretary	

2.2.3 Present status of power system

The GEC power system comprises two interconnected systems and isolated systems. The interconnected systems serve major cities and towns in Demerara, West Berbice and Corentyne areas, while the isolated systems serve three areas of Anna Regina, Wakenaam and Bartica.

(1) General situation

In Guyana, the population increased from 600 thousand in 1970 to 800 thousand in 1984 at an average rate of 2.08% per annum. This growth rate and actual data on the distribution of people in 1984 lead to estimate the numbers of population and households in 1988 as follows:

Table 2.2.3 (1) Numbers of households and electricity consumers

Power system	1984		1988		
	Population	Households	Population	Households	Electricity consumers
Demerara	378,389	75,821	411,670	72,000	71,420
Berbice	229,157	43,808	249,300	47,700	23,239
Anna Regina/Wakenaam	37,284	7,066	41,290	8,100	5,498
Bartica	6,223	1,239	6,770	1,400	1,202
Total	651,053	127,934	709,030	129,000	101,359

Note: Numbers of population and households .... Within 5 miles of primary lines.
Number of electricity consumers ..... Data provided by GEC

The total population in 1984 is estimated to be about 800 thousand. Therefore, the above table shows that about 70% of the total population inhabit urban areas where electricity is supplied by GEC.

Based on the above table, the rates of access to electricity at present are estimated as follows:

Demerara system	99.2%
Berbice system	48.7%
Anna Regina/Wakenaam system	67.9%
Bartica system	85.6%
Average	78.6%

Although supply of electricity has not been stable in the past several years, 78.6% of the people living in the GEC power system have access to electricity at present (For the country as a whole, this rate will be 78.6% x 0.7 = 55.0%).

The GEC power system consists of 8 power stations having a total installed capacity of 72.6 MW, of which 42.6 MW (15 units) are of diesel power plants and 30 MW (3 units) are of thermal power plant. There is no hydro power station.

Except for Versailles power station, which was commissioned in 1985, all of the GEC power plants entered service many years ago and are completely super-annuated. Some of them remain dismantled because of troubles and lack of spare parts. There are also some units which were retired and available spare parts were diverted to other generating units for repair.

Thus, total guaranteed capacity at present is only 40.2 MW against total installed capacity of 72.6 MW. The aggregate maximum power demand in the Demerara and Berbice systems in 1987 was 46.2 MW against their guaranteed capacity of 37.2 MW. From several years ago, the shortage of supply capability of GEC power system has been covered by scheduled load shedding and import of power (4 to 8 MW) from GUYMINE power station at Linden.

As of August 1988, the generating capacity by power system is summarized as follows:

Power plant	Number of units	Installed Capacity	Guaranteed capacity	Peak load in 1987
Demerara system:				
Kingston	3	30.0	25.5	-
Versailles	3	6.0/4.8	4.2	-
Garden of Eden	3	17.1	3.0	-
Subtotal		53.1/51.9	32.7	37.8
Berbice system:				
Canefield	2	11.6	4.5	-
Onverwagt	1	2.5	(1.8)	-
Subtotal	3	14.1	4.5	8.4

Isolated systems:

Anna Regina	3	4.08	2.1	1.91
Wakenaam	1	0.5	0.5	0.44
Bartica	2	0.78	0.4	0.38
Subtotal	6	5.36	3.0	2.73
Total GEC	18	72.6/71.4	40.2	48.9

(2) Interconnected system

a) Demerara system

GEC have three power stations in the Demerara system, i.e. Kingston steam power station, Versailles diesel power station and Garden of Eden diesel power station. As of August 1988, their total guaranteed capacity is 32.7 MW against total installed capacity of 51.9 MW.

This power system is divided into 50 Hz service area and 60 Hz service area. Kingston power station supplies power at 50 Hz. Garden of Eden power station supplies at 60 Hz, together with Linden power station of GUYMINE. Turbine-generators of Versailles power station are of dual type of 50/60 Hz.

Between 50 Hz service area and 60 Hz service area, power is exchanged through Sophia frequency convertor station. This station, equipped with three rotary convertors of each 10.0 MW, was commissioned in 1976.

Power plant	Frequency (Hz)	Installed capacity (MW)	Guaranteed capacity (MW)	Commissioning year
Kingston	50	10.0 x 3	8.5 x 3	1963 - 67
Versailles	60/50	2.0/1.6 x 3	1.4 x 3	1985
Garden of Eden	60	5.7 x 3	3.0 x 1	1975
Total		53.1/51.9	32.7	

Of the three generating units (No. 2, No. 3 and No. 4) of Garden of Eden power station, two units are out of order due to various troubles, i.e. No. 3 unit from 1986 and No. 2 unit from September 1987.

A 69 kV transmission line runs from Linden substation to Sophia frequency convertor station through Garden of Eden power station for a stretch of 110.4 km. From Sophia convertor station to Onverwagt power station of the Berbice system, a 13.8 kV line runs for a stretch of about 93 km. At present, power of about 3 MW is supplied at 60 Hz by this line from Sophia to Onverwagt.

The West Demerara area where Versailles power station is located is connected to the East Demerara area by two submarine cables laid on the bottom of the Demerara river. One is 50 Hz cable which connects Versailles power station to Kingston power station, the other is 60 Hz cable which starts from Garden of Eden power station and extends to Concervancy point, about 10 km before Versailles power station. However, 50 Hz cable was damaged by ship, and repair work has not yet been executed. Therefore, it is only West Demerara area which is supplied by Versailles power station at present.

In 1987, peak load in the Demerara area was 37.8 MW against guaranteed capacity of 32.7 MW. The shortage of supply capability of GEC power plants is very large. Although the shortage is partially covered by power imported from Linden power station of GUYMINE, GEC is forced to enforce load shedding throughout the day.

There is an installed capacity of 27.5 MW (generating 20 MW at present) of steam generating plant of the GUYMINE bauxite undertaking at Linden. This undertaking is not a potential consumer of GEC and there is an agreement between GEC and GUYMINE whereby GUYMINE will supply up to 4 MW of demand to GEC. However, in order to cover large shortage of supply capability of GEC power plants, power supplied by GUYMINE to GEC during peaking hours sometimes reaches 8 to 9 MW in recent years.

b) Berbice system

In the Berbice system which comprises two diesel power stations of Canefield and Onverwagt, power is supplied at 60 Hz. A 69 kV transmission line runs from Onverwagt power station to No. 53 substation through Canefield power station for a stretch of 97.6 km. As stated in Section a), Onverwagt power station is connected to Sophia convertor station by 13.8 kV line of about 93 km long.

The total number of generating units of this power system is only 3, of which 2 units are Canefield power station and 1 unit is Onverwagt power station. At Onverwagt power station, there are 4 other units of each 1.0 MW, but they were already retired from service.

Total installed capacity of this power system is 14.1 MW and total guaranteed capacity is 10.8 MW. But, the guaranteed capacity as of August 1988 is only 4.5 MW of Canefield No. 3 unit. Other 2 units are out of order at present because of troubles.

Power plant	Frequency (Hz)	Installed capacity (MW)	Guaranteed capacity (MW)	Commissioning year
Onverwagt	60	2.5 x 1	(1.8)	1981
Canefield	60	5.8 x 2	4.5 x 1(2)	1978
Total		14.1	4.5	

As described later, in the West Berbice and Corentyne areas there are three (3) captive power plants of GUYMINE (3.15 MW Everton power station) and GUYSUCO (3.4 MW Albion power station and 2.0 MW Blairmont Estate power station). In case of emergency, power is supplied from GEC to GUYMINE, or vice versa. However, between GEC and GUYSUCO power supply has never been made. Power generated (50 Hz generation) by GUYSUCO is supplied only for their own facilities.

(2) Isolated Systems

In the isolated power systems there are three power stations of Anna Regina, Wakenaam and Bartica, of which Anna Regina is 50 Hz generation and the other two power stations are 60 Hz generation.

a) Anna Regina power station

This power station is located at Anna Regina town, about 60 km west of Georgetown. The generating capacity as of August 1988 is as follows.

Unit	Installed capacity (MW)	Guaranteed capacity (MW)
No. 1	1.04 (1,400 HP)	0.55
No. 2	1.04 (1,400 HP)	0.55
No. 4	2.0 (2,920 HP)	1.0
Total	4.08	2.1

Note: No. 3 unit (2.0 MW) was retired in 1985.

At present, power generations are limited to 0.65 MW for No. 1 unit, 0.6 MW for No. 2 unit and 1.0 MW for N. 4 unit due to leakages of lubricating oil and cooling water, and temperature rises of cooling water and engine exhaust gas.

b) Wakenaam power station

This power station is located in the premises of rice milling plant of the government at Wakenaam island, about 40 km west of Georgetown. In the powerhouse there are two generating units which were retired in 1974. The remaining No. 3 unit of mobile type (out-door type) was commissioned in 1980, and has supplied power up to present. Between 1974 and 1980, power supply had not been provided.

The No. 3 unit has an installed capacity of 0.5 MW. For stable supply of electricity, construction of an additional unit is needed.

c) Bartica power station

This power station is located in the center of Bartica town, about 50 km upstream from the estuary of the Essequibo river.

As of August 1988, the generating capacity is as follows:

Unit	Installed capacity (MW)	Guaranteed capacity (MW)
No. 1	0.392 (490 kVA)	0.2
No. 2	0.392 (490 kVA)	0.2
Total	0.784	0.4

Table 2.2.3.(2) gives installed capacities, guaranteed capacities of all GEC power plants as of August 1988, and peak load of each power system in 1987.

Table 2.2.3.(3) gives gross and net energy generations, fuel consumption and thermal efficiencies of power plants in 1987.

(3) Captive power plants

There are undertakings who have private generation plants to supply their own needs, and these can be summarized as follows:

(a) Bauxite industry plants at Linden and Everton (GUYMINE)
(b) Sugar industry plants (GUYSUCO)
(c) Rice industry plants (Guyana Rice Milling and Marketing Authority)
(d) Other consumers with private generation

Linden power plant of GUYMINE has an installed capacity of 27.5 MW (operating capacity at present is 20.0 MW). This undertaking is not consumer of GEC and there is an agreement between GEC and GUYMINE whereby GUYMINE supply up to 4.0 MW of demand to GEC. However, in order to cover a serious shortage of supply capability of GEC, power exported to GEC sometimes reached 8 to 9 MW. GUYMINE also operate another bauxite undertaking at Everton in Corentyne, but Everton is not normally connected to GEC system. Power supply between the two in Corentyne is made only for emergency use.

Sugar estates of GUYSUCO, e.g. Albion estate and Blairmont estate, are not connected to GEC system and these sugar estates are almost self-supporting with 50 Hz generation.

Rice industry and other industries who have own power plants are consumers of GEC and their power plants are for stand-by use.

The general characteristics of GUYMINE power plants are as follows:

Unit	Installed capacity (MW)	Commissioning year	Operation records in 1987		
			Generation (MWh)	Fuel consu. (T.USG.)	Efficiency (%)
Steam:					
No. 1	(7.5)	1960	-	-	-
No. 2	7.5	1960	-	-	-
No. 3	12.5	1967	-	-	-
Total	20.0		121.018	13,399.2	21.1
Diesel (Stand-by):					
No. 1	2.5	1982	-	-	-
No. 2	2.5	1982	-	-	-
Total	5.0		6,381	-	-

- Peak load in 1987: 24 MW (Including export to GEC)
- Maximum power demand of the GUYMINE facilities: 18 MW

Note: Steam No. 1 unit was used for alumina production, and since 1984 it has not been operated due to stoppage of alumina production.

T. USG. (Thousand US gallon) .... 3.785 liters

b) Everton power station

Everton power station has an installed capacity of 3.15 MW against maximum power demand of about 1.8 MW for GUYMINE facilities. Therefore, of the three units in total, one (1) unit is for stand-by use.

Unit	Installed capacity (MW)	Commissioning year	Operation records in 1987 Generation (MWh)	Fuel consu. (T.USG.)	Efficiency (%)
No. 1	1.05	1968	471.4	22,618	-
No. 2	1.05	1968	554.5	155,042	-
No. 3	1.05	1968	2,911.6	1,009,843	-
Total	3.15		4,207.5	1,187,566	34.7

- Lube oil consumption: 1,840 gallons
- Lube oil specific consumption: 1.6 g/kWh

2.2.4 Evolution of power demand and supply

(1) Energy consumption

The national economy of Guyana depends mainly on the production of bauxite, sugar and rice.

The economy had steadily developed during the period from 1970 to around 1977 but since then up to present it has gradually aggravated due mainly to decline of international prices of major export products of this country. Gross domestic products (GDP) in real term has rather decreased year by year since 1981 as shown in Table 5.1 of Chapter 5. However, it seems that the economy is now turning upwards to revitalization and recovery.

The demand for electricity may have been affected by this economic stagnation. Energy consumption had grown at an average rate of about 6% per annum during the period from 1974 to 1977 but since then the growth trend has become irregular. Table 2.2.4.(1) shows that energy consumption in 1987 (178.8 GWh) is smaller than that in 1977 (184.7 GWh). However, attention should be paid to the fact that the decrease of energy consumption in recent years was caused mainly by shortage of supply capability of GEC power system. In fact, GEC are currently shedding load throughout the day.

Electricity consumers are classified into 5 categories by tariff class. i.e. residential (Tariff A), commercial (Tariff B), industrial (Tariffs C and D), and street lighting (Tariff E).

Energy consumption in the Demerara and Berbice systems for 1987 are shown below. Shares of consumption by category in the Demerara system were 47.3%

for residential, 19.6% for commercial, 31.1% for industrial and 2.0% for street lighting, while in the Berbice system these were 63.6% for residential, 20.2% for commercial, 15.6% for industrial and 0.6% for street lighting.

Category	Energy consumption (MWh)	Share (%)	Number of consumers	Energy per consumer (MWh)
Demerara system:				
Residential	73,281	47.3	64,860	1.13
Commercial	30,379	19.6	6,396	4.75
Industrial	48,251	31.1	137	352.40
Street lighting	3,008	2.0	27	111.41
Total	154,919	100.0	71,420	2.17
Berbice system:				
Residential	11,233	63.6	21,915	0.51
Commercial	3,569	20.0	1,314	2.72
Industrial	2,753	15.6	5	550.60
Street lighting	106	0.6	5	21.20
Total	17,661	100.0	23,239	0.76

(2) Energy generation and system loss

Energy generation of GEC power system was 195.5 GWh in 1974 and 215.0 GWh in 1987. The largest annual energy generation ever achieved is 256.2 GWh in 1981. During the last three years from 1985 to 1987, energy generation decreased every year due to shortage of supply capability of GEC power system caused by:

- Retirement of two gas turbines of Kingston power station and of No. 5 unit of Garden of Eden power station;
- Out of order of two units of Garden of Eden power station, i.e. No. 3 unit from 1986 and No. 2 unit from September 1987;
- Out of order of No. 3 unit of Canefield power station from 1987;
- Retirement of No. 4 unit of Onverwagt power station in April 1987.

Since 1977, the shortage of supply capability of GEC power system in the Demerara area has been covered by GUYMINE power plant at Linden, and especially from 1983 energy imported from Linden has rapidly increased. The share of imported energy in the total energy supplied in the Demerara system reached 10.4% in 1983, 6.2% in 1984, 7.1% in 1985, 8.0% in 1986 and 10.6% in 1987.

In the Berbice system, export and import of electricity between GEC and GUYMINE has been almost negligible.

The system loss factor including station service loss, transmission and distribution losses is very large. The average loss factor during the period from 1974 to 1987 is as follows:

Power system	System loss (%)
Demerara	27.3
Berbice	37.2
Anna Regina/Wakenaam	22.4
Bartica	25.8
Average	27.5

This loss factor of 27.5% is extremely large, as compared with those of other developing countries. Even if distribution loss is large because of voltage drop due to unbalance between power demand and supply, such a large loss factor cannot be explained by other reasons than theft and/or accounting difficulties.

(3) Peak load and load factor

The climate is tropical divided into dry season and rainy season, but there is no large seasonal variation of ambient temperature. Therefore, monthly peak load does not vary greatly.

In each power system, daily peak load occurs at around 20:00 hours. In the Demerara system the 2nd peak appears at around 14:00 hours, and in the other systems the 2nd peak appears at around 6:00 hours in the morning.

In the Demerara system, annual peak load grew from 33.0 MW in 1974 to 37.8 MW in 1987 (largest so far). This brought the aggregate maximum power demand of the whole power system from 36.7 MW in 1974 to 48.8 MW in 1987.

There has been no large variation in load factor from 1974 to 1987. The average load factor of each power system for this period is as follows:

Power system	Load factor (%)
Demerara	65.9
Berbice	40.1
Anna Regina/Wakenaam	45.9
Bartica	47.1
Average	61.4

(4) Shares of energy supplied by system

The shares of energy supplied by power system in 1980 and 1986 were as follows:

Power system	1980 (GWh)	1980 (%)	1986 (GWh)	1986 (%)	Average (%)
Demerara	212.6	86.8	204.4	84.3	85.5
Berbice	23.0	9.4	29.6	12.2	10.8
Anna Regina/Wakenaam	7.9	3.2	6.9	2.8	3.0
Bartica	1.4	0.6	1.6	0.7	0.7
Total	244.9	100.0	242.5	100.0	100.0

Note: Energy supplied in the Berbice system in 1987 decreased abnormally over the previous year due to forced outage of 3 generating units, so that operation record for 1986 was used for the study.

Energy sold, energy generated, import from GUYMINE, peak load, system loss factor and load factor of each power system during the period from 1974 to 1987 are shown in Tables 2.2.4.(1) to 2.2.4.(5).

2.2.5 Electricity tariff

The electricity tariff of GEC is classified into five categories of Tariff A (Domestic lighting), Tariff B (Commercial), Tariff C (Small industrial), Tariff D (Large industrial) and Tariff E (Street lighting). The tariff rates as of November 1988 are as follows:

Tariff A (Domestic lighting)

- For monthly consumption of less than 50 kWh:

. Fixed charge	G$ 2.30/month
. Energy charge	G$ 0.45/kWh

- For monthly consumption of more than 51 kWh:

. Fixed charge	G$ 2.50/month
. Energy charge (first 50 kWh)	G$ 0.45/kWh
. Energy charge (above 50 kWh)	G$ 1.00/kWh

Tariff B

- Applicable to contracted power of less than 1000 V:

. Fixed charge	G$ 4.14/month
. Energy charge	G$ 1.96/kHw

Tariff C

- Applicable to contracted power of less than 1000 V (High voltage):

. Fixed charge (for maximum demand)	G$32.30/kVA/month
. Minimum fixed charge	G$1615.00/month
. Energy charge (first 200 kWh/KVA)	G$ 1.73/kWh
. Energy charge (above 200 kWh/KVA)	G$ 1.49/kWh

Tariff D

- Applicable to contracted power of more than 1000 V (High voltage):

. Fixed charge (for maximum demand)	G$30.22/kVA/month
. Minimum fixed charge	G$3022.00/month
. Energy charge (first 200 kWh/KVA)	G$ 1.82/kWh
. Energy charge (above 200 kWh/KVA)	G$ 1.51/kWh

Tariff E (Street lighting)

. Fixed charge	G$ 4.14/month
. Energy charge	G$ 0.90/kWh

The share of energy consumption by category of usage in Demerara and Berbice systems in 1987 was as follows:

Category		Demerara system		Berbice system	
		Share (%)	Monthly consumption per consumer (MWh)	Share (%)	Monthly consumption per consumer (MWh)
A.	Domestic	47.3	1.13	63.6	0.51
B.	Commercial	19.6	4.75	20.2	2.72
C,D	Industrial	31.1	352.20	15.6	550.60
E.	Street lighting	2.0	111.41	0.6	21.20
	Total	100.0	2.17	100.0	0.76

The average rate per unit sold during the period from 1974 to 1986 for the entire power system was as follows:

Year	Average rate (G$/kWh)
1974	0.13
1975	0.19
1976	0.21
1977	0.24
1978	0.27
1979	0.27
1980	0.37
1981	0.58
1982	0.59

1983	0.59
1984	0.75
1985	0.84
1986	0.84
1987	-

As compared with the average tariff rate of 0.84 G$/kWh in 1986, the fuel cost per kWh of Kingston and Garden of Eden power plants at present are calculated as follows:

- Thermal efficiency of power plant:

  . Kingston 20.5% (4,195 kcal/kWh)
  . Garden of Eden 26.2% (3,282 kcal/kWh)

- Prince of fuel:

  . Bunkder C (Kingston) US$13.01/barrel
  . Diesel oil (GOE) US$21.16/barrel

- Fuel cost per kWh:

  . Kingston US$0.03537 (G$0.3537)
  . Garden of Eden US$0.04977 (G$0.4977)

Note: (*) The following currency exchange rate was used:
Official rate US$1.0 = G$10.0

The electricity tariff must be determined on the cost basis which allows to cover not only fuel cost but also capital cost (amortization and interest), operation and maintenance cost, and general expenses.

Seen from the fuel costs at present, the current price level of electricity (0.84 G$/kWh) is judged to be relatively low. To establish a sound financial position of GEC, it would be necessary to amend the tariff rates as soon as possible.

Table 2.2.3.(2) GENERAL CHARACTERISTICS OF EXISTING POWER PLANTS

Power plant	Type & Unit	Installed capacity (MW)	Guaranteed capacity (MW)	Peak load in 1987 (MW)	Commissioning year
Demerara system					
Kingston B (50 Hz):					
	ST No.1	10.0	8.5		1963
	ST No.2	10.0	8.5		1964
	ST No.3	10.0	8.5		1967
	Subtotal	30.0	25.5	28.2	
Versailles (60/50 Hz):					
	DSL No.1	2.0/1.6	1.4		1985
	DSL No.2	2.0/1.6	1.4		1985
	DSL No.3	2.0/1.6	1.4		1985
	Subtotal	6.0/4.8	4.2	4.3	
Garden of Eden (60 Hz):					
	DSL No.2	5.7	(3.0)		1975
	DSL No.4	5.7	3.0		1975
	DSL No.3	5.7	(3.0)		1976
	Subtotal	17.1	3.0		
	System total	53.1/51.9	32.7	37.8	
Berbice system					
Onverwagt (60 Hz):					
	DSL No.5	2.5	(1.8)	1.8	1981
Canefield (60 Hz):					
	DSL No.3	5.8	4.5		1978
	DSL No.4	5.8	(4.5)		1978
	Subtotal	11.6	4.5		
	System total	14.1	4.5	8.4	
Isolated systems					
Anna Regina (50 Hz):					
	DSL No.1	1.04	0.55		1972
	DSL No.2	1.04	0.55		1972
	DSL No.4	2.0	1.0		1986
	Subtotal	4.08	2.1	1.91	
Wakenaam (60 Hz):					
	DSL No.3	0.5	0.5	0.44	1980
Bartica (60 Hz):					
	DSL No.1	0.39	0.20		1978
	DSL No.2	0.39	0.20		1978
	Subtotal	0.78	0.4	0.38	
GEC Whole Power System		72.6/71.4	40.2	48.9	

Table 2.2.3.(3) THERMAL EFFICIENCY OF EXISTING POWER PLANTS

Power plant	Unit	Gross generation (MWh)	Net generation (MWh)	Fuel consumption (T.I.G.)	Thermal efficiency (%)
Kingston	No.1	59,668.3	-	-	-
	No.2	57,120.0	-	-	-
	No.3	26,316.9	-	-	-
	Subtotal	143,105.2	134,919.6	12,834.0	20.5
Garden of Eden	No.2	3,205.5	-	-	-
	No.4	19,474.0	-	-	-
	No.5	-	-	-	-
	Subtotal	23,679.5	23,163.1	1,905.0	26.2
Versailles	No.1	7,025.3	-	-	-
	No.2	6,212.8	-	-	-
	No.3	6,212.1	-	-	-
	Subtotal	19,450.2	18,595.9	1,189.0	33.7
Whole Demerara		186,234.9	176,658.6	15,928.0	22.03
Onverwagt	No.3	396.2	-	-	-
	No.5	8,315.0	-	-	-
	Subtotal	8,711.2	8,650.4	611.0	30.5
Canefield	No.3	9,336.7	-	-	-
	No.4	164.1	-	-	-
	Subtotal	9,800.8	9,644.4	617.0	33.7
Whole Berbice		18,512.0	18,294.8	1,228.0	32.1
Demerara-Berbice		204,746.9	194,953.4	17,156.0	22.3

Note: T.I.G.(Thousand Imperial Gallon) ... = 4.546 liters
Calorific value:
- Bunker C ... 18,290 BTU/lb (10,161 kcal/kg)
- Diesel oil ... 19,500 BTU/lb (10,834 kcal/kg)

Specific gravity:
- Bunker C ... 0.955
- Diesel oil ... 0.81

Table 2.2.4.(1) EVOLUTION OF POWER DEMAND & SUPPLY

GEC Whole Power System

Year (AD)	Energy sold (GWh)	E.gene-rated (GWh)	From GUYMINE (GWh)	Total supply (GWh)	Peak load (MW)	System loss (%)	Load factor (%)	Number of consumers
1974	155.1	195.5	0.0	195.5	36.7	20.6	60.8	73514
1975	165.3	208.6	0.0	208.6	38.6	20.8	61.7	80088
1976	176.2	226.9	0.0	226.9	39.9	22.3	64.9	81014
1977	184.7	244.2	5.2	249.4	43.3	25.9	65.8	82478
1978	157.4	223.4	5.1	228.5	43.0	31.1	60.7	85840
1979	178.8	236.8	6.8	243.6	45.6	26.6	61.0	87266
1980	190.2	239.4	5.5	244.9	44.9	22.3	62.3	80900
1981	180.5	256.2	-4.3	251.9	47.5	28.4	60.6	95152
1982	164.2	230.5	4.6	235.1	45.5	30.2	59.0	89758
1983	178.9	224.3	24.6	248.9	46.7	28.1	60.9	82876
1984	162.7	235.8	13.0	248.8	46.3	34.6	61.4	86916
1985	169.5	235.8	15.3	251.1	48.4	32.5	59.3	84770
1986	160.9	226.0	16.5	242.5	47.7	33.6	58.1	85546
1987	178.9	215.0	22.4	237.4	48.8	24.6	55.6	101359

Table 2.2.4.(2) EVOLUTION OF POWER DEMAND & SUPPLY

Demerara System

Year (AD)	Energy sold (GWh)	E.gene-rated (GWh)	From GUYMINE (GWh)	Total supply (GWh)	Peak load (MW)	System loss (%)	Load factor (%)	Number of consumers
1974	147	184	0.0	184.0	33.0	20.1	63.7	61360
1975	155	192	0.0	192.0	33.9	19.3	64.7	63707
1976	163	208	0.0	208.0	34.8	21.6	68.2	65476
1977	170	222	5.2	227.2	37.6	25.2	69.0	66436
1978	141	200	5.1	205.1	36.9	31.3	63.5	68847
1979	159	206	9.5	215.5	36.4	26.2	67.6	67502
1980	166	204	8.6	212.6	36.2	21.9	67.0	54321
1981	153	213	0.0	213.0	36.1	28.2	67.4	66597
1982	138	187	2.1	189.1	34.7	27.0	62.2	60720
1983	154	184	21.4	205.4	34.8	25.0	67.4	54841
1984	136	193	12.8	205.8	34.2	33.9	68.7	58572
1985	145	197	15.1	212.1	37.4	31.6	64.7	56827
1986	138	188	16.4	204.4	36.9	32.5	63.2	57052
1987	155	187	22.3	209.3	37.8	25.9	63.2	71420

Table 2.2.4.(3) EVOLUTION OF POWER DEMAND & SUPPLY

Berbice System

Year (AD)	Energy sold (GWh)	E.gene-rated (GWh)	From GUYMINE (GWh)	Total supply (GWh)	Peak load (MW)	System loss (%)	Load factor (%)	Number of consumers
1974	4.5	6.4	0.0	6.4	2.3	29.7	31.8	8438
1975	5.9	10.6	0.0	10.6	3.2	44.3	37.8	12336
1976	7.4	12.2	0.0	12.2	3.4	39.3	41.0	10892
1977	8.7	14.6	0.0	14.6	3.7	40.4	45.0	10946
1978	8.9	14.7	0.0	14.7	3.9	39.5	43.0	11126
1979	12.3	21.6	-2.7	18.9	7.0	34.9	30.8	13857
1980	17.6	26.1	-3.1	23.0	6.4	23.5	41.0	20024
1981	20.6	34.1	-4.3	29.8	9.2	30.9	37.0	22336
1982	18.3	33.9	2.5	36.4	8.5	49.7	48.9	22955
1983	18.4	30.5	3.2	33.7	8.9	45.4	43.2	22008
1984	18.5	33.5	0.2	33.7	9.4	45.1	40.9	21862
1985	18.9	32.2	0.2	32.4	9.1	41.7	40.6	21498
1986	17.3	29.5	0.1	29.6	8.3	41.6	40.7	22006
1987	17.7	18.5	0.1	18.6	8.4	4.8	25.3	23239

Table 2.2.4.(4) EVOLUTION OF POWER DEMAND & SUPPLY

Anna Regina & Wakenaam System

Year (AD)	Energy sold (GWh)	E.generated (GWh)	From GUYMINE (GWh)	Total supply (GWh)	Peak load (MW)	System loss (%)	Load factor (%)	Number of consumers
1974	3.0	4.2	0.0	4.2	1.2	28.6	40.0	2791
1975	3.7	5.1	0.0	5.1	1.3	27.5	44.8	3081
1976	4.9	5.6	0.0	5.6	1.4	12.5	45.7	3458
1977	5.1	6.3	0.0	6.3	1.6	19.0	44.9	3876
1978	6.6	7.4	0.0	7.4	1.8	10.8	46.9	4339
1979	6.4	7.9	0.0	7.9	1.8	19.0	50.1	4486
1980	5.6	7.9	0.0	7.9	1.9	29.1	47.5	5134
1981	5.9	7.5	0.0	7.5	1.8	21.3	47.6	4798
1982	6.7	8.0	0.0	8.0	1.9	16.3	48.1	4745
1983	5.1	8.2	0.0	8.2	2.6	37.8	36.0	4775
1984	7.0	7.8	0.0	7.8	2.3	10.3	38.7	5328
1985	4.5	5.1	0.0	5.1	1.6	11.8	36.4	5281
1986	4.5	6.9	0.0	6.9	2.1	34.8	37.5	5307
1987	5.1	7.8	0.0	7.8	2.2	34.6	40.5	5498

Table 2.2.4.(5) EVOLUTION OF POWER DEMAND & SUPPLY

Bartica System

Year (AD)	Energy sold (GWh)	E.generated (GWh)	From GUYMINE (GWh)	Total supply (GWh)	Peak load (MW)	System loss (%)	Load factor (%)	Number of consumers
1974	0.6	0.9	0.0	0.9	0.2	28.4	47.8	925
1975	0.7	0.9	0.0	0.9	0.2	24.7	46.2	964
1976	0.9	1.1	0.0	1.1	0.3	18.6	43.0	1188
1977	0.9	1.3	0.0	1.3	0.4	26.2	41.1	1210
1978	0.9	1.3	0.0	1.3	0.4	27.7	42.4	1228
1979	1.1	1.3	0.0	1.3	0.4	16.5	40.3	1421
1980	1.0	1.4	0.0	1.4	0.4	26.1	43.8	1421
1981	1.0	1.6	0.0	1.6	0.4	40.5	47.7	1421
1982	1.2	1.6	0.0	1.6	0.4	24.8	48.4	1338
1983	1.4	1.6	0.0	1.6	0.4	12.4	52.5	1252
1984	1.2	1.5	0.0	1.5	0.4	23.5	49.9	1154
1985	1.1	1.5	0.0	1.5	0.3	30.9	62.0	1164
1986	1.1	1.6	0.0	1.6	0.4	28.3	47.8	1181
1987	1.1	1.7	0.0	1.7	0.4	32.5	50.8	1202

CHAPTER 3

CURRENT STATUS OF POWER FACILITIES

CHAPTER 3 CURRENT STATUS OF POWER FACILITIES

3.1 POWER GENERATION FACILITIES

3.1.1 Outline of facilities

The power generation facilities of Guyana Electricity Corporation (GEC) consist solely of thermal power plants, and there is no hydroelectric power plant.

There are 8 thermal power plants in the country of Guyana, with the total installed capacity of 72.6 MW. They consist of 15 diesel generation units, with a total generating capacity of 42.6 MW (59%), and 3 steam generation units with a total capacity of 30 MW (41%).

All power generation facilities, with the exception of Versailles Power Station, which has 3 diesel generation units constructed by grant cooperation of the Japanese Government, are extremely aged. These facilities have not been properly maintained due to the difficulty of procuring spare parts, and therefore they are either operated at reduced output or they can not be operated. Furthermore, parts of some units have been removed when units had faults, to have the parts appropriated to other units which need spare parts, and such units are left disassembled in power station.

Consequently, the guaranteed total output of these facilities is as low as 55% of the installed capacity, or 40.3 MW, at present. The deficit of supply capacity caused by such situation is supplemented by purchased power (amounting to approximately 4 to 6 MW) from Guyana Mining Enterprise (GUYMINE), a governmental corporation, and periodical load restrictions (scheduled load shedding) in certain regions.

The status and conditions of thermal power plants in Guyana, as of July to August of 1988 when the Study Mission visited each power plant, are presented in Table 3.1.1-1.

3.1.2 Kingston "B" power station

Kingston "B" Power station is located on the eastern bank of Demerara River, near Georgetown, the Capital City of Guyana. This is the key power supply source in Demerara Power System, and it is the only steam power plant possessed by GEC.

Table 3.1.1－1 Existing Thermal Power Stations

(as of August, 1988)

Name of P.S	Type	Name of Manufacturer	Unit NO	Frequency (Hz)	Installed Capacity(MW)	Guaranteed Capacity(MW)	Commission-ing year
Kingston "B"	Steam	Boiler: International Combustion LTD. UK Turbine: Associated Electrical Industries, UK Generator: Ditto	1	50	10	8.5	1963
			2	50	10	8.5	1964
			3	50	10	8.5	1967
Versailles	Diesel	Engine : Nigata Engineering CO.,LTD Japan Generator; Nishishiba Electric CO.,LTD. Japan	1	60/50	2.0/1.6	1.4	1985
			2	60/50	2.0/1.6	1.4	1985
			3	60/50	2.0/1.6	1.4	1985
Garden of Eden	Diesel	Engine: Crossiy Pielstick, UK Generator: GEC, UK	2	60	5.7	※(3.0)	1975
			4	60	5.7	3.0	1975
			5	60	5.7	※(3.0)	1976
Canefield	Diesel	Engine: Mirrlees Blackstone, UK Generator: Brush Electric, UK	3	60	5.8	4.5	1978
			4	60	5.8	※(4.5)	1978
Onverwagt	Diesel	Engine: GM, USA Generator: GM, USA	5	60	2.5	※(1.8)	1981
Anna Regina	Diesel	Engine: Ruston, UK Generator: AEI, UK	1	50	1.04	0.65	1972
			2	50	1.04	0.60	1972
			4	50	2.0	1.0	1986
Wakenaam	Diesel	Engine: GM, USA Generator: GM, USA	3	60	0.5	0.50	1980
Bartica	Diesel	Engine: Mirrlees Blackstone, UK Generator: Brush Electric, UK	1	60	0.39	0.34	1978
			2	60	0.39	※(0.20)	1978
Total	—	——	18	——	72.6／71.4	40.3	——

Note: ※( ) shows generating units which are out of order at present due to troubles.

Kingston "B" Power Station has 3 steam power generation units, which have been completed one by one from 1963 to 1967. Specifications of these units are as presented below.

(1) Major equipment specifications

Boiler: Manufactured by International Combustion Co. of U.K.

Type: Natural circulation type.
Superheater outlet pressure: 625 psi (43.9 kg/cm2)
Boiler outlet temperature: 860°F (460°C)
Flow rate: 110,000 lbs/hr (49.1 t/hr)
CV of fuel required: 18,350 BTU/lb (10,194 kcal/kg)

Turbine: Manufactured by Associated Electrical Industries Co. of U.K.

Type: Condensating turbine.
Steam pressure: 600 psi (42.2 kg/cm2)
Steam temperature: 850°F (454°C)
Rotation speed: 3000 RPM

Generator: Manufactured by Associated Electric Industries Co. of U.K.

Type: Horizontal shaft, rotating field, 3 phase AC synchronous generator
Capacity: 12,500 kVA (output; 10,000 kW)
Frequency: 50 Hz
Voltage: 11 kV

(2) Results of on-site survey

The Study Mission visited Kingston "B" Power Station in mid-July and mid-August of 1988, to survey the status of the plant. The followings are the findings of the Study Mission concerning the status of power generation facilities.

Garden of Eden power plant is the second largest power supply source in Demerara Power System. As all units of Garden of Eden Power Plant are unoperable, all three units of Kingston "B" Power Plants were operated at their guaranteed output of 8,500 kW. When the Mission visited the plant, No. 2 Unit had improper combustion, with black smoke emitting from the stack, and No. 3 Unit was operated but its boiler feedwater was leaking. There were 2 units of mobile gas turbine generating facility (with rated

capacity of 10 MW x 2, manufactured by GEC-Rolls Royce Co. of U.K. in 1971). These two units were commissioned in 1978 and 1979 respectively, and they were shut down in 1980 and 1983 due to failure of instrumentation and detection systems. These units are not in operation and it looks impossible to rehabilitate them.

Kingston "B" Power Station is located at the center of Georgetown, as described before, and it is situated at an ideal location for power supply. As this power plant is a precious asset of the power system in the sense that all units are operable, this level of performance must be maintained by all means for the sake of GEC which is suffering from power supply shortage.

(3) Current status of plant operation and maintenance

The operation and maintenance of Kingston "B" Power Plant is performed by a team of 140 personnels, which consists of 4 engineers and 136 crew members.

The operation and maintenance of the power plant is conducted according to the specifications and manuals supplied by the manufacturers.

The maintenance system of this power plant consists of routine daily patrols plus periodical inspection/maintenance, the latter including annual inspection of boilers and turbine/generator inspections which are conducted in every 5 years. With this practice, we can assume that somewhat proper operation and maintenance duties are being performed. However, as the Study Mission questioned the station manager, he told that sufficient repair works can not be performed as it is difficult to procure the necessary parts and spare parts.

There are repair shops and warehouses in the power plant premises, but these are old facilities that survived from the age of Kingston "A" Power Station. The shops and warehouses are narrow. In particular, the machine tools in the repair shops are poor, and some attention need to be placed on the current status of the shops, including the conditions of the building.

3.1.3 Versailles power station

Versailles Power Station is located to the opposite side of Georgetown on Demerara River, or on the western bank of the river. This power plant used to supply the Demerara Power System, but currently, it has been isolated from the main power system when the submarine cable crossing Demerara River failed (in 1987, with no definite repair plan), and today it supplies only the western Demerara area.

Versailles Power Station has been completed in 1972, and then rehabilitated in 1985 by a grant cooperation program of the Japanese Government (to supply 3 units of 2 MW/1.6 MW diesel generators). Today, only these three diesel units are operable. Three of the four old diesel generators had been replaced by Japanese units, and the remaining No. 4 Unit (2,000 kW output, manufactured by Ruston-AEI of U.K. in 1972) is left unattended, with the diesel engine left installed on the foundation, which present condition is such that repair is no longer possible.

Although the power system of this area is currently operated at 50 Hz, the equipments are designed by dual rating specification according to a plan to unify the power system frequency to 60 Hz in future.

(1) Major equipment specifications

Diesel Engine: Manufactured by Nigata Engineering Co., Ltd. of Japan

Type: 4-cycle, compression ignition, water-cooled, turbo-charged type with charge air cooler.

Output: 2860/2295 PS (60/50 Hz)

Rotation speed: 900/750 RPM

Generator: Manufactured by Nishishiba Electric Co., Ltd. of Japan.

Type: 3-phase, synchronous generator.

Capacity: 2,500/2,000 kVA (output; 2,000/1,600 kW)

Frequency: 60/50 Hz

Voltage: 13.8/11 kV

(2) Results of on-site survey

The Study Mission visited Versailles Power Station in mid-July, 1988, to survey the status of the plant. The followings are the findings of the Study Mission concerning the status of power generation facilities.

The power plant is today operated at 50 Hz. The time the Study Mission visited the plant was an off-peak hour, and No. 1 Unit was standing-by, and No. 2 Unit and No. 3 Unit were operating smoothly at 800 kW each (50% of the installed capacity).

As stated before, this power power plant is responsible to supplies the peak load of the western Demerara area which is 3.2 MW, due to failure of the submarine cable crossing Demerara River, but this demand is below the capacity of the plant. The status of plant equipment is good, and there is no need to conduct an extensive repair program of rehabilitation plan, although it is required to procure spare parts for periodical inspections. However, substantial items of spare part will fall short in 1989, as the 24,000 hour overhaul must be conducted in this year.

(3) Current status of plant operation and maintenance

The operation and maintenance duties of this power plant is being conducted by a team of 37 personnels, which consists of 1 engineer and 36 crew members. The premises and outside areas of the power plant are kept clean, and operation and maintenance of the power plant are properly performed according to specifications and manuals supplied by the manufacturers. One problem is that all units have been operated for about 17,000 hours, and reaching the time for preparation of overhauling inspection and repair. According to the statement of the station manager, some spare parts are not currently available. Although orders have been placed on these parts, they have not been procured due to disagreement on payment conditions.

There is no repair shop or warehouse in the power plant, and only routine consumables are stored in the power plant. The spare parts and other items required for overhauling are stored in the Garden of Eden Power Plant.

3.1.4 Garden of Eden Power Station

The Garden of Eden Power Station is situated on the eastern bank of Demerara River, approximately 22 km to the south of central Georgetown. It is a diesel power plant which is the second largest, next to Kingston "B" power station, among the power plants belonging to Demerara Power System and owned by GEC. The units of Garden of Eden Power Station have been completed from 1975 to 1976, and they are important power supply source in Demerara Power System as power is supplied to the nearby international airport. There are 4 diesel generators, and their specifications are as presented below.

(1) Major equipment specifications

Diesel Engine: Manufactured by Crossly Pielstick Co. of U.K.
- Type: 4-cycle, compression ignition, water-cooled, turbo-charged type.
- Output: 7,920 HP (8,030 PS)
- Rotation speed: 514 RPM

Generator: Manufactured by GEC Co. of U.K.
- Type: 3-phase, synchronous generator.
- Capacity: 7,170 kVA (output; 5,736 kW)
- Frequency: 60 Hz
- Voltage: 13.8 kV

(2) Results of on-site survey

The Study Mission visited Garden of Eden Power Station in mid-July and mid-August of 1988, to survey the status of the plant. The followings are the findings of the Study Mission concerning the status of power generation facilities.

The stator winding of No. 2 Unit (No. 1 Unit has not been named) had failed, and its rotor was transferred to No. 4 Unit. Then the crank shaft of No. 4 Unit diesel engine was damaged, and this unit was disabled in September, 1987. Preparation for repair and overhaul of No. 4 Unit has been started at this time, and an inquiry has been placed on the manufacturer through GIBBS & HILL/DRAVO SERVICES, INC. for the spare parts required for overhaul, and overhaul work will be implemented as soon as spare parts are procured.

No. 3 Unit has also been disabled by the end of 1985 due to damage on crank shaft. This unit is today left at the site with usable parts deprived of.

A rehabilitation plan, to be financed by IDB loan, is being planned for revival of No. 2 and No. 4 Units. It is necessary, however, to assess the current conditions of these units to evaluate the feasibility of rehabilitation.

The stator coil of No. 4 Unit has also failed, and this unit is being operated with the generator which has been transferred from No. 5 Unit. However, oil and water leak from many parts of this unit, and its condition is serious from the point of view of safety as well as operational efficiency. The performance of this unit was only 2,600 kW (only 46% of the installed capacity) in terms of average output for a period from January to June of 1988. The fuel consumption is high, being 316 g/kWh (as compared to 260 g/kWh at the time of commissioning). This unit is being exploited at low efficiency due to supply shortage. It is recommended to procure spare parts and overhaul this unit as soon as possible.

No. 5 Unit has been disabled in 1986 by damage on crank shaft which was caused by bearing failure. Today, both main machines and auxiliary machines of this unit are removed. The foundation of the unit has been diagnosed by a civil engineer (of a foreign consulting firm) to be in good condition.

Auxiliary equipment

* Lubrication System: The cooling water pumps, priming pumps, etc. must be replaced and spare parts procured.

* Cooling Water System: In cooling lubrication oil and supercharged air, the river water is pumped up and supplied to heat exchangers. The engines are cooled by recirculating clean water which is also cooled by heat exchangers. The river water contains a lot of silt, and also sea water as the site is near sea shore. The silt and sea water create wear, erosion and corrosion in coolers and pipes, which limit engine output and causes hazards such as ingress of water into lubrication oil. The pumps, coolers and pipes have to be replaced, and their spare parts procured.

* Fuel System: The engines are so designed that diesel oils are used at startup, and C-fuel oil is used in continuous operation. In 1984, 10 years

after commissioning, fuel cleaners were installed to reduce the burden on fuel purifiers (centrifugal type fuel cleaners). The new cleaner for only No. 4 unit is operable today. As failure of fuel injectors occurred frequently, diesel oils are used to avoid such troubles. Therefore, the fuel oil cleaners are not used today.

It is not clear whether the troubles with fuel oils have been caused by mismatching of fuel oil characteristics with specification of the purifier system, or the capacity of purifier is not sufficient. Anyway, it is recommended to switch the system to diesel oil, which is more easily handled, by taking the opportunity of rehabilitation.

* Startup Air System: There is one unit each of motor driven and diesel driven starters. The parts of these starters are worn out, and specified air pressure can not be created, causing delays in startup due to insufficient startup pressure. Immediate overhauling and procurement of spare parts are required.

* Intake and Exhaust Systems: The air intake filters, silencers and exhaust stacks must be replaced.

Electrical systems

* Generators: As described above, there are problems including damaged stators. Cleaning by overhaul, spraying insulation varnish, and other repairs are needed.

* Generator Control Panel: The instruments appropriated for other purposes must be replaced with those employing modern electrical technology, and spare parts must be replenished.

13.8 kV Circuit Breakers and House Service Switchboards: Overhauling of No. 4 generator circuit breaker and circuit breakers of house service switchboards must be overhauled, and related spare parts supplied.

House Service Transformer: Replenishment of insulation oil and replacement of drier agents are required.

DC Systems: Replacement of 48 V and 125 V batteries, and procurement of spare parts of chargers of these batteries are required.

69 kV Outdoor Switchyard Equipment: There is no specific problem at present.

(3) Current status of plant operation and maintenance

The operation and maintenance duties of this power plant is being conducted by a team of 53 personnels, which consists of 3 engineer and 50 stuffs.

When the Study Mission visited the power plant, the station manager told that No. 4 Unit is mainly used, but many faults occurred, which can not be reduced by the regular 500 hour inspection, and the unit is shut down for 2 to 3 days a week, and the plant personnels are kept busy with repair work. The next overhaul had been scheduled at June, 1988, which preparation had been started from November, 1987, but the exact timing of overhaul was not decided yet.

The power plant building was covered with soot. Equipments, floors, piping ducts, etc. are soiled with oil and water. The removed crank case, generator stator, rotor and used parts were scattered all over the place. The switchboard room, which is the very heart of the power plant, was dark as some fluorescent lamps had been removed. Piping and cable ducts of the plant were often filled with oil or water. The operation and maintenance duties of the plant seemed to have been conducted in a poor manner. The conditions of this power plant must be improved to a level of decent working place, in view of safety and equipment maintenance.

The repair shop and warehouse are located in the same building with the power plant. The repair shop is equipped with an ordinary set of machine tools such as lathe and shaper, and the repair work of all diesel power plants possessed by GEC is implemented here. Spare parts of Versailles, Anna Regina, Wakenaam, Bartica, etc., as well as this power plant, are stored in the warehouse here.

3.1.5 Canefield Power Station

Canefield Power Station is located at a suburb of New Amsterdam, and it is one of major power plant in Berbice Power System. Canefield Power Station is a diesel power plant completed in 1979. Two diesel generator units are installed, which have the following specifications.

(1) Major equipment specifications

Diesel Engine: Manufactured by Mirrless Blackstone Co. of U.K.

Type	:	4-cycle, compression ignition, water-cooled, turbo-charged type.
Output	:	8,060 HP (8,170 PS)
Rotation speed	:	514 RPM

Generator: Manufactured by Brush Electric Co. of U.K.

Type	:	3-phase, synchronous generator.
Capacity	:	7,230 kVA (output; 5,784 kW)
Frequency	:	60 Hz
Voltage	:	13.8 kV

(2) Results of on-site survey

The Study Mission visited Canefield Power Station in mid-July, 1988, to survey the status of the plant. The followings are the findings of the Study Mission concerning the status of power generation facilities.

No. 3 Unit

This unit was operated at 4.5 MW (as against the installed capacity of 5.8 MW). The lubrication oil and exhaust gas were leaking, and the unit had been operated in this condition since August of 1987. It is planned to conduct an overhaul by IDB loan in 1989, and this overhaul should be implemented.

No. 4 Unit

Operation of this unit became impossible in January, 1987 due to failure of crank shaft. A new crank shaft has been procured by IDB loan, and other spare parts have been ordered. It is planned to conduct an overhaul in November, 1988, and start operation of this unit in January, 1989.

Auxiliary Equipments

There is a fuel oil purification system, but it is not currently used as the maintenance cost is excessive. Presently, diesel oil is used as fuel.

(3) Current status of plant operation and maintenance

The operation and maintenance duties of this power plant is being conducted by a team of 48 personnels, which consists of 1 engineer and 47 staffs. The 500-hour inspections are implemented in this power plant similarly to other plants, but the working environment looks relatively poor, with some of fluorescent lamps of the control board room missing.

The repair shop and warehouse are located in the power plant premises. There is a milling machine in the repair shop but it is not fully equipped, and parts of No. 4 Unit were littered on the remaining space. There is a warehouse next to this repair shop, in which parts of this power plant and the parts for overhaul of Onverwagt Power Plant are stored.

3.1.6 Onverwagt Power Station

Onverwagt Power Station is located on the cost of Atlantic Ocean, approximately 80 km to the east of Georgetown. This is a diesel power plant connected to Berbice Power System. No. 1, No. 2 and No. 4 Units of this power plant have been commissioned in 1973, and No. 3 Unit in 1980, (all of these units were manufactured by Ruston-GEC Company of U.K., each having 1,000 kW output). No. 5 Unit (2,500 kW output) was commissioned in 1981. All units from No. 1 through No. 4 went out of service due to crank shaft failure, and these units are to be abandoned by the rehabilitation plan based on IDB loan. The specifications of major equipments are given below.

(1) *Major equipment specifications (No. 5 unit)*

Diesel Engine: Manufactured by General Motors, Ltd. of USA

Type	:	2-cycle, compression ignition, water-cooled, turbo-charged type with charged air cooler.
Output	:	3,600 HP (3,650 PS)
Rotation speed	:	900 RPM

Generator: Manufactured by General Motors, Ltd. of USA

Type	:	3-phase, synchronous generator.
Capacity	:	3,250 kVA (output; 2,500 kW)
Frequency	:	60 Hz
Voltage	:	4.16 kV

(2) Results of on-site survey

The Study Mission visited Onverwagt Power Station in mid-July, 1988, to survey the status of the plant. The followings are the findings of the Study Mission concerning the status of power generation facilities.

No. 1 Unit; 1979, crank shaft failure, not operable.
No. 2 Unit; Aug., 1987, crank shaft failure, not operable.
No. 3 Unit; April, 1987, crank shaft failure, not operable.
No. 4 Unit; March, 1986, crank shaft failure, not operable.
No. 5 Unit; June, 1988, turbo-charger failure, not operable.

The above series of failures deprived the power plant of all generating capacity. Berbice Power System is supplied from Demerara Power System with 1 MW of power, which is transmitted from Sophia Frequency Converter Station by 13.8 kV tie line through this power plant.

The station manager stated to the Study Mission that he had been advised that it is more economical to abandon No. 1, No. 2, No. 3 and No. 4 Units rather than repairing them, to rehabilitate No. 5 Unit, and to install another unit which has the same type and capacity as No. 5 Unit. At present, the repair of the turbo charger of No. 5 Unit and other spare parts have been ordered by IDB loan, and it is planned to conduct overhaul in October, 1988, to resume operation of No. 5 Unit in December.

(3) Current status of plant operation and maintenance

The operation and maintenance duties of this power plant is being conducted by a team of 33 personnels, which consists of 1 engineer and 32 staffs.

The repair shop and warehouse are located in the compound of the power plant. The machine tools in the repair shops are old, with some of them disassembled and parts spread over the floor. The warehouse is a provisional building, where old and used pipes were stored. The spare parts to be used in the overhaul are stored in Canefield Power Plant.

3.1.7 Anna Regina Power Station

Anna Regina Power Station is located approximately 60 km to the west of the capital city of Georgetown. This power plant is situated to the most western location among the power plants of GEC, and Anna Regina is operated in an isolated power system that supply power to Anna Regina region.

No. 1 and No. 2 Units of Anna Regina Power Plant (each having output of 1,040 kW and manufactured by Ruston-AEI Co.) were commissioned in 1975. No. 3 Unit (2,000 kW output, manufactured by Ruston-AEI Co.) was commissioned in 1975, and No. 4 Unit (2,000 output, manufactured by Ruston-AEI Co. in 1972 and moved from Versailles Power Plant in 1985) was commissioned in 1986.

(1) Major equipment specifications

Diesel Engine:

No. 1 and No. 2 Units: Manufactured by Ruston of U.K.

Type	:	4-cycle, compression ignition, water-cooled, turbo-charged type with charged air cooler.
Output	:	1,400 HP (1,420 PS)
Rotation speed	:	750 RPM

No. 4 Unit: Manufactured by Ruston of U.K.

Type	:	4-cycle, compression ignition, water-cooled, turbo-charged type with charged air cooler.
Output	:	2,920 HP (2,960 PS)
Rotation speed	:	750 RPM

Generator:

No. 1 and No. 2 Units: Manufactured by AEI Co. of U.K.

Type	:	3-phase, synchronous generator.
Capacity	:	1,300 kVA (output; 1,040 kW)
Frequency	:	50 Hz
Voltage	:	11 kV

No. 4 Unit: Manufactured by AEI Co. of U.K.

Type	:	3-phase, synchronous generator.
Capacity	:	2,500 kVA (output; 2,000 kW)
Frequency	:	50 Hz
Voltage	:	11 kV

(2) Results of on-site survey

The Study Mission visited Anna Regina Power Station in early August, 1988, to survey the status of the plant. The followings are the findings of the Study Mission concerning the status of power generation facilities.

No. 1 Unit: Operating at an output of 400 kW.

No. 2 Unit: Standing-by.

No. 3 Unit: This unit has become inoperative in October, 1985 due to crank shaft failure. At present, the machine is left with cylinder block, radiator and panel instruments removed. Rehabilitation of this unit is impossible.

No. 4 Unit: Operating at an output of 400 kW.

The units being operated are aged, with lubrication oil and cooling water leaking, and there are problems including temperature rises of cooling water and exhaust gas. The practical output of No. 1 Unit is limited to 650 kW (with installed capacity of 1,040 kW), No. 2 Unit to 600 kW (with installed capacity of 1,040 kW), and No. 4 Unit to 1,000 kW (with installed capacity of 2,000 kW).

(3) Current status of plant operation and maintenance

The operation and maintenance duties of this power plant is being conducted by a team of 28 personnels, which consists of 1 engineer (who is in charge of Wakenaam Power Station and Bartica Power Station too) and 27 staffs.

The power plant building is covered with soot, instruments as well as floors soiled with oil and water, piping ducts are partially filled with water, which sometimes spill away to the outside from the compound of power plant. It looks that the plant is not operated and maintained properly. There is no repair shop or warehouse. Only daily consumables are stored in the power plant, and spare parts for overhauling and other items are stocked in Garden of Eden Power Plant.

3.1.8 Wakenaam Power Station

Wakenaam Power Plant supplies power to an isolated power system in Wakenaam Island, which is situated approximately 40 km to the west of the capital city of Georgetown. The power plant is located in the compound of a rice mill factory operated by the Government. The power plant building contains two units of diesel generators (with 1,040 kW output each and manufactured by Ruston-AEI), which are disassembled and forsaken inside the building. The facility which is actually operated is a movable type diesel generator, which is separately installed on an outdoor site. This unit has been commissioned in 1980, and its specifications are presented below.

(1) Major equipment specifications

Diesel Engine: Manufactured by General Motors, Ltd. of USA

Type	:	2-cycle, compression ignition, water-cooled, turbo-charged type with charged air cooler.
Output	:	675 HP (680 PS)
Rotation speed	:	750 RPM

Generator: Manufactured by General Motors, Ltd. of USA

Type	:	3-phase, synchronous generator.
Capacity	:	500 kVA (output; 500 kW)
Frequency	:	60 Hz
Voltage	:	4.16 kV

(2) Results of on-site survey

The Study Mission visited Wakenaam Power Station in early August, 1988, to survey the status of the plant. The mobile type diesel unit was operating at a load of 490 kW, but the date of manufacture of this unit was not identified (probably before 1963), and it looked that this unit had been exploited at various sites. The station manager stated to the Study Mission that the indoor diesel generator facilities have been abandoned in 1974, and there no electric power source in the island for some time.

As there is only one generator currently available in this island, it is being operated without proper maintenance. Frequent failure would be expected on this unit, and it would be required to install another new unit.

(3) Current status of plant operation and maintenance

There is no engineer who is regularly stationed in this power plant, as the engineer of another station also supervises this plant, as described earlier. 9 staffs are assigned to this power plant.

There is no repair shop or warehouse, and only daily consumables are stored in this power plant. The parts required for overhauling are stored in Garden of Eden Power Plant.

3.1.9 Bartica Power Station

Bartica Power Station is in Bartica Town which is situated on Essequibo River, that runs approximately 40 km to the west of Georgetown, at a location approximately 50 km upstream from its river mouth.

Bartica Power Station has been completed in 1978, and a business office of GEC is also located in the power plant building. The specifications of power plant equipment are presented below.

(1) Major equipment specifications

Diesel Engine: Manufactured by Mirrlees Blackstone Co. of U.K.

Type	:	4-cycle, compression ignition, water-cooled, turbo-charged type with charged air cooler.
Output	:	600 HP (608 PS)
Rotation speed	:	900 RPM

Generator: Manufactured by Brush Electric Co. of U.K.

Type	:	3-phase, synchronous generator.
Capacity	:	490 kVA (output; 392 kW)
Frequency	:	60 Hz
Voltage	:	4.16 kV

(2) Results of on-site survey

The Study Mission visited Bartica Power Station in early August, 1988, to survey the status of the plant. The followings are the findings of the Study Mission concerning the status of power generation facilities.

No. 1 Unit: Operating at an output of 250 kW.

No. 2 Unit: Disabled in January, 1985 due to a crack in the main engine, and currently shut down. It is planned to restore the unit as soon as budget is authorized, but there is no definite prospect of budget authorization at this moment. If only one unit is available, as currently is, the remaining unit would be forced to operate under adverse conditions, with higher possibility of getting disabled by failures. Therefore, it is recommended to rehabilitate No. 2 Unit as soon as practicable.

There was a plan to build an interconnection cable line with Kaow Island across the river by an IDB loan, but this plan has been suspended.

(3) Current status of plant operation and maintenance

The operation and maintenance duties of this power plant is being conducted by a team of 12 personnels who are assigned to this power plant, but with no permanently stationed engineer, and this duty is performed by an engineer of another power plant as described earlier. There was little oil or water leakage from the engine then operating, and it looks that cleaning and maintenance are properly performed despite the fact that this power plant is fairly small. The failed No. 2 Unit is ready for repair work, with components vulnerable to humidity, such as generator, covered with sheets and dehumidified by space heater.

The repair shop and ware house have minimum functions. Only daily consumables are stored in this power plant and spare parts are stored in Garden of Eden Power Plant.

3.1.10 GUYMINE owned power stations

The thermal power stations owned by Guyana Mining Company (GUYMINE), which are interconnected to GEC's power system are described below.

(1) Linden Power Station

Linden Power Station is located in Linden Town, which is approximately 100 km to the upstream on Demerara River from Georgetown. It is an in-house power plant owned by GUYMINE, and interconnected to Demerara Power System through Linden Substation of GEC (16,700 kVA, 69/13.8 kV). There is a power sales agreement between GEC and GUYMINE, and 4 to 6 MW of power is

supplied from GUYMINE to GEC according to this agreement. GUYMINE produces bauxite, which is exported to various nations of the world including Japan, Europe, U.S. and Australia, and for this reason, Linden is a lively town. Linden Power Station consists of two power plants, a steam power plant (27.5 MW with 3 units) and a diesel power plant (5MW with 2 units), which are sited independently at a distance of approximately 2 km. The diesel power plant being used as a emergency power source when the steam power plant fails. There are 4 boilers in the diesel power plant, which are used as the power source for processing bauxite.

1) Major equipment specifications

(Steam generation units)

	No. 1, No. 2	No. 3
Boiler: Manufactured by Foster Wheeler Co. of Canada		
Steam pressure	850 Psi (59.8 kg/cm^2)	
Steam temperature	900°F (482°C)	
Fuel	C heavy oil	
Turbine: Manufactured by General Motors, Ltd. of U.S.A.		
Steam pressure	850 Psi (59.8 kg/cm^2)	
Steam temperature	900°F (482°C)	
Rotation speed	3,600 RPM	
Generator: Manufactured by General Motors, Ltd. of U.S.A.		
Type	Horizontal shaft, rotating field 3 phase AC synchronous generator	
Capacity	9,375 KVA (Output: 7,500 kW)	15,625 KVA (Output: 12,500 kW)
Frequency	60 Hz	
Voltage	13.8 kV	

(Diesel generation unit)

Diesel Engine: Manufactured by General Motors, Ltd. of U.K.	
Type	2-cycle, compression ignition, water-cooled, turbo-charged type with charged air cooler.
Output	3,700 PS
Rotation speed	900 RPM

Generator: Manufactured by General Motors, Ltd. of U.K.

Type	:	3-phase, synchronous generator.
Capacity	:	3,125 kVA (output; 2,500 kW)
Frequency	:	60 Hz
Voltage	:	2.3 kV

2) Results of on-site survey

The Study Mission visited Linden Power Station in late July, 1988, to survey the status of the plant. The followings are the findings of the Study Mission concerning the status of power generation facilities. In the steam power plant, No. 1 Unit and No. 3 Unit were operating with satisfactory performance and with output of 6,200 kW and 8,000 kW respectively, with No. 2 Unit standing by. The diesel power plant was not operating, because it is, as described earlier, the emergency power source. There are five diesel generator units in this power plant, and it is planned to abolish two of them.

3) Current status of plant operation and maintenance

The operation and maintenance of Linden Power Plant is performed by a team of 146 personnels, which consists of 10 engineers and 136 staffs. In the steam power plant, boilers are overhauled every year, and turbines and generators inspected every year and overhauled in every 5 years. The manuals supplied by manufacturers are observed properly. Spare parts are procured as they are consumed. When equipments are damaged by faults, etc., communication is directly established with manufacturers to have their engineers dispatched. It looks that such performance can be maintained because the foreign currencies acquired by export of bauxite can be used fairly freely for such purposes.

Concerning education of plant personnels, GUYMINE owns and operates a private school for fosterage of necessary personnels. GUYMINE recruits graduates of national schools, and fosters operation and maintenance crews mainly through on-the-job training.

The plants are clean, control room and office rooms are adequately illuminated, and earnest efforts for creation of good working environment was observed.

(2) Everton Power Station

Everton Power Station is a diesel power plant owned by GUYMINE, which is interconnected to Berbice Power System through Canefield Power Plant. This power station has been completed in 1968, and has 4 units of diesel generator facilities. The specifications of these units are presented below.

1) Major equipment specifications

Diesel Engine: Manufactured by Norberg Co. of U.S.A.

Type	:	4-cycle, compression ignition, water cooled, turbo-charged type.
Output	:	1,485 HP (1,500 PS)
Rotation speed	:	514 RPM

Generator: Manufactured by Electric Product Co. of U.S.A.

Type	:	3-phase, synchronous generator.
Capacity	:	1,313 kVA (output; 1,050 kW)
Frequency	:	60 Hz
Voltage	:	4.16 kV

2) Results of on-site survey

The Study Mission visited Everton Power Station in mid-July, 1988, to survey the status of the plant. The followings are the findings of the Study Mission concerning the status of power generation facilities.

3 Units out of the four are operable. The operable units, one was shut down then and the remaining two were carrying 450 kW and 650 kW of loads respectively. The disabled unit had been removed with only the foundation left. The power generated is used to transport bauxite and drive kilns, and the excess power is supplied to GEC, as described earlier. The power plant was clean, with the floors dry. There was little water or oil leakage from equipments being operated, and operational and maintenance cares seemed proper. Diesel oil is used as fuel.

3) Current status of plant operation and maintenance

The operation and maintenance of Everton Power Plant is performed by a team of 81 personnels. The operation and maintenance of the power plant is conducted properly according to the specifications and manuals supplied by the manufacturers.

3.2 TRANSMISSION, DISTRIBUTION AND SUBSTATION FACILITIES

3.2.1 Transmission and distribution facilities

(1) Transmission facilities

The outline of GEC's transmission facilities are presented in Table 3.2.1-1, and its power system in Figure 3.2.1-1.

Table 3.2.1-1 Existing transmission line
(as of August, 1988)

Name of line section	Voltage x No. of circuits	Length (km)	Commissioning year
Linden - Garden of Eden	69 kV x 1	81.6	1976
Garden of Eden - Sophia	69 kV x 1	28.8	1977
Onverwagt - Canefield	69 kV x 1	41.6	1986
Canefield - No. 53 Corentyne	69 kV x 1	56.0	1987
Total		208.0	

According to a transmission system expansion program, a single circuit, 69 kV transmission line from Sophia Frequency Converter Station to Onverwagt Power Plant, 73.6 km in length, will be constructed by 1990 as an interconnection line between eastern and western districts. The materials for this project is currently being procured, and the construction work will be started in 1989. It is also being planned to construct a single circuit, 69 kV transmission line, 28.8 km in length, between Sophia Frequency Converter Station and Garden of Eden Power Plant, but implementation of this plan has not been decided yet. The standard transmission line conductor is ACSR partridge (266.8 MCM, 135.2 mm^2). The transmission line supports are wood poles made of wallaba. Wallaba grows in Guyana, and it is a very hard wood. Steel towers are used at special positions such as river crossing. There are two such crossings along the transmission line from Onverwagt to Canefield on Berbice River and Canje River. Steel towers 66.8 meter high and having a span of 780 meters are used at the former crossing, and towers 36.6 meter high have a 177 meter long span at the latter crossing.

(2) Distribution facilities

The primary distribution lines in 50 Hz systems have voltage classes of 11 kV and 4 kV, while 13.8 kV, 11 kV, 4.16 kV, 4 kV and 2.3 kV are used in 60 Hz systems. GEC selects the standard voltage of 11 kV for 50 Hz systems and 13.8 kV for 60 Hz systems. The outline of major distribution facilities is presented in Table 3.2.1-2.

Table 3.2.1-2 Existig distribution facilities
(as of August, 1988)

Name of line section		Line voltage (kV)	No. of feeders	Length	Installed capacity (kVA)
Kingston P.S	(50 Hz)	11	7	70	59,125
Ditto	(50 Hz)	4	4	20	7,390
Sophia F.C	(50 Hz)	11	3	5	12,415
Versailles P.S	(50 Hz)	11	2	60	8,500
Garden of Eden P.S	(60 Hz)	13.8	3	65	16,215
Onverwagt P.S	(60 Hz)	13.8	2	71	5,630
Canefield P.S	(60 Hz)	13.8	3	106	6,398
Anna Regina P.S	(50 Hz)	11	3	92	6,850
Bartica P.S	(60 Hz)	4.16	3	24	691
Wakenaam P.S	(60 Hz)	13.8	3	26	740
Sophia F.C	(60 Hz)	13.8	3	-	-
Linden S.S	(60 Hz)	13.8	3	-	-
No. 53 Corentyne S.S	(60 Hz)	13.8	3	-	-
New Amsterdam S.S	(60 Hz)	11	1	-	-
		2.3	4		
Connecting line					
Versailles P.S - Kingston		11	1	25	
Sophia F.C - Kingston P.S		11	2	10	
Sophia F.C - Garden of Eden P.S		13.8	1	24	
New Amsterdam S.S - Everton P.S		13.8	1	5	
Canefield P.S - New Amsterdam S.S		13.8	2	12	
Sophia F.C - Onverwagt P.S		13.8	1	74	
Canefield P.S - No. 53 Corentyne S.S		13.8	1	63	

There is no specific plan for expansion of the distribution facilities. However, it is being planned to establish "Distribution Master Plan" by January, 1989 in order to deal with increase of loads after 1990.

The standard conductors used in the primary distribution lines are ACSR "Hawk" (477 MCM, 241.7 mm^2) and hard aluminum stranded cables named "Tulip" (336.4 MCM, 170.5 mm^2). Supports are wood poles made of Wallaba. The poles of primary distribution lines are often used for stringing low voltage distribution lines and communication cables.

The details of low voltage distribution lines are not clear because records are not well maintained. GEC selects the single phase three conductor system with voltage of 120/240 V or the three phase three conductor system with 480 V voltage, and trying to unify the diversified voltage classes. The single phase 2 conductor (with one conductor grounded) 240 V system is used except in Georgetown and New Amsterdam. The standard conductors are hard aluminum stranded cable (HA1) "Wasp" (106 mm^2) and "Tulip".

Distribution transformers of various capacities are being used, and many transformers are equipped with off-load tap changer ($\pm$2.5% or $\pm$5%). The high voltage side of 13.8 kV and 11 kV transformers are protected with fuse and lightning arresters, but no protective devices are provided on the low voltage lines connecting the general customers.

When a new customer request supply of electricity, GEC bears the cost of the conductor which is no more than 60 feet (18.3 m) from the existing distribution line plus the cost of meter. The customer is charged with G$1.5/feet in case of two wire system, G$2.5 for 3 wire system, and G$10.88 for 4 wire system.

The power systems on both sides of Demerara River are interconnected by two submarine cables. One runs from Versailles Power Plant to Garden of Eden Power Plant, and operated at 50 Hz, 11 kV. Another cable is operated at 60 Hz, 13.8 kV, and runs from Garden of Eden Power Plant to the distribution system in the southern part of Western Demerara District. The 50 Hz interconnection cable has been damaged by a fault occurring in May, 1987, and it is not used today. A replacement cable has been proceed from Venezuela, but the schedule for replacement has not been decided yet. The length of both submarine cables is 1.4 km.

(3) Line faults

The detailed statistics of line faults are not known because data before 1987 are not properly maintained. According to a record that cover the period from November, 1987 to June, 1988, there were 9,473 faults, and the amount of supply failure was 767 MWh. Fault causes are failures of insulators, poles and cable terminals, falling trees and loose connections, etc. 77% of total faults (7,289) were caused by overloading, which occurred at ends of distribution lines or at customers, and the supply failure caused by these faults are limited in area, being 2.8% (21.4 MWh) of the total. 41% (316 MWh) of the total supply failure have been caused by falling trees or contacts of different conductors, which account for 17% (1,581) of the total faults. Faults caused by faulty equipments are 537 (6%), which caused supply failure of 165.1 MWh (22%).

The electric hazard by kite flying is frequent, and some children have died. Although GEC is arousing attention of people, this effort is not sufficiently awarded and every year GEC spends several thousand dollars carrying out repairs to the system after the kite flying season at Easter.

(4) Results of site survey

Although 69 kV transmission lines and new distribution lines were relatively well maintained, the survey team often found the relics of kites and wild pines. There were many items for which improvement should have done, such as aged equipments and rotten wool poles which should have been replaced, and transformers connected in parallel inadequately with different capacities.

The survey team observed the river crossing transmission towers for crossing over Berbice River and Canje River. The while coating on these towers was thinned, and rust were found on many places. As these towers are only ten plus several kilometers from river mouth, they are subjected to salt from sea and dust from GUYMINE's bauxite plant, and they should be painted as soon as possible.

Concerning distribution lines, GEC should start with what it can do, such as removing kite relic and plants reaching conductors, ant nests in wood poles, and vines stranding conductors and stays. Cleaning facilities and improving their environment make it easier to find faults on the facilities.

3.2.2 Substation facilities

(1) Outline of facilities

The outline of major substation facilities is presented in Table 3.2.2-1.

Name of substation	Voltage (kV)	Capacity (MVA)	Commissioning year
Garden of Eden	69/13.8	2 x 16.7	1976
Linden	69/13.8	1 x 16.7	1976
Sophia	69/13.8	1 x 16.7	1977
Canefield	69/13.8	1 x 16.7	1984
Onverwagt	69/13.8	1 x 16.7	1986
No. 53 Corentyne	69/13.8	1 x 16.7	1987
New Amsterdam	13.8/2.3	2 x 1.5	
Total		119.9	

Two 2,000 kVA substation units and one 1,000 kVA substation units are located inside the fence in Georgetown as the substation facility for stepping down 11 kV to 4 kV, and corresponding transformers are installed.

There is a plan for expansion of substation facilities by installing two 20 MVA, 69/13.8 kV transformers each at Sophia Frequency Converter Station and Garden of Eden Power Plant, or a total of four new transformers by 1990, but the schedule for implementation has not been decided yet.

(2) Results of site survey

The substations are surrounded by strong fences, which are properly grounded with due consideration on public safety.

However, many substations are located on marshy lands, where weeds grow and water pools, and patrol roads are not well prepared. It is necessary to remove weeds and provide good patrol roads. Power and control cables are directly buried in these grounds.

3.2.3 Power system control facilities

(1) Sophia Control Center

Sophia Control Center is the key station for operation of GEC's power systems, and this is operated by a 3-shift, 4-team system. The displays on the power system display board are manually controlled based on information collected by telephone, and the status of the whole system can be displayed this way.

The control board room of this center is equipped with, in addition to the power system display board, the relay boards for the converter station and substation, instrument boards, and communication facilities for shift duties. The room is narrow, and lighting was not adequate for operation and monitoring jobs.

(2) Sophia frequency converter station

Sophia Frequency Converter Station has been completed in February, 1978 as a part of a plan to standardize power system frequency. There are 3 units of 10 MW (12.5 MVA) rotary converters. Two of these units are being operated, but another is shutdown due to burning of stator coil. GEC has purchased a new stator and rotor to restore this unit, and this was completed in January 1989. When the survey team visited this station in mid-August, one of the two units in service was under periodical inspection. This converter station is operated under 3-shift, 4-team system, with a team consisting of two operators.

(3) Power exchange with GUYMINE

The power exchange agreement with GUYMINE consists of general terms including rates, terms of payment, and provisions for claim, and technical terms concerning division of facility ownership, actions in accident, etc. The power exchange for Demerara Power System is performed at Linden Substation (GEC), and that for Berbice Power System at Everton Power Plant (GUYMINE).

According to this agreement, a maximum of 4 MW of power is to be transferred at Linden Power Plant, but more than 4 MW of power is being supplied when GUYMINE has surplus supply capability. From 6 to 10 MW of powers have been supplied from GUYMINE to GEC from 1987 to 1988.

(4) Communication facilities for power system operation

The communication facilities for power system operation and power exchange, which is built with GEC at the center and with GUYMINE and Mahaicony & Abary Rice Development Scheme (MARDS), consists of VHF radio, power line carrier telephone and public telephone. The outline is given in Figure 3.2.2-1.

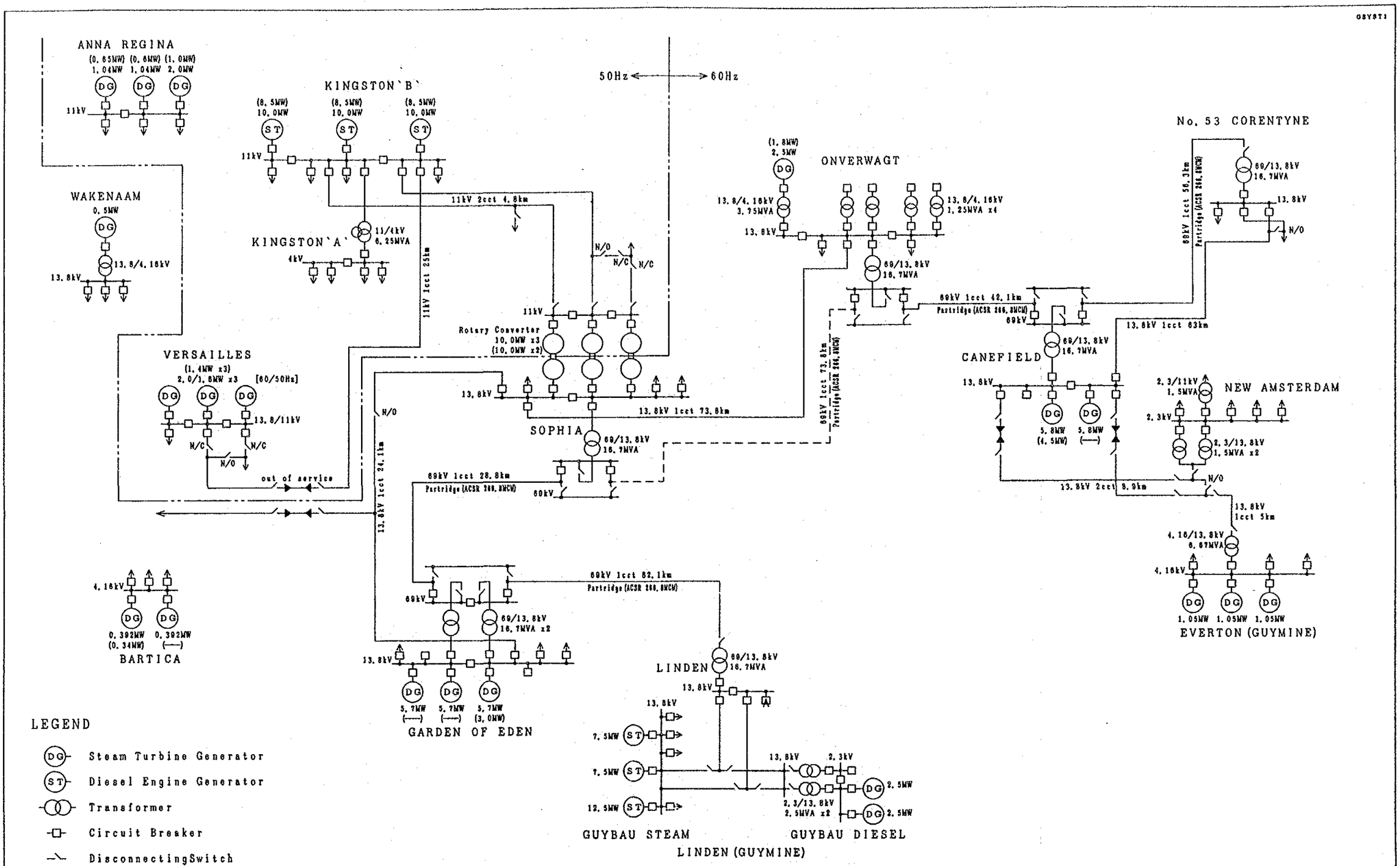
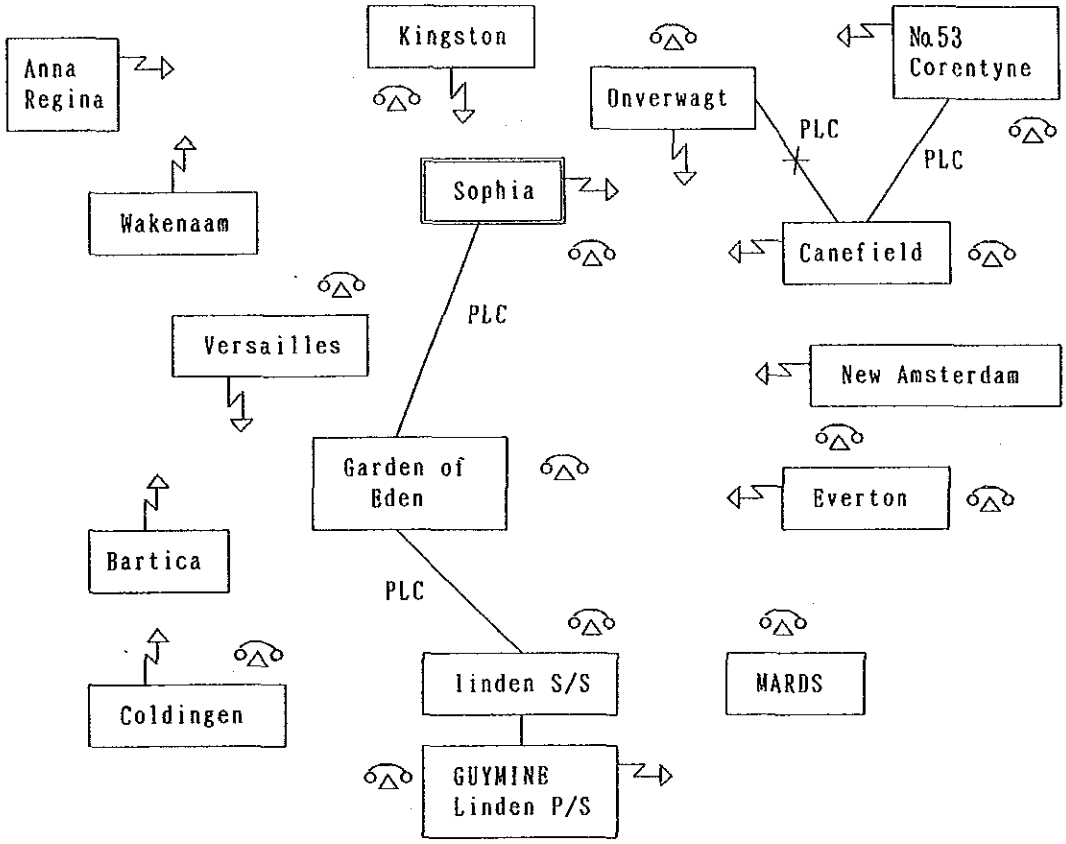


Fig. 3.2.1-1
SINGLE LINE DIAGRAM
OF INTERCONNCTED SYSTEM
IN 1988 (ACTUAL)

Fig. 3.2.2-1 Communication System of GBC



(注) PLC : Power Line Carrier

: VHF Radio

: Public Telephone

PLC : Out-of-Order PLC

3.3 OPERATION, MAINTENANCE AND TRAINING OF PERSONNEL

3.3.1 Operation and maintenance of power generation

The operation and maintenance system of each power plant has been discussed in Section 3.1, "Power Generation Facilities". To summarize these discussions, the engineers and other staff members are assigned to each power power plant as illustrated in Table 3.3.1-1.

Table 3.3.1-1 Number of employees at thermal power station
(as of August, 1988)

Name of P.S.	Engineer	Staff	Total
Kingston	4	136	140
Versailles	1	36	37
Garden of Eden	3	50	53
Canefield	1	47	48
Onverwagt	1	32	33
Anna Regina	1	27	28
Wakenaam	-	9	9
Bartica	-	12	12
Total	11	349	360

The operation and maintenance duties are performed on 24 hour basis, and personnels belonging to Rank 1 or above work under 3-shift, 5-team system, and those belonging to Rank 2 or below work on 3-shift, 4-team basis.

The organization chart of the steam power plant is given in Figure 3.3.1-1, and that of diesel power plant in Figure 3.3.1-2.

Fig 3.3.1-1 Organization of Steam Power Plan

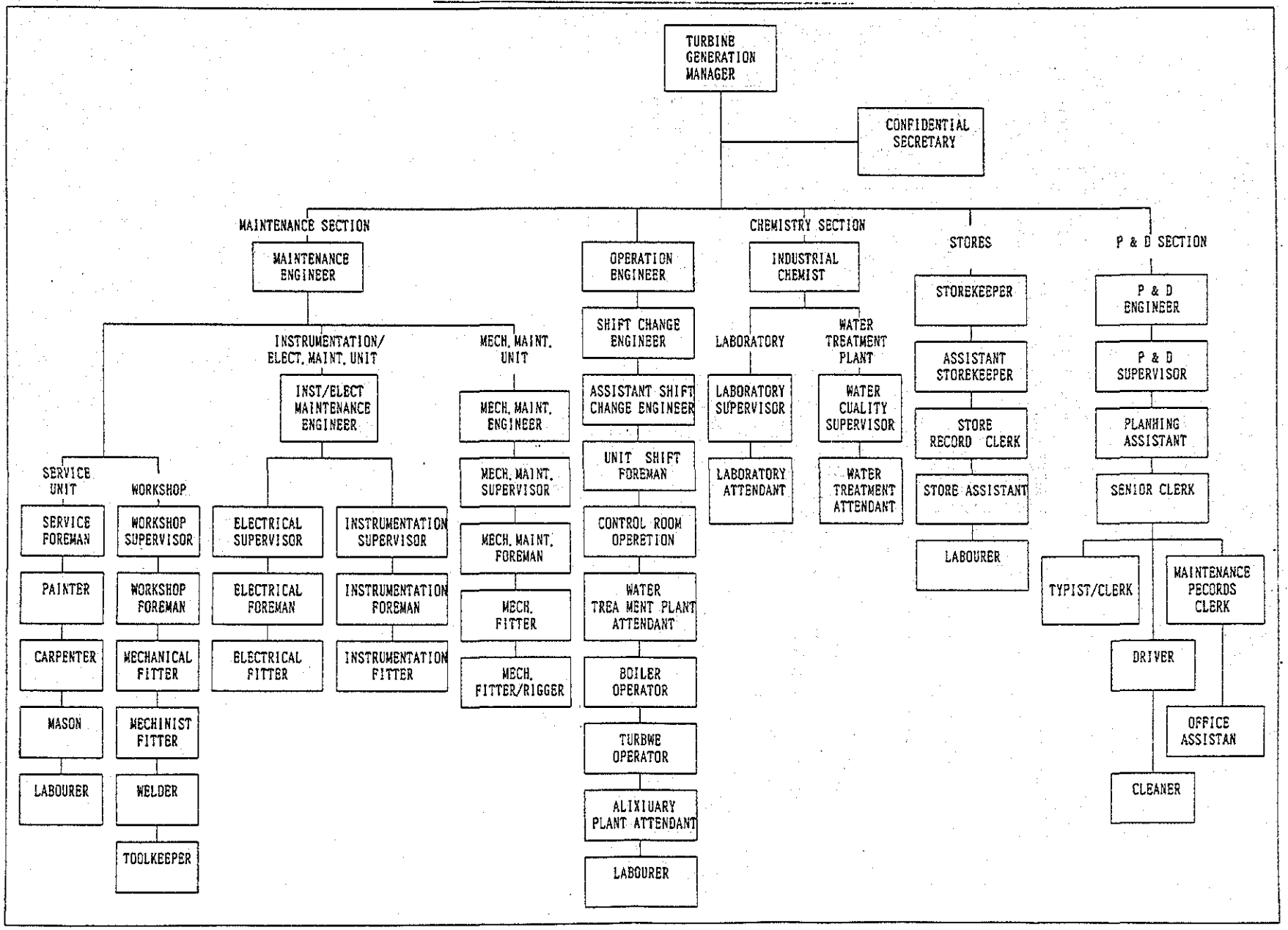
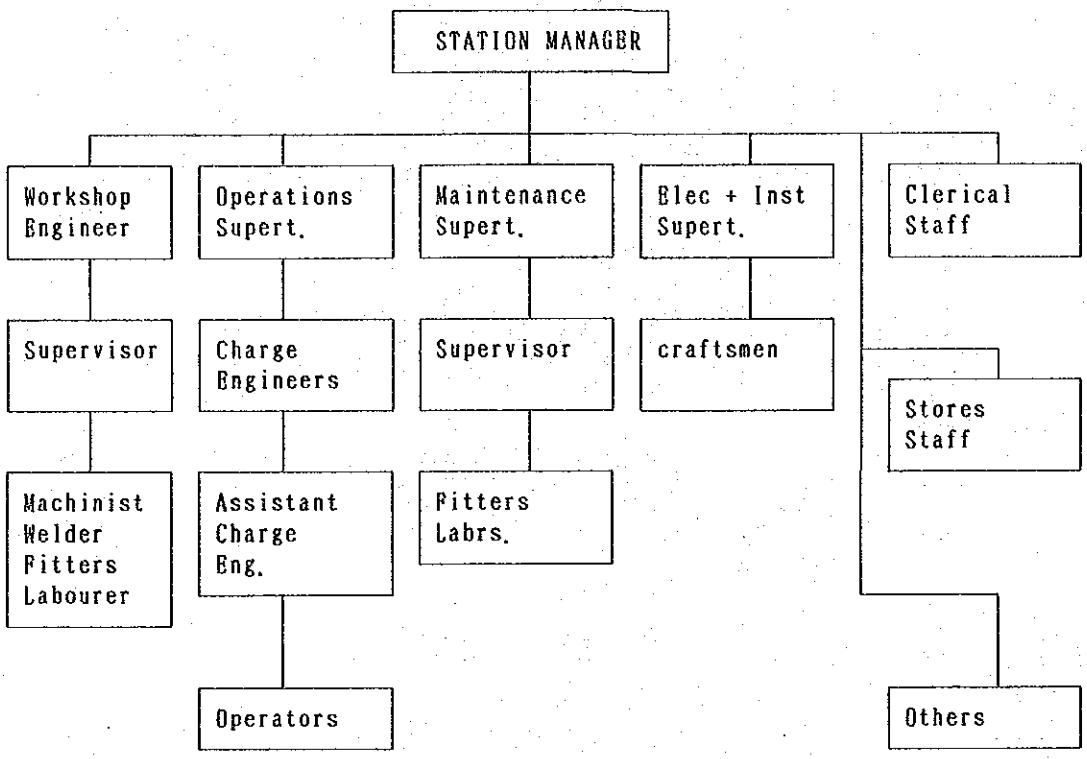


Fig 3.3.1-2 Organization of Diesel Power Station



According to the current maintenance and supervision system, the periodical inspection is performed on a steam power plant once every year for boilers and turbines, and the overhaul of generator is performed once in every 5 years.

In diesel power plants, the standard inspections are conducted in very 500 hours, 1,000 hours, 3,000 hours, 6,000 hours and 12,000 hours, and overhaul is conducted in every 24,000 hours as standard practice.

The spare parts are purchased by GEC directly from the manufacturer or through contractors. In storing spare parts and consumables of diesel power plants, the routine consumables are stored at each power plant, while parts for overhaul works are stored in the central power plant in a region, such as:

Parts stored in Garden of Eden Power Plant:
Parts for its own power plant plus those for Versailles, Anna Regina, Wakenaam and Bartica Power Plants.

Parts stored in Canefield Power Plant:
Parts for its own power plant plus those for Onverwagt Power Plant.

In case of facility failure, GEC contacts manufacturers directly, to work out measures including dispatch of engineers.

3.3.2 Operation and maintenance of transmission, distribution and substation facilities

(1) Transmission and distribution facilities

The construction and maintenance/supervision of transmission and distribution facilities are being performed by divisions responsible to construction and maintenance respectively, and these duties are performed by dividing the the whole facilities into 7 areas according to the locations, that is, central, eastern, western and southern districts of Georgetown, eastern Berbice, western Berbice and Essequibo district (which includes Bartica and Wakenaam). The maintenance division has the tree trimming team, which is engaged in the duty of preventing the fault created by hazardous trees.

In dealing with faults on distribution lines, duties are performed on 24 hour basis in three shifts. The team receives reports by radio com-

munication from the various area offices and repairs the faulted facilities.

The necessary materials and instruments for maintenance, as well as vehicles, are in serious shortage, and it is being planned to improve this situation by the rehabilitation plan which is being implemented.

(2) Substation facilities

The operating duties of independent substations such as Linden, New Amsterdam and No. 53 Corentyne are performed by 24 hour basis 3-shift duties. The substation facilities of Garden of Eden, Onverwagt and Canefield Power Plants and Sophia Frequency Converter Station are operated and maintained as parts of respective plants and station.

The inspection of substation facility is performed as annual periodical inspection. The oil circuit breakers are checked every year, but the circuit breakers have never been overhauled.

(3) Power system operation facilities

The organization for power system operation consists of the load dispatching duties, such as monitoring and logging status of power system, issuance of commands for circuit breaker and line switch operations for generators and transmission/distribution lines, and formulation of load shedding, shutdown and inspection schedules for power system facilities. The forced load shedding schedules for the next week are publicized in Saturday's newspapers.

There are two control centers at Sophia and Canefield respectively. The control center at Canefield supervises operation of power plants and stations in the eastern district, Onverwagt, Canefield, New Amsterdam Substation. The control center at Sophia operates the power system facilities in the western district, as well as operation of Sophia Frequency Converter Station. When the 69 kV interconnection line between Sophia Frequency Converter Station and Onverwagt Power Plant is completed in future, Sophia will become the main contorl centre.

3.3.3 Training of personnels

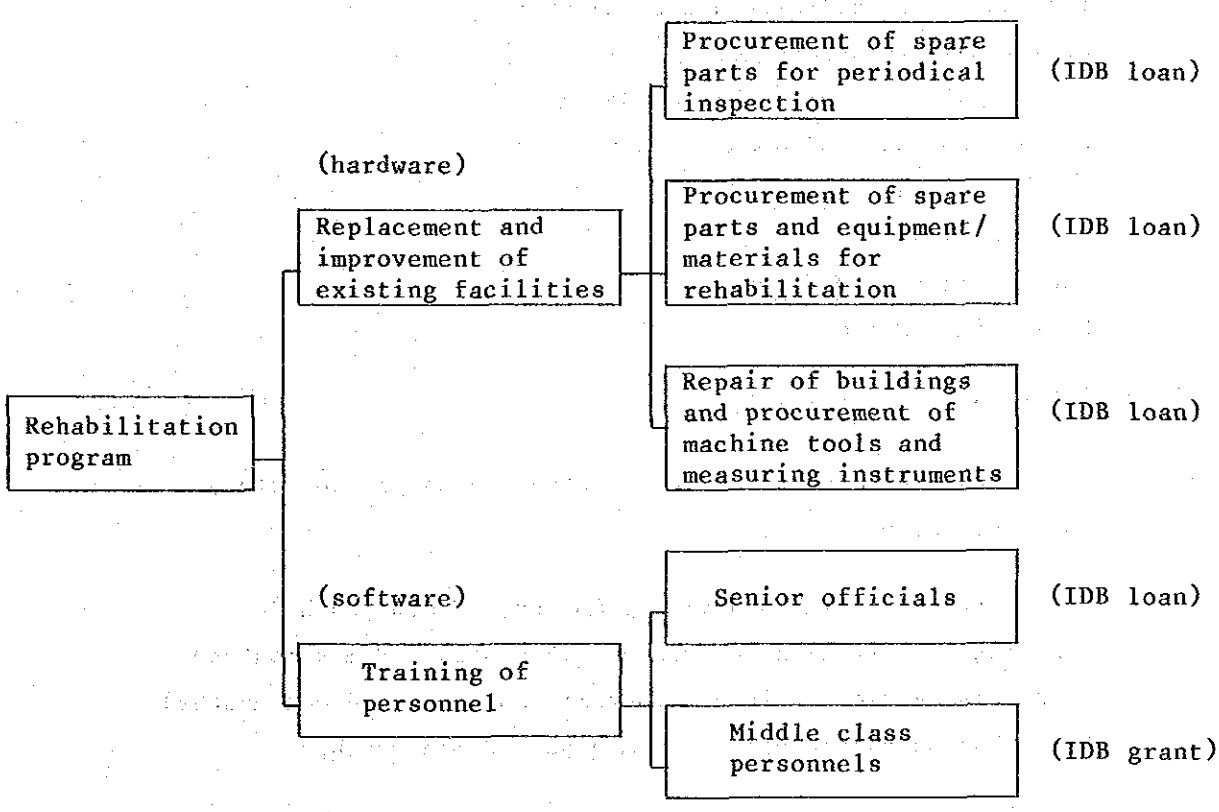
(1) Training center

A Training Center is established by GEC in the compound at Sophia Frequency Converter Station. At this Training Center GEC is training employees who are in charge of power plant, substation, transmission and distribution lines operation and maintenance.

(2) Rehabilitation program

The rehabilitation program being implemented by GEC can be illustrated as Figure 3.3.3-1.

Fig. 3.3.3-1 Table of rehabilitation work program



On the hardware side, emphasis is placed on recovery of functions of existing facilities as well as enhancement of reliability, while on the software side, focus is placed on improvement of knowledges of personnels concerning their duties.

As the hardware side has been discussed with rehabilitation program for existing thermal power plants in Chapter 4, the software side, or the training of personnels is discussed in this section.

(1) Senior officials

Foreign consultants or other professionals having sufficient experience and ability shall be hired to provide practical training as well as recommendations and advice on business operation for the period which is deemed necessary for GEC. Such on job training shall be provided to the following officials.

Operation Manager
Maintenance Manager
Turbine Generator Manager
Turbine Generator Maintenance Engineer
Diesel Generation Manager
Transmission and Distribution Manager
Protection and Instrumentation Engineer
Deputy General Manager (Finance)
Finance Manager
Data Processing Manager
Commercial Manager

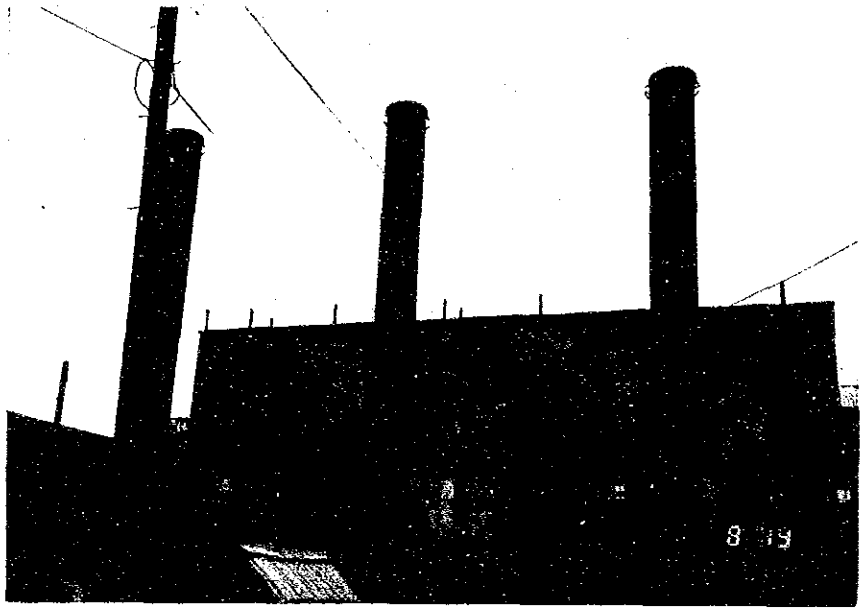
(2) Middle class personnels

The training course provided to the middle class personnels are as illustrated below.

Tariff and financing study: (6 months, 12 man months)
Staffing and organization study: (6 months, 18 man months)
Middle management training program: (30 months, 8 man months)
Distribution master plan: (8 months, 20 man months)

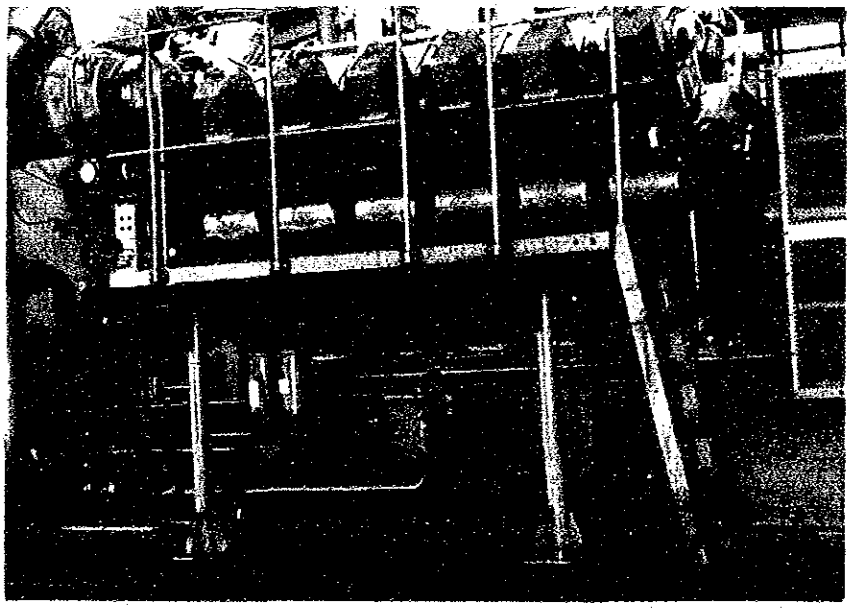
Kingston "B" Power Station

(10MW × 3)



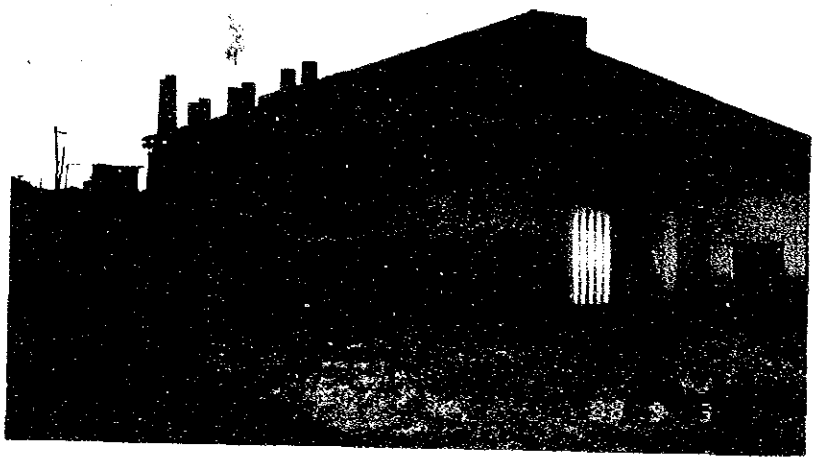
Versailles Power Station

(2 MW × 3)



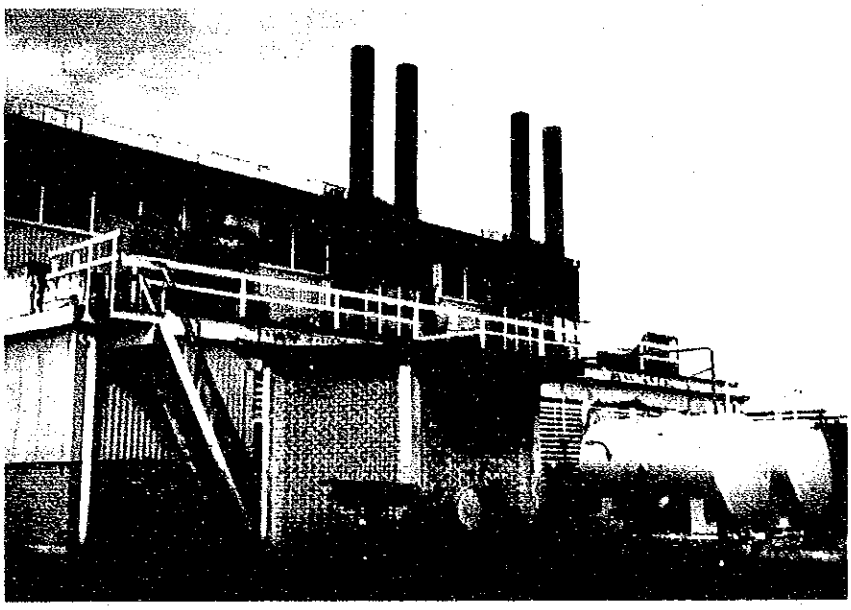
Garden of Eden Power Station

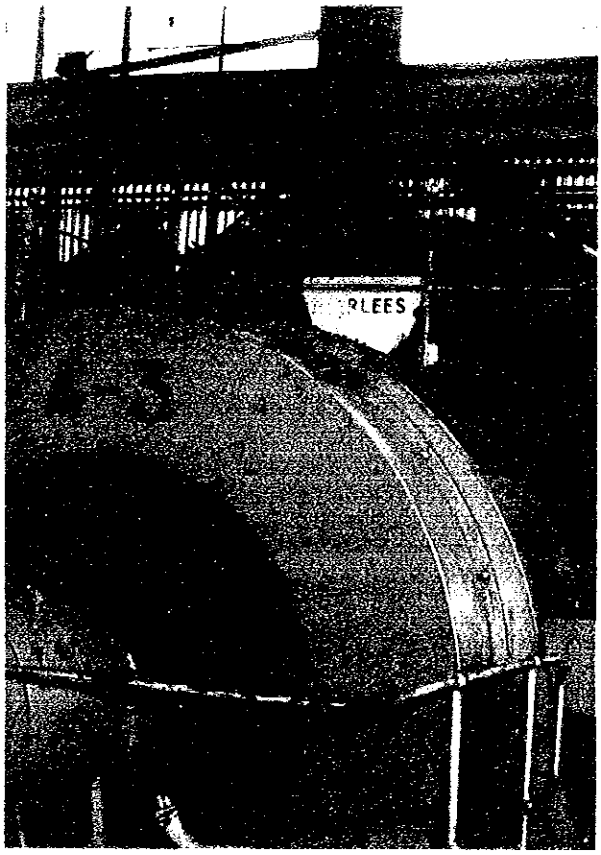
(5.7MW × 3)



Canefield Power Station

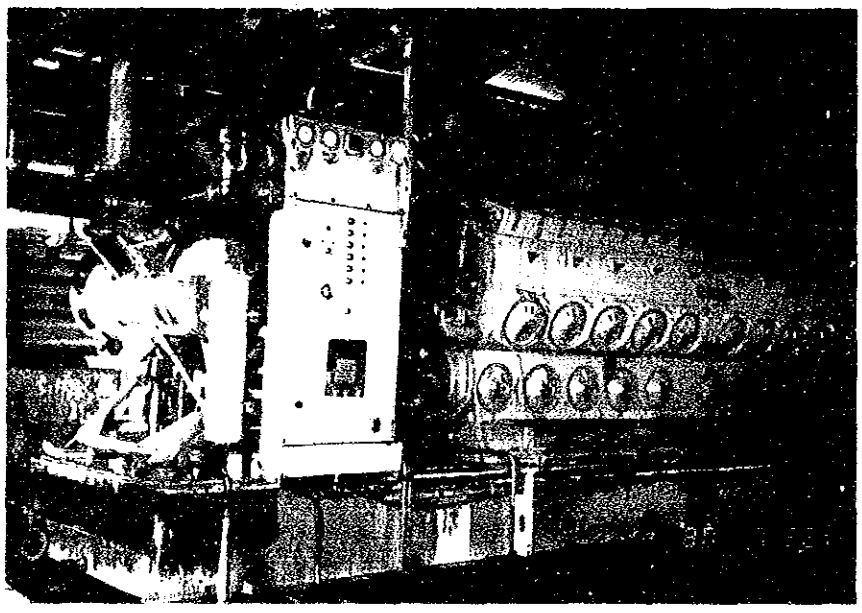
(5.8MW × 2)





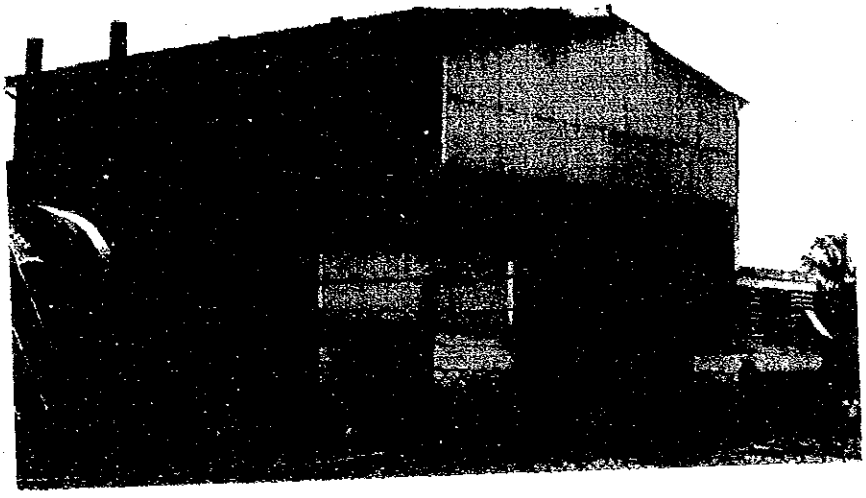
Onverwagt Power Station

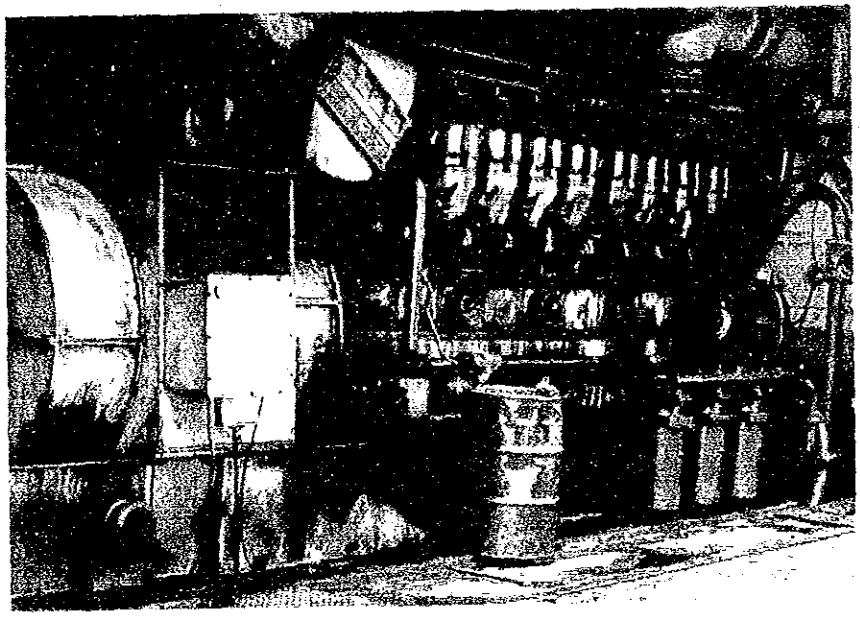
(2.5MW × 1)



Anna Regina Power Station

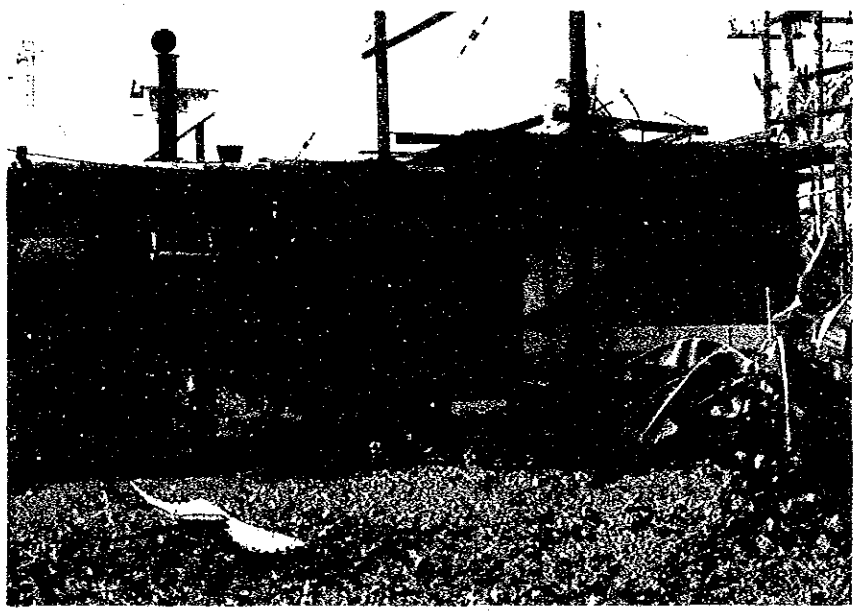
(1 MW × 2)
(2 MW × 1)





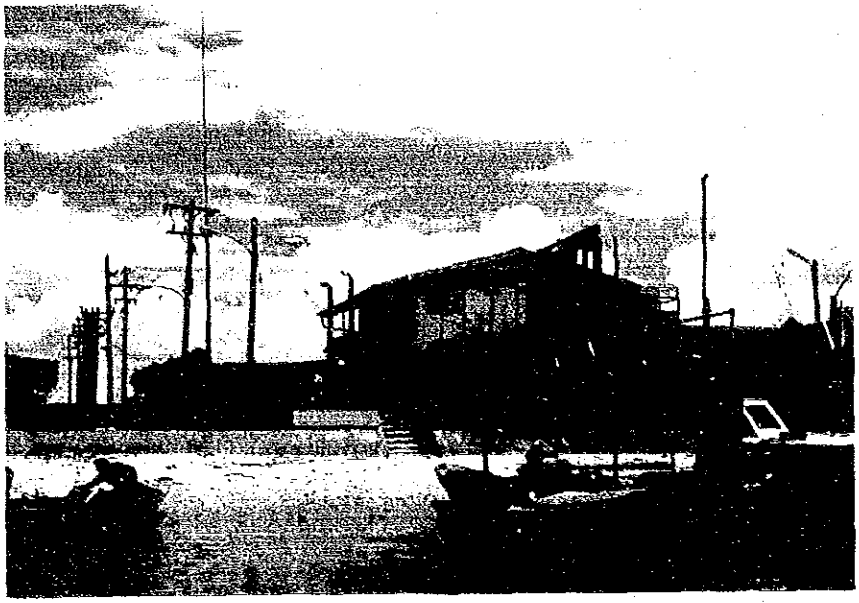
Wakenaam Power Station

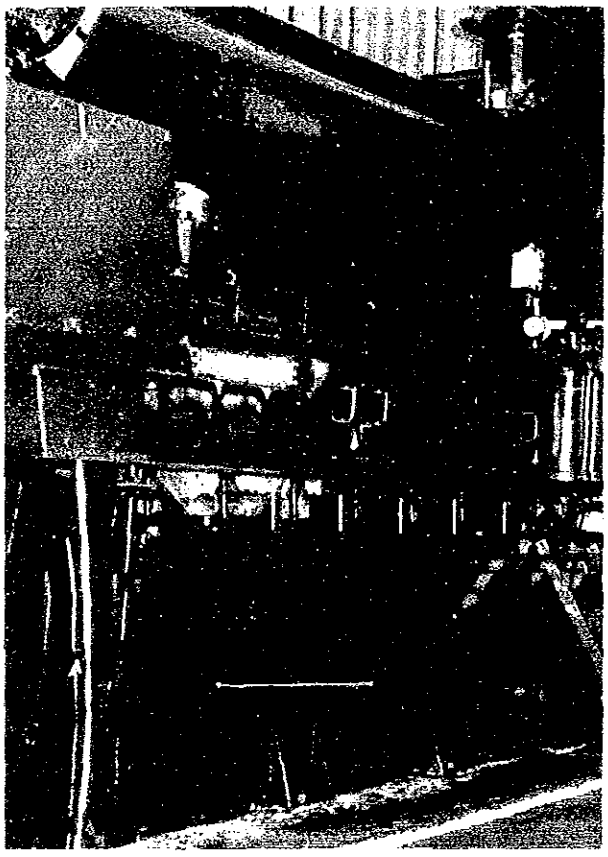
(0.5MW × 1)



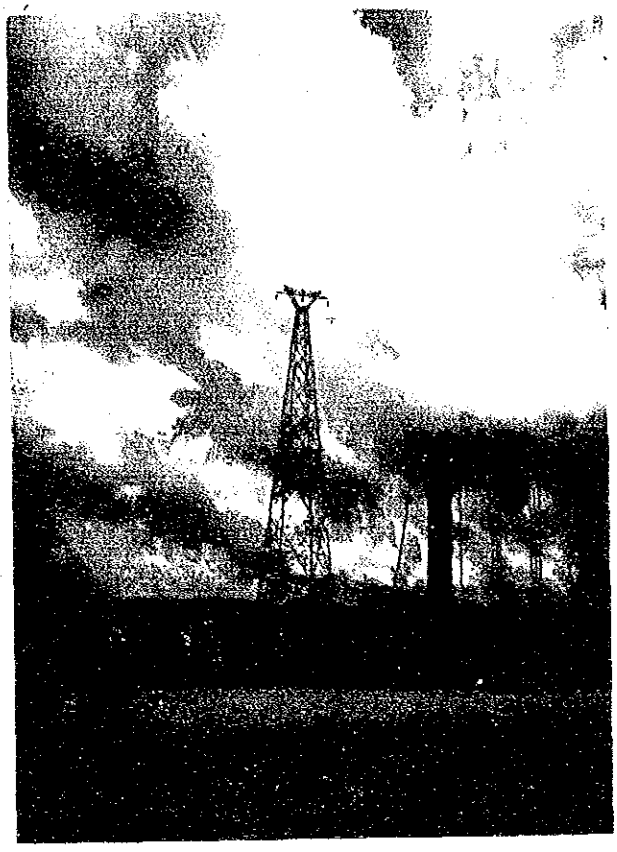
Bartica Power Station

(0.4MW × 2)





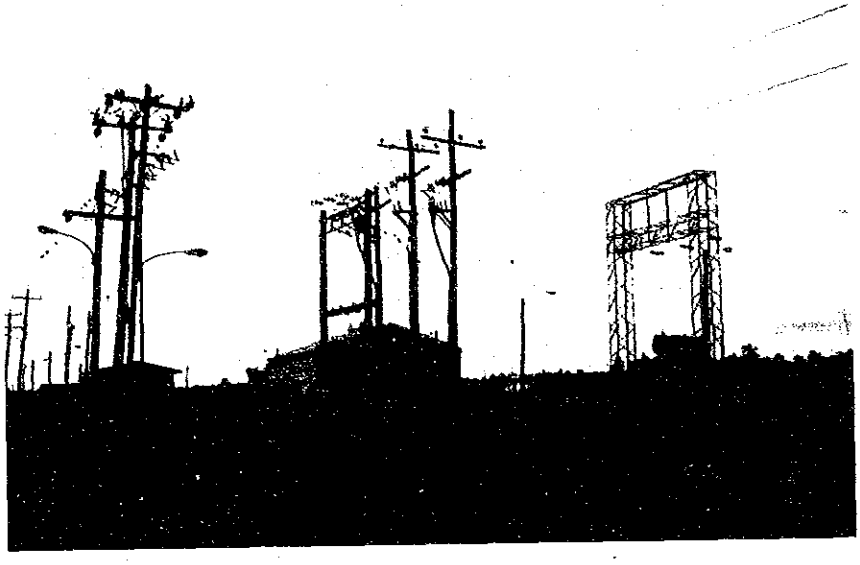
69kV Transmission Line (Across The Canje River)



13.8kV Distribution Line (Georgetown)

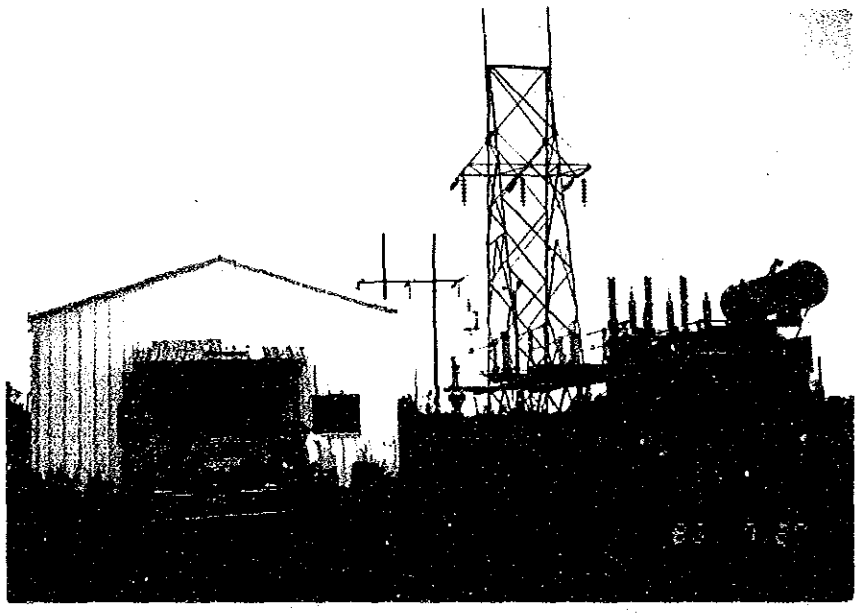
No. 53 CORENTYNE Sub Station

(16.7MVA × 1 , 69/13.8kV)

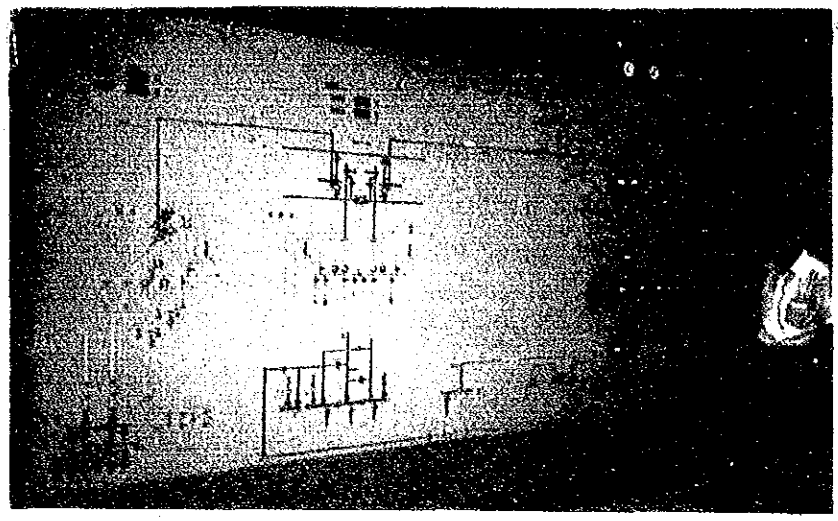


Linden Sub Station

(16.7MVA × 1 , 69/13.8kV)



Sophia Control Centre



Sophia Fvequency Converter Station

(10MW × 3)