

JAPAN INTERNATIONAL COOPERATION AGENCY(JICA)

No. 1

THE REPUBLIC OF UGANDA
THE UGANDA ELECTRICITY BOARD (UEB)

THE BASIC DESIGN STUDY
ON
THE PROJECT FOR THE REINFORCEMENT
OF
ELECTRIC POWER DISTRIBUTION NETWORK
IN
KAMPALA SUBURBAN AREA
IN
THE REPUBLIC OF UGANDA

NOVEMBER 1993

YACHIYO ENGINEERING CO., LTD.

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PREFACE

In response to a request from the Government of the Republic of Uganda, the Government of Japan decided to conduct a basic design study on the Project for the Reinforcement of Electric Power Distribution Network in Kampala Suburban Area and entrusted the study to the Japan International Cooperation Agency (JICA).

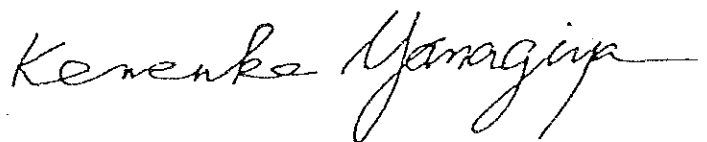
JICA sent to Uganda a study team headed by Mr. Yasuhiro Morimoto, Grant Aid Division of Economic Cooperation Bureau, the Ministry of Foreign Affairs and constituted by members of Yachiyo Engineering Co., Ltd., from June 6 to July 15, 1993.

The team held discussions with the officials concerned of the Government of Uganda, and conducted a field study at the study area. After the team returned to Japan, further studies were made. Then, a mission was sent to Uganda in order to discuss a draft report, and as this result, the present report was finalized.

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

I wish to express my sincere appreciation to the officials concerned of the Government of the Republic of Uganda for their close cooperation extended to the teams.

November 1993



Kensuke Yanagiya

President

Japan International Cooperation Agency

November 1993

Mr. Kensuke Yanagiya,
President
Japan International Cooperation Agency
Tokyo, Japan

Letter of Transmittal

We are pleased to submit to you the basic design study report on the Project for the Reinforcement of Electric Power Distribution Network in Kampala Suburban Area in the Republic of Uganda.

This study was conducted by Yachiyo Engineering Co., Ltd., under a contract to JICA, during the period from June 2 to November 30, 1993. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of Uganda and formulated the most appropriate basic design for the project under Japan's grant aid scheme.

We wish to take this opportunity to express our sincere gratitude to the officials concerned of JICA, the Ministry of Foreign Affairs, and the Ministry of International Trade and Industry. We would also like to express our gratitude to the officials concerned of the Uganda Electricity Board, JICA Kenya Office and the Embassy of Japan in Kenya for their cooperation and assistance throughout our field survey.

Finally, we hope that this report will contribute to the further promotion of the project.

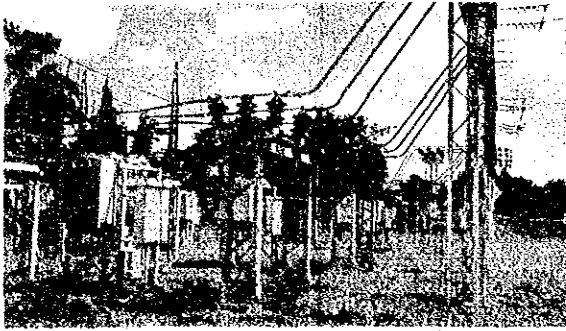
Very truly yours,



Tadao Okabe
Project Manager,
Basic design study team on
the Project for the Reinforcement of Electric Power
Distribution Network in Kampala Suburban Area
Yachiyo Engineering Co., Ltd.

Present Conditions of Substation Sites under The Project

① Kampala South Substation



Existing 33 kV switchgear facilities
(These will be removed after the
completion of the new substation.)



Project Site
(Within the yard of the existing
switching station.)

② Ntinda Substation



Project Site
(A 32-m x 32-m site was purchased
for new construction)



(Construction of a new housing project is
underway nearby, for which supplying
electricity is urgent.)

③ Kisugu Substation



Project Site
(As there is no distribution substation nearby, this
neighborhood now experiences large voltage drops and
its supply of electricity is unstable.)



A roughly 900m² area was purchased for the Project
(Two 33 kV transmission lines run
through the site.)

Present Conditions of Substation Sites under The Project

④ Kawanda Substation

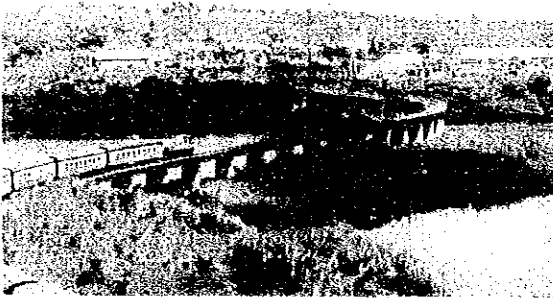


Project Site
(A 33 kV transmission line runs through the site)

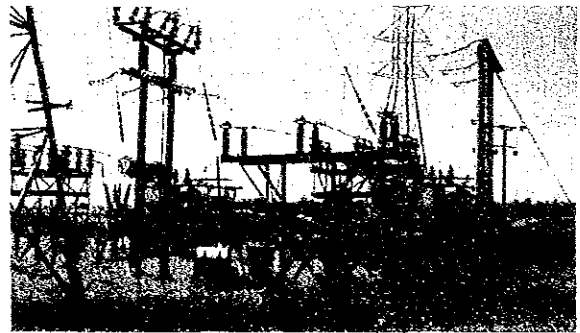


The existing substation was destroyed in the 1979 civil war (Scrapped transformers can be seen in the background.).

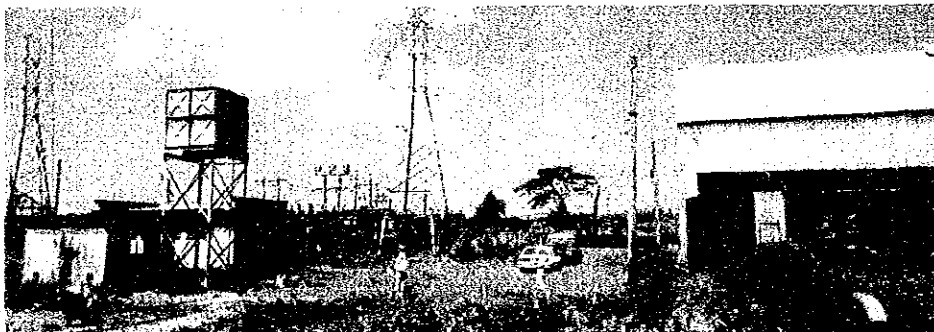
⑤ Njeru Substation



(This Project Site is located at the headwaters of the Nile river.)



(The available capacity of the existing equipment has declined due to deterioration, and can no longer provide a stable supply of electricity.)



Project Site
(Open space adjacent to existing substation will be used.)

Present Conditions of Substation Sites under The Project

⑥ Kisubi Substation



(The existing transformers have stopped functioning due to deterioration.)



Access road to Project Site (This area is owned by UEB, but is currently used as a banana grove. UEB has indicated that they will restore it before construction begins.)

⑦ Kawala Substation



Project Site
(There are 132 kV and 33 kV transmission lines in the distance)



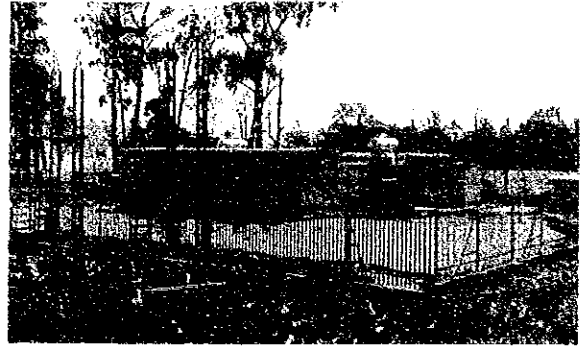
(Construction of a housing project by World Bank Aid is being pursued, and infrastructure facilities such as power are needed.)

Conditions of Facilities Built under Previous Project

Queensway Substation

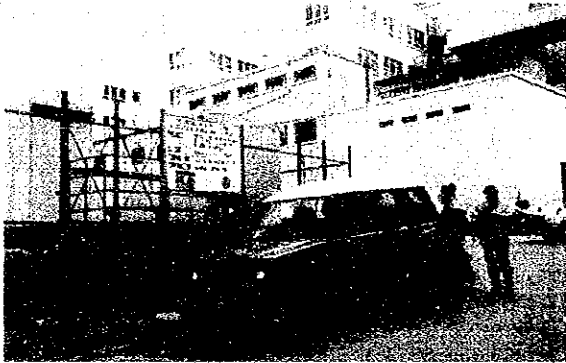


Environment surrounding Queensway Substation (By the completion of the previous Project, the electrical supply situation in Kampala central area has been improved, and it now receives a stable supply of electricity).

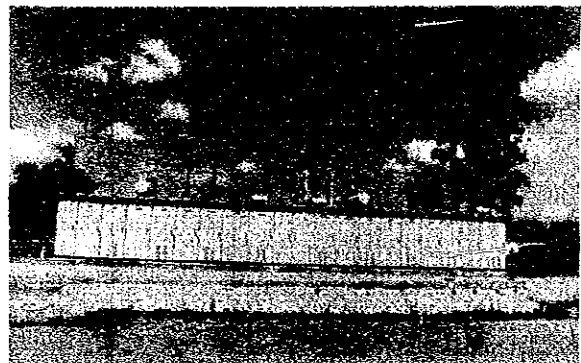


Queensway Substation, Phase I of the previous Project (embankment and fence construction was undertaken by Uganda).

Motor Mart Switching Station



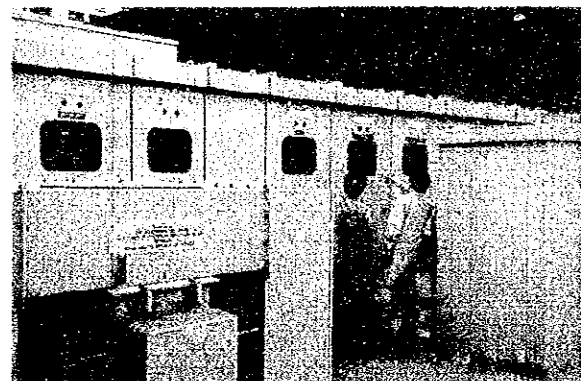
From this switching station, electricity is distributed to the capital's central district.



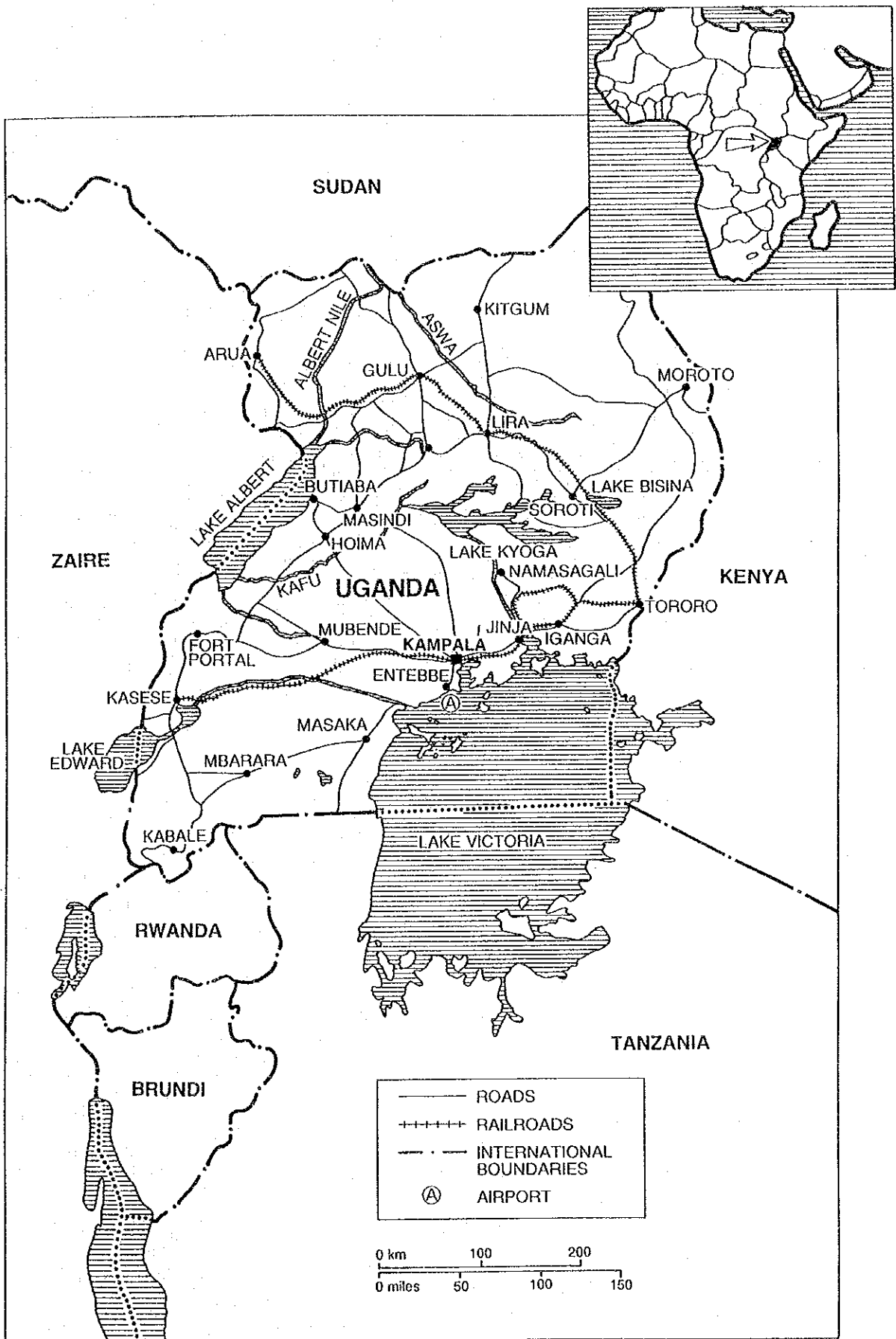
A view of the 11 kV outdoor type switchgear cubicles.



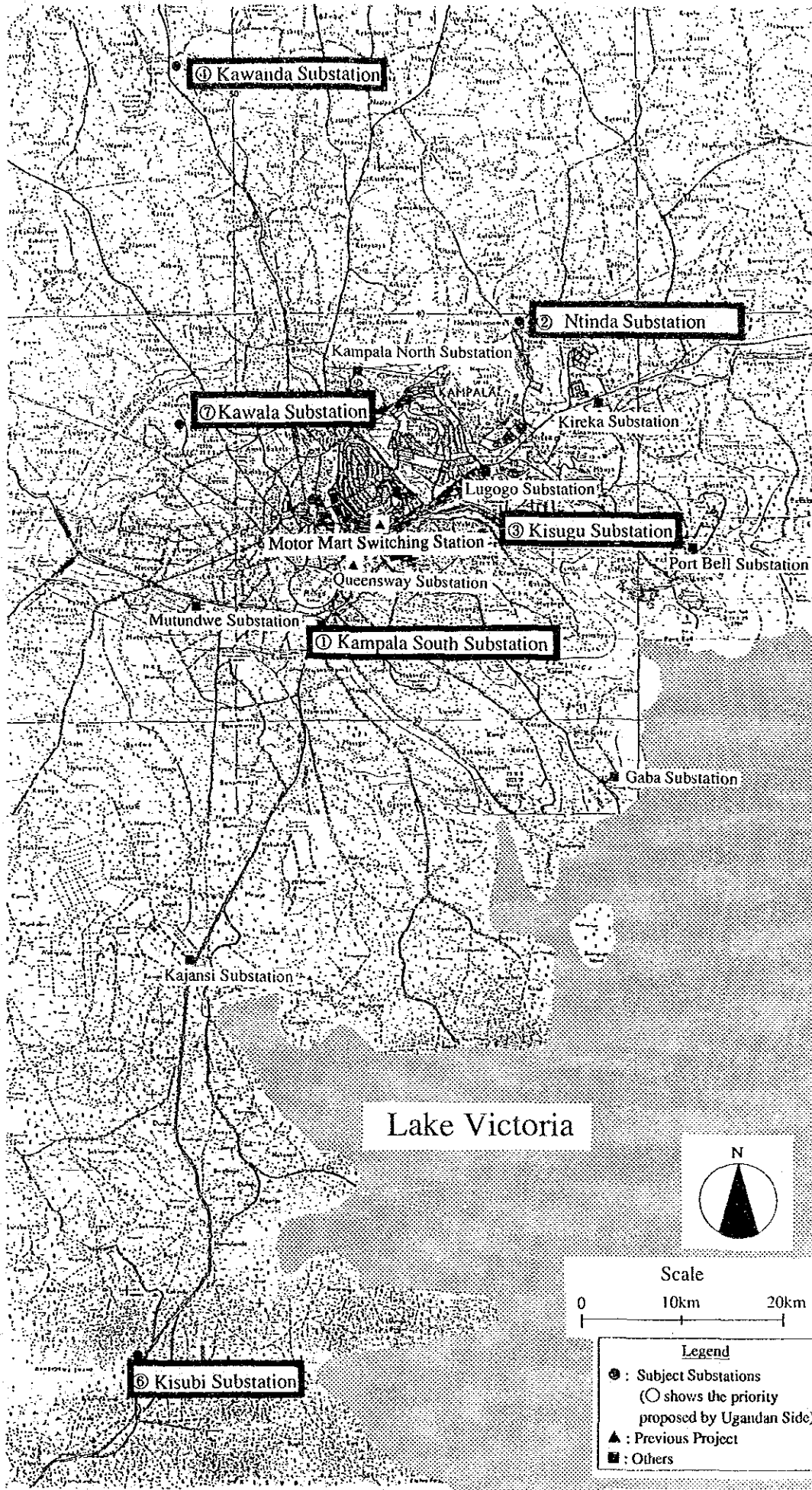
A view of the 11 kV outdoor type switchgear cubicles.



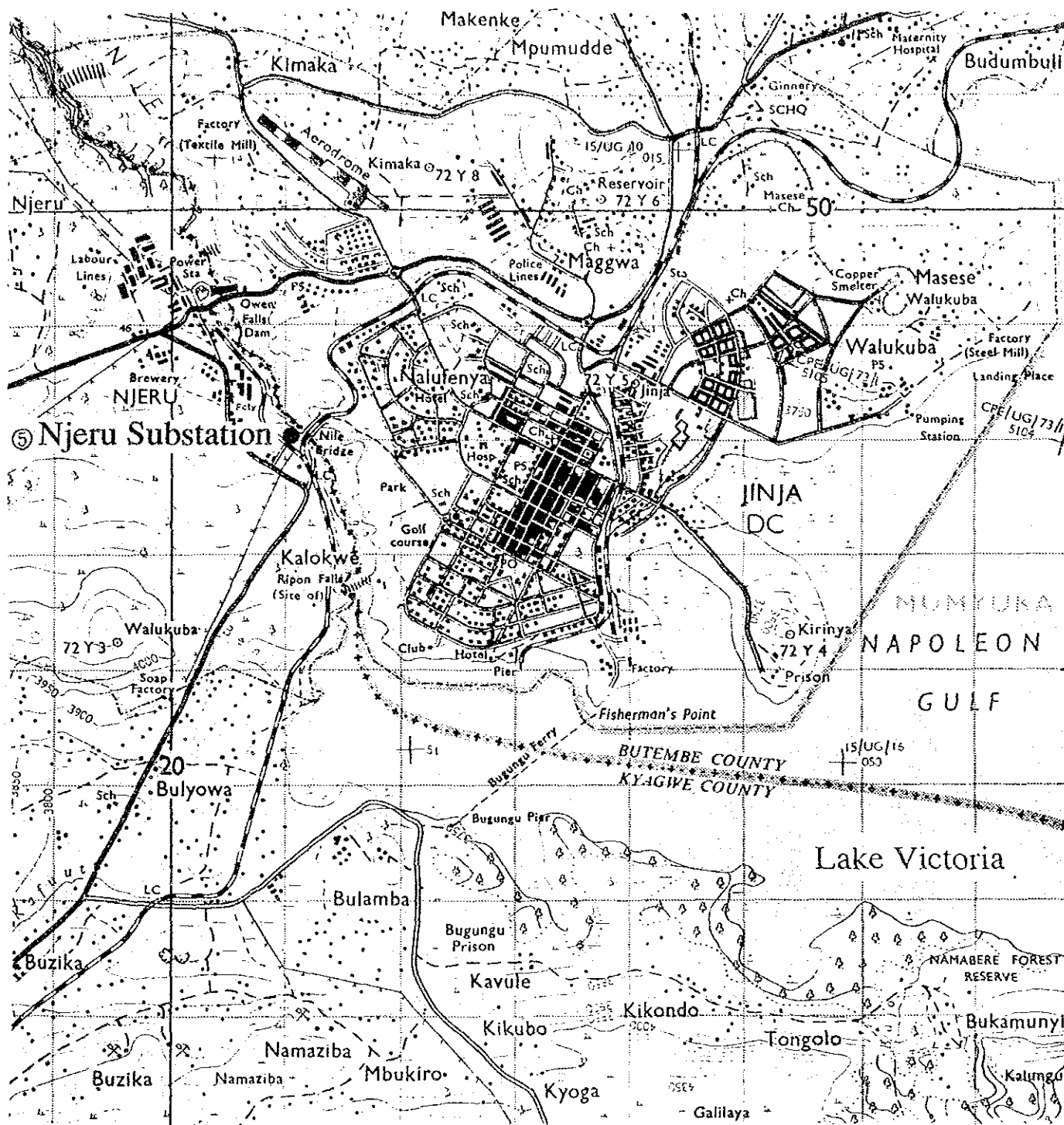
The equipment operates normally, which has improved the electrical situation in the capital's central district.



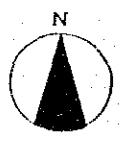
UGANDA LOCATION MAP



Location of Subject Substations (Kampala City)

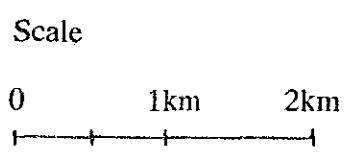


● Njeru Substation



Legend

- : Subject Substation
- shows the priority proposed by Ugandan Side.)



Location of Subject Substations (Jinja City)

SUMMARY

SUMMARY

The Republic of Uganda (hereinafter referred to as Uganda) is a landlocked country located at the equator. It is bordered by five countries, i.e., the Sudan to the north, Zaire to the west, Rwanda and Tanzania to the south, and Kenya to the east. Lake Victoria, the third largest lake in the world, is located in Uganda. The national land area is 197,000 km² and the population is some 16.67 million (1991 census). The GDP is approximately 2.155 trillion shillings (1991, 1US\$ = about 1,170 shillings) and the capital, Kampala, is located in the south-central part of the country, facing Lake Victoria.

Since the Uganda economy is largely dependent on the export of such primary agricultural products as coffee and cotton, it is vulnerable to weather and market trends in industrial countries. The Ugandan economy underwent a period of stagnancy due to a controlled economy under military rule in the 1970's and civil war in the early 1980's, with the real growth rate of the GDP dropping to minus 6.5 percent in 1984. The introduction of the Rehabilitation and Development Plan with the purpose of building "an independent, integrated and self-standing national economy" in subsequent years initiated a recovery of the economy in 1986. The real growth rate of GDP from 1987 to 1991 was 4.0 percent to 7.6 percent . Nevertheless, the burden of economic ruin in the past is still strongly felt today and the economic conditions are far from ideal. The Government of Uganda is, therefore, promoting the establishment of a self-reliant economy with agriculture and industries at the core on the grounds that the urgent recovery of the economy is a priority target for national reconstruction efforts.

Improvement of the social infrastructure to achieve economic recovery is emphasized in the Rehabilitation and Development Plan (1988/89 ~ 1991/92), which states that the rehabilitation of the existing power generation and transmission facilities is the prime objective in the energy sector. Furthermore, as one of the goals of the energy sector, the latest Rehabilitation and Development Plan (1991/92–1994/95) is continuously restoring and upgrading the electrical power facilities with a view to promoting the electrification of suburban and rural areas.

The transmission and distribution networks in Kampala, the capital of Uganda, and the center of the country's political, economic and social activities, were largely constructed in the 1950's and show signs of deterioration. Regular restrictions on the power supply (regular power cuts) have been imposed and brownouts occur in remote areas due to insufficient transformer capacity to meet increased demand for electricity. This situation hinders social and economic activities of the city. Furthermore, it is urgent that the power generation capacity of the Owen Falls Hydroelectric Power Station, the main power supply source for Kampala, is increased through upgrading and improvement of superannuated facilities in order to respond to the sharp increase in demand for electricity.

The Uganda Electricity Board (UEB), the public organization solely responsible for power generation and supply, has 3,161 employees (as of May, 1993), and has made concerted efforts to provide adequate maintenance for the existing facilities. However, difficulties in obtaining spare parts for the aged facilities, and in the procurement of equipment and materials due to pressing foreign currency shortages, have resulted in inadequate maintenance. Thus, power supplies in the metropolitan area are extremely unstable.

Under these circumstances, the Government of Uganda has prepared the Second Power Project with a view to improving the power supply network in Kampala, including the renovation of the Owen Falls Power Station, increasing the facility capacity from 150 MW to 180 MW with the assistance of the World Bank, the British Government, etc. In 1989, it became apparent that the original project budget had fallen far below the required level due to inflation, the worsening exchange rate, etc., making a review of the project necessary. Consequently, the Second Power Project is being implemented on a smaller scale than originally anticipated. Following the Second Power Project, the Government of Uganda also plans the Third Power Project with the assistance of the World Bank and others to achieve the medium and long-term economic recovery of the country (as improvement of the limited power supply situation is crucial for such economic recovery). The main component of the Third Power Project is the extension of the Owen Falls Power Station (200 MW), and the installation of a new transmission line.

However, it appears difficult to secure a new loan for further renovation of the distribution network and substations which are not included in the Second and the Third Power Projects, but which provide electricity to areas for the general public, as minimal profits would be generated.

Against this background, the Government of Uganda prepared a plan for reinforcement of the electric power distribution network in Kampala for an area not included in the Second and Third Power Projects. The intention of the plan was to complement these Projects in order to vitalize industrial, commercial, and social activities in the capital by securing a stable power supply. The Government of Uganda subsequently made a request to the Government of Japan for the provision of grant aid for the plan. Then the Government of Japan conducted the Basic Design Study in 1991. In 1991 and 1992, the renovation of the electric power distribution facilities (The Project for the Reinforcement of Electric Power Distribution Network in Kampala Phase I and II, herein after referred to as the previous project), mainly Queensway substation and Motor Mart switching station, was implemented, resulting in a vast improvement in the power supply situation for governmental facilities and economic areas in the center of Kampala. However, problems such as extreme voltage drops, transformer deterioration, and unstable power supply due to the shortage of capacity, etc., continue in areas other than the center of Kampala city, particularly in suburban areas (estimated service population in 1995: 198,000, estimated maximum load demand: 26.4 MVA), and there has been an increase in complaints. Therefore, the Government of Uganda prepared a plan to provide new installation and

renovation of power distribution substations in order to improve the power situation of the suburban areas of Kampala, and made a request to the Government of Japan for the provision of grant aid for the Project.

In response to this request, the Government of Japan decided to conduct the Basic Design Study on the Project and entrusted the study to the Japan International Cooperation Agency (JICA) which sent a study team to Uganda from June 6 to July 15, 1993. The same study team was sent to Uganda again from September 2 to 13 in 1993, to explain the contents of the Draft Final Report.

The study team gained an understanding of the power service situation in Uganda through discussions and a field survey, and confirmed the poor situation of the power facilities in the concerned areas; i.e., the superannuated condition of the distribution equipment and facilities, extreme voltage drops in the distribution areas, and the regular power cuts due to transformer capacity shortage. Furthermore, since the concerned power distribution substations are located in the Kampala suburban area, which is the economic and social center of the country, the team confirmed that urgent implementation of the Project is necessary.

The Project is an important program which will supplement the Second and Third Projects implemented through the cooperation of the World Bank, etc., and the scale of the facilities (33/11 kV power distribution substation: 7 locations) requested by Uganda and the major specifications thereof (① bus-line capacity 33/11 kV: 2000 A and ② system short-circuit capacity 33 kV: 16 kA, 11 kV: 20 kA, etc.) match the substation facilities indicated in the comprehensive power transmission distribution network plan. The scale of the facilities also, is in accord with the power demand forecast of the relevant distribution areas, and it was confirmed that the facility scale requested from Uganda was proper.

The necessity for the procurement of equipment and materials for the Medium Voltage (MV) and Low Voltage (LV) distribution networks and maintenance vehicles was also confirmed based on recognition of the factors that the unreliable power supply in Kampala is caused by 1) a shortage of power distribution materials, such as insufficient distribution transformer capacity, etc., and 2) an inability of the maintenance work of power distribution network to fully perform functions due to deterioration and the shortages of maintenance vehicles owned by the UEB District Offices.

It was decided not to include the procurement of equipment and materials to repair the existing 132 kV high voltage power transmission tower that was included in the initial request (as it is outside the scope of the power distribution network amelioration that is the objective of the Project). The procurement of a pole treatment plant was also excluded because there are existing private companies in Uganda that are able to handle the work as demand increases.

In the design of the substations to be constructed under the Project, special attention was paid to securing an immediate supply of power to residents of the area. Therefore, it was decided that an outdoor cubicle type switchgear would be installed to shorten the construction period, to

avoid the further construction of a building to house the switchgear cubicles, and to minimize the required space.

As for the Project sites, maximum use of the land of the existing substations shall be made, and for newly constructed substations, the following sites, which were prepared by the UEB for the Project, will be used.

Kampala South, Kawanda, Njeru and Kisubi Substations	:	Within existing switching stations or substation sites
Ntinda, Kisugu and Kawala Substations	:	Within sites purchased by the UEB for the Project

As the table below indicates, the actual construction will be conducted in two phases, i.e., Phase I: construction of substation facilities intended to immediately improve the power service situation in the existing concentrated housing areas and areas of small/medium-sized industries in the Kampala suburban area, and Phase II: construction of substation facilities intended to improve the power service situation in the newly developed housing and suburban areas.

Project Outline

Project Item	Phase I	Phase II
(Facility Construction Plan)		
Construction or rehabilitation of distribution substations	Construction of the following facilities and foundations. 1) Kampala South substation (transformer capacity 5MVA x 2 units) 2) Ntinda substation (transformer capacity 5MVA x 1 unit) 3) Kisugu substation (transformer capacity 5MVA x 1 unit) 4) Kawanda substation (transformer capacity 5MVA x 1 unit)	5) Njeru substation (transformer capacity 5MVA x 2) 6) Kisubi substation (transformer capacity 2.5MVA x 1 unit) 7) Kawala substation (transformer capacity 5MVA x 1 unit)
On-the-Job Training (OJT)	OJT on operation and maintenance techniques for above facilities to be provided by engineers of the Japanese contractor.	Same as at Phase I.
(Equipment and Materials Procurement Plan)		
Equipment and materials for MV and LV distribution network	Equipment and materials required for the Project • Distribution transformers • Surge arrestors • Aluminum-alloy stranded conductors for 33 kV transmission line • Insulators for 33 kV transmission line	Equipment and materials required for the Project • Distribution transformers • Surge arrestors
Maintenance vehicles for distribution network	Vehicles required for maintenance of distribution network supplied by above substations. • 4-wheel drive vehicles • Spare parts	Vehicles required for maintenance of distribution network supplied by above substations. • Lorries • 4-wheel drive vehicles • Spare parts
Auxiliary equipment and materials related to the substations	1) 11 kV underground distribution cable to connect existing 11 kV network to new facilities 2) Aluminum-alloy stranded conductor to connect new 33 kV cable terminal and existing 33 kV transmission line. 3) 33 kV cable for the future planned line of Kawanda substation. 4) Surge arrestors of the above. 5) Spare parts for new facilities	1) 11 kV underground distribution cable to connect existing 11 kV network to new facilities 2) Aluminum-alloy stranded conductor to connect new 33 kV cable terminal and existing 33 kV transmission line. 3) Spare parts for new facilities

The executing agency for the Project in Uganda is the UEB, which will also be responsible for the operation and maintenance of the new facilities after the completion of the Project.

In the event that the Project is implemented under the Grant Aid extended by the Government of Japan, major items of work to be undertaken by the Ugandan side will be the preparation of land at each substation construction site, the dismantling and

removal of existing equipment and facility in the Project sites, and the construction of roads for access to the Project sites, etc. The cost involved is about US\$76,000 (about ¥8.8 million based on an exchange rate of US\$ = ¥116.53 as of July, 1993).

The following time periods will be required to complete the relevant work.

- Phase I : Detailed design – 3 months,
Manufacture and/or procurement of equipment – 6 months,
On-site construction - 8 months
- Phase II : Detailed design – 3 months,
Manufacture and/or procurement of equipment – 6 months,
On-site construction - 8 months

The UEB is required to complete the extent of the construction to be undertaken by Uganda, such as land preparation work at the Project sites and construction of access roads, including the provisioning of a temporary storage yard, and to cooperate with the Japanese side in the establishment of communication/coordination links with the related government agencies for the smooth implementation of the Project.

The Project implementation is expected to have a direct benefit of providing a stable power supply through the construction of new substations and the installation of new distribution equipment, including distribution transformers, etc. Also, it will enable power to be supplied to new consumers in distribution areas, thus the current ratio of electrification will increase by about 10 percent from the current 33 percent. Cost required for maintenance and control of the concerned substations is estimated to be about US\$2,600/year, which accounts for just about 0.1 percent of the total maintenance and control cost in the 1993 UEB budget. Therefore, it is understood that the UEB can definitely secure the outlays required for maintenance and control of the facilities to be installed by the Project.

In view of the facts that the Project will improve the power service in the Kampala suburban area and that it will contribute to the improvement of the people's life in suburban areas and stimulate social and economical activities, it has been concluded that the implementation of the Project under Japan's grant aid is highly significant and proper.

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ABBREVIATIONS

EEC.....	European Economic Community
E/N.....	Exchange of Notes
GDP	Gross Domestic Product
GNP.....	Gross National Product
GWh.....	Giga Watt Hour (= 1,000MWh = 1,000,000kWh)
IEC.....	International Electrotechnical Commission
ISO.....	International Organization for Standardization
JEC	Japanese Electrotechnical Commission
JICA.....	Japan International Cooperation Agency
JIS	Japan Industrial Standards
ODA	Overseas Development Administration (UK)
O&M.....	Operation and Maintenance
OJT	On the Job Training
SCADA.....	System Control and Data Acquisition
UEB	Uganda Electricity Board

CHAPTER 1 INTRODUCTION

CHAPTER 1 INTRODUCTION

Impoverished under military rule in the 1970s, the Republic of Uganda (hereinafter referred to as Uganda) is now undergoing economic recovery and the government is implementing a national development plan with the rehabilitation and promotion of agriculture and industry in order to firmly establish a self-reliant economy. The Rehabilitation and Development Plan (RDP) indicates the measures to be implemented in each sector on a biannual basis and the latest RDP addresses the period between fiscal year 1991/92, and fiscal year 1994/95.

The electricity distribution network in Kampala, the capital of Uganda and the country's center for political, economic, and social activities, was first established in the 1950s and has largely deteriorated.

The Owen Falls Hydroelectric Power Station, the primary power station to Kampala, is being forced to repair its deteriorated equipment to raise generating capacity from 150 MW to 180 MW to cope with a soaring power demand. Despite conscious efforts on the part of the UEB to maintain the present facilities at a reasonable standard, the reliability of these facilities has declined due to difficulties in spare parts procurement for the old equipment and the securing of parts as well as other supplies due to the low level of the country's hard currency reserves. Poor transformer capacity has thus made regular power cuts necessary and the electricity supply in the capital has been very unstable for some time.

To improve the situation, the Government of Uganda listed the reinforcement of the existing electricity distribution network in the suburbs and the countryside as a priority target in the electric power sector in the RDP (1991/92~1994/95) to implement the urgent improvement of this important element of the social infrastructure.

Under these circumstances, the Government of Uganda prepared the Second Power Project with a view to improving the power supply network in Kampala, including the rehabilitation of the Owen Falls Hydroelectric Power Station, with the assistance (US\$83.9 million dollar loan) of the World Bank, the British Government, etc. In 1989, it became apparent that the original project budget had fallen far below the required level due to inflation, the worsening exchange rate, and other economic reasons, making a review of the Project necessary. Consequently, the Second Power Project is being implemented on a smaller scale than originally anticipated. Following the Second Power Project, the Government of Uganda also plans the Third Power Project with the assistance (US\$247 million dollar loan) of the World Bank and others to

achieve the medium and long-term economic recovery of the country as improvement of the scarce power supply situation is crucial for such an economic recovery. The major target of the Third Power Project is to add 200 MW increase capacity at the Owen Falls Hydroelectric Power Station and construct a 132kV transmission line.

The Second Power Project will provide main transmission lines and the repair of the existing hydraulic power station. The primary purpose of the Third Power Project is to reinforce the power station. Therefore, it appears difficult to secure a new loan for further renovation of the distribution network and substations that provide electricity supply to areas for the general public, as minimal profit would be generated.

Against this background, the Government of Uganda prepared a plan (with a view to improving infrastructure and the distribution substations in the center of Kampala) for reinforcement of the electric power distribution network in Kampala for an area not included in the Second and Third Power Projects. The intention of the plan was to complement these Projects in order to vitalize industrial, commercial, and social activities in the capital by securing a stable power supply. The Government of Uganda subsequently made a request to the Government of Japan for the provision of Grant Aid for the project. The basic design was implemented in 1990. In 1991 and 1992, a power distribution facility improvement plan (The Project for the Reinforcement of the Electric Power Distribution Network in Kampala, below referred to as "the previous project") was carried out to renovate the Queensway substation and the Motor Mart switching station which improved the power situation for government facilities and the business area in the center of Kampala.

However, there is growing discontent with the unstable supply of power due to voltage drops and the poor state of the distribution facilities in the suburban area of Kampala, especially in areas at a distance from distribution substations. To correct this situation, Uganda plans to build more distribution substations and rehabilitate existing facilities. It has made a request to the government of Japan for Grant Aid to finance the Project.

The Japanese government decided to conduct a Basic Design Study. Then, the Japan International Cooperation Agency (JICA) was entrusted with the study and dispatched the a Basic Design Study Team headed by Mr. Yasuhiro Morimoto, the Grant Aid Division of Economic Cooperation Bureau, the Ministry of Foreign Affairs, to Uganda for the period from June 6 to July 15, 1993. A list of the Study Team members and the field survey schedule are given in Appendices 1 and 2 of this report.

The objectives of the Basic Design Study were to correctly assess the Ugandan request: (1) reconstruction of seven substations in Kampala Suburban area; (2) procurement of distribution materials for a low-voltage distribution network; (3) procurement of distribution materials for 11kV, 33kV and 132kV high-voltage distribution networks; (4) procurement of equipment for

poles treatment plant; and (5) maintenance vehicles for the distribution network, and to examine the possible effects of the Project and its propriety as a Grant Aid project.

In Uganda, the Study Team visited the Ministry of Natural Resources (formerly the Ministry of Water, Energy, Minerals and Environment Protection), UEB, etc., to explain the objectives of the survey. The general conditions of electricity generation and distribution in Uganda and especially in Kampala were discussed. The Study Team also reviewed the contents of the Project, reconfirming the background and the main items of the request. As a result, the Study Team and the Ugandan officials agreed that the procurement of materials for 132kV high-voltage transmission line to repair the existing steel towers was outside the scope of the Project. It was also agreed that treated poles could be manufactured by local firms if given proper training. Thus, the following three items were confirmed as the objectives of the Project, removing the above two items.

- ① Constructing seven (7) substations in Kampala suburban area
- ② Procuring equipment and materials for Medium-voltage (MV) and Low-voltage (LV) distribution networks
- ③ Procuring maintenance vehicles for the distribution network

It was also confirmed that the Project would reinforce the Second and Third Power Projects conducted with the assistance of the World Bank and other organizations.

The Minutes of Discussions (M/D) (see Appendix 4) was concluded on June 14, 1993 based on the results of the discussions and the studies of the outlined background as well as objectives of the request. The list of interviewees is given in Appendix 3.

Following the signing of the M/D, the Study Team continued to collect and analyze data and information, and submitted the Field Report to the UEB on July 5, 1993 to confirm the basic technical concept for the Basic Design of the Project with the Ugandan representatives (Appendix 5). The UEB then issued the Letter of Approval (Appendix 6) for the said Field Report.

Upon return to Japan, the Study Team prepared a Draft Final Report for the Basic Design Study for the Project, documenting the current conditions of power supply in Uganda, current conditions of Project sites, the relationship between the Project and higher level plans, and the propriety, contents, and scale of the Grant Aid into consideration. JICA then sent a Draft Final Explanation Team headed by Ms Eri Honda, Planning Department and Planning Division, JICA from September 2 to September 13, 1993, to explain the contents of the Draft Final Report to the Ugandan representatives and the Basic Design Study Report was finalized.

The Member List of Draft Final Explanation Team, the Field Survey Schedule, and the M/D for the consultation on the Draft Report are given in Appendices 1, 2 and 4, respectively.

CHAPTER 2 BACKGROUND OF THE PROJECT

CHAPTER 2 BACKGROUND OF THE PROJECT

2-1 Background of the Project

2-1-1 Outline of the Actual Conditions of the Concerned Sector

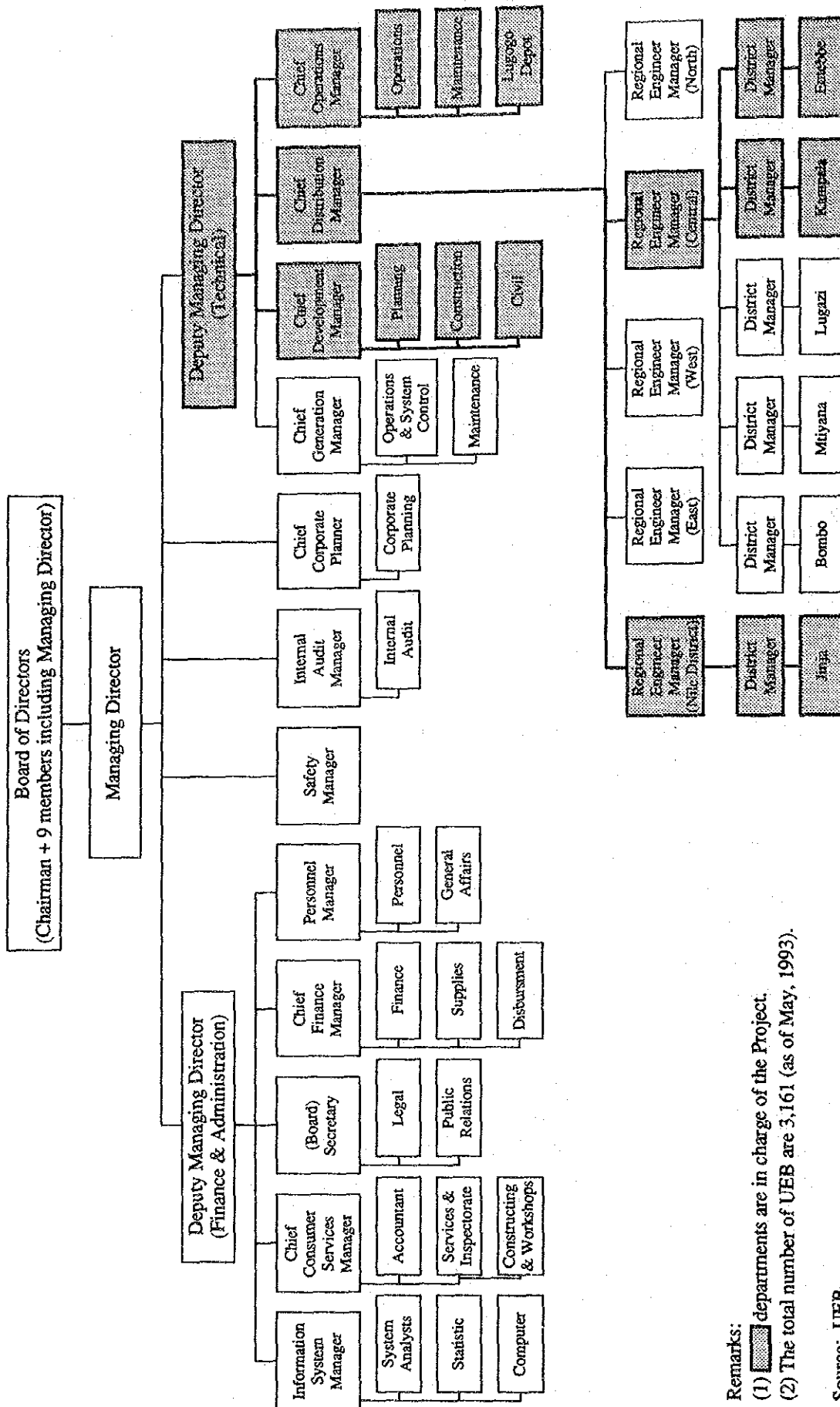
2-1-1-1 Administrative and Executive Organization of Power Sector

The UEB established by the Uganda Electricity Ordinance in 1948 is responsible for all aspects of the power sector in Uganda, ranging from the construction of power stations and transmission lines to the collection of electricity consumption charges.

The sections of the Ordinance relating to the administrative organization and finance were revised in 1961, and the Ordinance was reinforced following independence in 1962. The Ordinance provides adequate autonomy to the UEB to supply electricity throughout Uganda and also to export electricity to neighboring countries. The UEB is under the jurisdiction of the Ministry of Natural Resources (formerly the Ministry of Water, Energy, Mineral and Environment Protection), which is responsible for formulating administrative policies for the power sector.

As shown in Fig. 2-1, the highest decision-making body of the UEB is the Board (consisting of nine members, including a Managing Director of UEB). The UEB employs 3,161 people nationwide (as of May 1993) under the Managing Director and two Deputy Managing Directors. The Project will be handled by the Development, Distribution and Operation Divisions under the leadership of the Deputy Managing Director responsible for technical aspects.

Operating through its eastern offices in Kampala and Jinja, the UEB will oversee operation, maintenance, and control of the substations upon their completion and the vehicles will be used to maintain the distribution networks. The Material Department located at Lugogo substation will be responsible for the operation and control of distribution materials used for medium and low-voltage distribution network maintenance.



Remarks:
 (1) [Shaded box] departments are in charge of the Project.
 (2) The total number of UEB are 3,161 (as of May, 1993).

Source: UEB

Figure 2-1 Organization Chart of UEB

2-1-1-2 Financial Conditions of UEB

The financial conditions of UEB are given in Table 2-1. Although, a substantial rise in electric charges in 1992 increased revenues, they yielded an operating deficit of about 4.6 billion Ush, and resulted in a deficit of about 10 billion Ush for the year including other expenses.

The operating balance for 1993 is about 2.5 billion Ush; however, the operating deficit is expected to reach about 4.4 billion Ush, in the red again. This is largely due to expenses for repayments of loans that account for as much as 25% of total income. The gradual decrease in the loan repayment ratio indicates that the management are making an effort to improve the situation.

Table 2-1 Financial Conditions of UEB (profit and loss statement)

(Unit : 1000s of Ugandan Shillings)

	1990	1991	Provisional settlement of accounts for 1992	Budget proposal for 1993	Increase in 1993 budget proposal over 1992 provisional settlement of accounts (%)
Income					
Sales of energy	4,426,142	10,116,704	23,330,000	44,720,000	92
Miscellaneous income	16,414	124,207	100,000	125,000	25
(Total income)	4,442,256	10,240,911	23,430,000	44,845,000	91
Expenditure					
Salaries and allowances	764,349	1,839,352	5,117,405	7,874,029	54
Traveling expenses	377,134	632,878	2,385,215	3,489,491	46
Maintenance and management costs	1,690,497	2,805,617	1,082,113	2,416,232	123
Miscellaneous expenditure	1,357,138	977,173	1,152,823	2,039,200	77
Power generating expenses	165,422	306,485	417,752	1,374,491	229
Depreciation	106,675	104,826	15,540,000	20,700,000	33
Debts	186,696	2,414,888	2,333,000	4,500,000	93
Total Expenditures	4,647,911	9,081,151	28,028,308	42,393,443	51
Operating surplus/deficit	▲ 205,355	1,159,760	▲ 4,598,308	2,451,557	▲ 153
Other expenses (repayment of loans, etc.)	211,961	122,027	6,070,671	6,880,764	13
Deficit for the year	▲ 417,311	1,037,733	▲ 10,668,979	▲ 4,429,207	▲ 58

(Source: UEB)

2-1-1-3 Power Supply Situation

(1) Power Generating Facilities

As already described in 2-1-1-1, the UEB is responsible for all components of the power sector in Uganda, including power stations, substations, transmission lines, etc. The power stations operated by the UEB and current operation are shown in Table 2-2. The total installed capacity of the UEB is some 153 MW, with a total output of some 996 GWh of electricity in 1992, the main source of which was generated by the Owen Falls Hydroelectric Power Station (installed capacity: 150 MW) located in Jinja, about 80 km east of Kampala.

In addition to the Owen Falls Power Station, Uganda has some diesel generating power stations in local areas with a total installed capacity of some 3 MW; the annual energy supply in 1992 was 1.2 GWh (only 0.12% of the national total).

The output of the Owen Falls Power Station declined by about 73% from the installed capacity of 150 MW to 110 MW because of the general deterioration of the facilities. A rehabilitation project is currently under way with the financial assistance of the World Bank, ODA, etc., with completion scheduled for 1995. Following the completion of this project, the total installed capacity will increase from 150 MW to 180 MW.

Table 2-2 UEB's Power Generating Facilities and Current Operation

Type	Plant location	Unit size (MW)	Number of facilities	Total installed capacity (MW)	Annual energy supply (GWh) (1992)	Commissioning dates	Remarks
Hydro	Owen Falls	15	10	150.00	995.0	1954~1968	- output as of Sept. 1991 : some 110 MW - out of order
	Kabale (Sub-total)	0.25	2	<u>0.50</u> 150.50	—	1963	
Diesel	Arua	0.35	2	0.70	1.12	1989	
	Kabale	0.35	2	0.70		1989	
	Kapchorwa	0.14	1	0.14		1989	
	Kitgum	0.25+0.14	2	0.39		1989	
	Moroto	0.35+0.25	2	0.60		1989	
	Moyo	0.14	1	0.14		1989	
	Rukungiri (Sub-total)	0.25+0.21	2	<u>0.46</u> 3.13			
National Total				153.63	996.2		

(Source: UEB)

The expansion of the Owen Falls Power Station, a part of the Third Power Project initiated in 1992, began as a long-term measure to cope with growing electricity demand. An additional hydroelectric power station will be built on the other side of the river bank from the Owen Falls Power Station. The new station will eventually have an output of 200 MW (40 MW x 5 units). The output will be 80 MW (40 MW x 2 units) upon completion of the first stage in 1996. Contractual arrangements with a construction firm are already under way.

About 70% (707 GWh) of the total power output (995 GWh in 1992) generated by the Owen Falls Power Station goes to domestic consumption, with the approximately 30% remaining (288 GWh) being sold to Kenya.

The electrification rate as of December 1992, is approximately 33% for Kampala, 14% for Jinja city, and 3% for Uganda as a whole.

(2) Current state of transmission lines

The power generated by the Owen Falls Power Station is distributed by 132kV, 66kV or 33kV overhead power lines. The trunk 132kV national grid runs from the Owen Falls Power Station (in Jinja) via Kampala, the capital, through the western city of Kabulasoke to Nkenda and Masaka cities in West Uganda. Lines also go eastward from the Owen Falls Power Station to the eastern city of Tororo, where lines split to carry power to Lira city in the North, and on to Kenya.

The line from Owen Falls Power Station to Kampala and that from Owen Falls Power Station to Kenya via Tororo are dual lines, other lines are single lines. The 132kV grid has a total length of 1,009 km. Figure 2-2 shows Uganda's national grid.

Power from the 132kV grid via Tororo is sold to Kenya. Uganda is also planning to sell power to Tanzania. The 90-km 132kV transmission line from Masaka city to the border of Tanzania is expected to be completed in autumn 1993.

The approximately 80km long 66kV transmission line between Owen Falls Power Station and Kampala is a single line. At major 132/33kV substations, the power is stepped down to 33kV for further distribution via 33kV transmission lines to remote areas of the country. The total length of the 33kV transmission lines (including 33kV distribution lines) is about 2,300 km.

Kampala North and Lugogo substations located in Kampala city are used to step down the voltage from 132kV to 33kV or 11kV and from 66kV to 11kV for further distribution.

In Jinja city the 33kV supplied from the Owen Falls Power Station is stepped down to 11kV at the Njeru and Jinja Industrial substations. There are also a number of large

(3) Current state of distribution lines

Although buried cables are used in some areas in Kampala, power is mainly distributed via 11kV and 415V overhead power lines. The total length of the 11kV distribution and the 415V distribution lines is about 3,900 km and 2,300 km, respectively.

The 33kV ring grid connects the major distribution substations in Kampala. These substations step down the power to 11kV for distribution to normal users while they supply the power to major load areas on the outskirts of Kampala with 33kV directly.

The 11kV distribution lines extend radially from the distribution substations. The power in the lines is converted to 415 V (three phase) or 240 V (single phase) by distribution transformers before being supplied. Rising demand and overloads due to unbalanced distribution of loads, deterioration on the transformers, and illegal connections, cause distribution losses that are as high as 25% in Kampala.

Voltage fluctuation due to load variations are often greater than $\pm 20\%$ in the countryside.

2-1-2 Outline of related plans

2-1-2-1 National development plan

In Uganda, national development is implemented according to the biannual Rehabilitation and Development Plan. The content of the Plan is based on the discussions on the Structural Adjustment Facility with the World Bank, etc. The most recent Rehabilitation and Development Plan announced in September 1992, began in 1991/1992 and is scheduled to remain in effect until 1994/1995. The objectives of this plan are as follows:

- ① An annual economic growth rate of at least 5% per annum;
- ② A reduction in the rate of inflation to 10% by 1994/95;
- ③ An improvement in the economy's external creditworthiness as measured by:
 - An accumulation of foreign reserves to over 1 month of imports;
 - A reduction in the debt service ratio;
 - A reduction in the level of arrears on external debt.
- ④ Substantial economic and social improvements and independence through review of budget distribution for investment in high priority public works projects.

The power sector is implementing the following policies to fulfill these targets.

(1) Rehabilitation of the existing hydroelectric installations

The country has considerable hydroelectric resources. The rehabilitation and development of the electricity sector is critical in order to remove a key bottleneck in rehabilitation of other sectors, particularly manufacturing. In addition to the ongoing major

rehabilitation of the 150 MW Owen Falls Power Station, which includes up-rating of the station to 180 MW capacity, the construction of a new power house [initial capacity 80 MW (40 MW x 2 units), final capacity 200 MW (40 MW x 5 units)] on the other riverside of the present power house will begin soon.

(2) Acceleration of the program for urban and rural electrification

As many houses and factories are being built in the suburbs with urbanization, electricity sector has to service for new consumer, giving special attention to new investment area.

Electricity sector has social responsibility through intensification and expansion of rural electrification programs in order to reduce environmental degradation arising from the search for fuel wood.

(3) Raising tariffs

UEB has to raise tariffs to the level of the long run marginal cost to generate resources for investment. Real tariff increases on the order of 150% will be required over the next 2 to 3 years.

(4) Expansion of exports of electricity to neighbouring countries

The country has abundant hydroelectric power potential, enough to meet its own requirements and to export to neighbouring countries.

It has been exporting electricity to Kenya since 1955. It will begin to export to Tanzania with completion of installation of a transmission line in the near future.

2-1-2-2 Development Plans for Power Sector

UEB has conducted a nationwide restoration and upgrading of its power facilities with the assistance of various organizations, including the World Bank, EEC, IDA, etc., since the 1960s. In more recent years, its efforts have coincided with the objectives of the National Development Plan described in 2-1-2-1. The main power development projects, its history, and status are shown in Fig. 2-3.

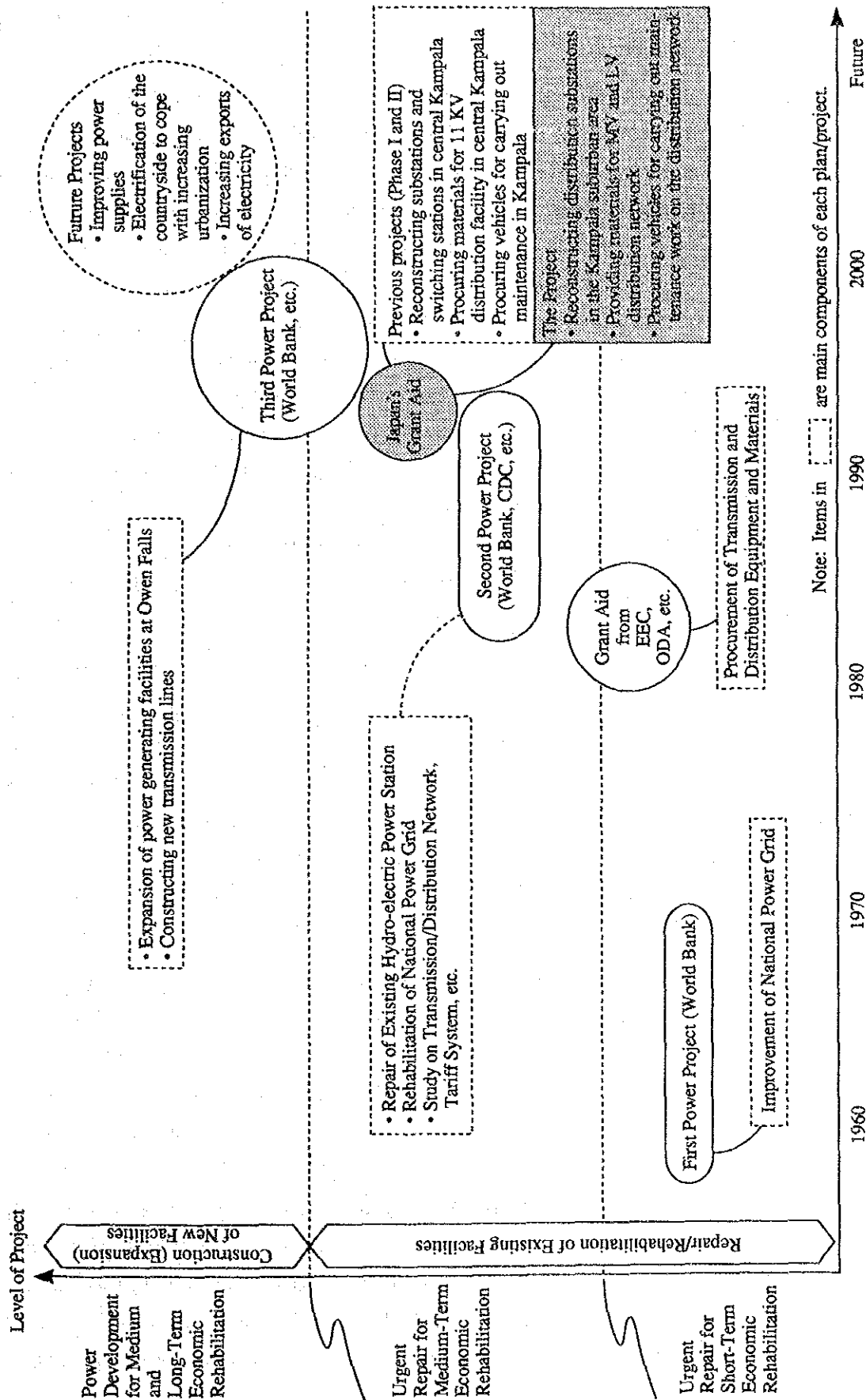


Fig 2-3 Main Power Development Projects in Uganda and Its Relationship with the Project

As Fig. 2-3 shows, the Second Power Project is currently being implemented in Uganda with the assistance of the World Bank, CDC, etc.

The implementation period of the Second Power Project was originally planned from 1985 to 1987, with a total loan of U.S. \$83.9 million, aimed at rehabilitation of power facilities from the perspective of the medium-term recovery of the Ugandan economy. The main contents of the Second Power Project were the rehabilitation of the Owen Falls Hydro-electric Power Station as well as the existing power transmission and distribution networks. The commencement of the Second Power Project, however, was delayed and, in 1989, it became necessary to revise the contents of the project due to the substantial financial shortfall caused by price increases, changes in exchange rates, and other economic reasons. The UEB had no choice but to select particularly urgent targets such as industrial areas for the Second Power Project which had to be restructured in line with these selected targets for quick completion. Thus, the Queensway substation and Motor Mart switching station both public utilities that were rehabilitated under the previous project, Kawanda substation and Njeru substation a part of the Project, had to be abandoned. Table 2-3 shows the outline of the Second Power Project which has some bearing on the Project.

The Government of Uganda believes that a power project that can generate foreign income by the sale of power to neighboring countries and assists the medium- and long-term rehabilitation of the national economy, is essential in order to improve the increasingly tight economic situation. It has accordingly drawn up a Third Power Project. The main objectives of the Third Power Project are the expansion of the Owen Falls Power Station and construction of new transmission lines. The World Bank and other financial organizations decided to finance the Third Power Project at about U.S. \$247 million in June 1992.

The Project (Japan's Grant Aid) is intended to overhaul the substations that provide power to Kampala originally included in the Second Power Project, but which had to be dropped due to financial difficulties. The substations were overhauled under the previous project and the electric power supply situation in central Kampala has considerably improved. However, supply of electric power is still unstable in the outskirts of Kampala and the countryside, especially in areas that are at a distance from distribution substations due to voltage drops and deteriorating substations. For this reason, it is the aim of the Second Power Project to improve the supply of power in areas that were not part of the previous project. Distribution substations will be overhauled and new ones will be built under the Project. The recovery of urgent electric power facilities and the medium and long-term rehabilitation of the economy will achieve

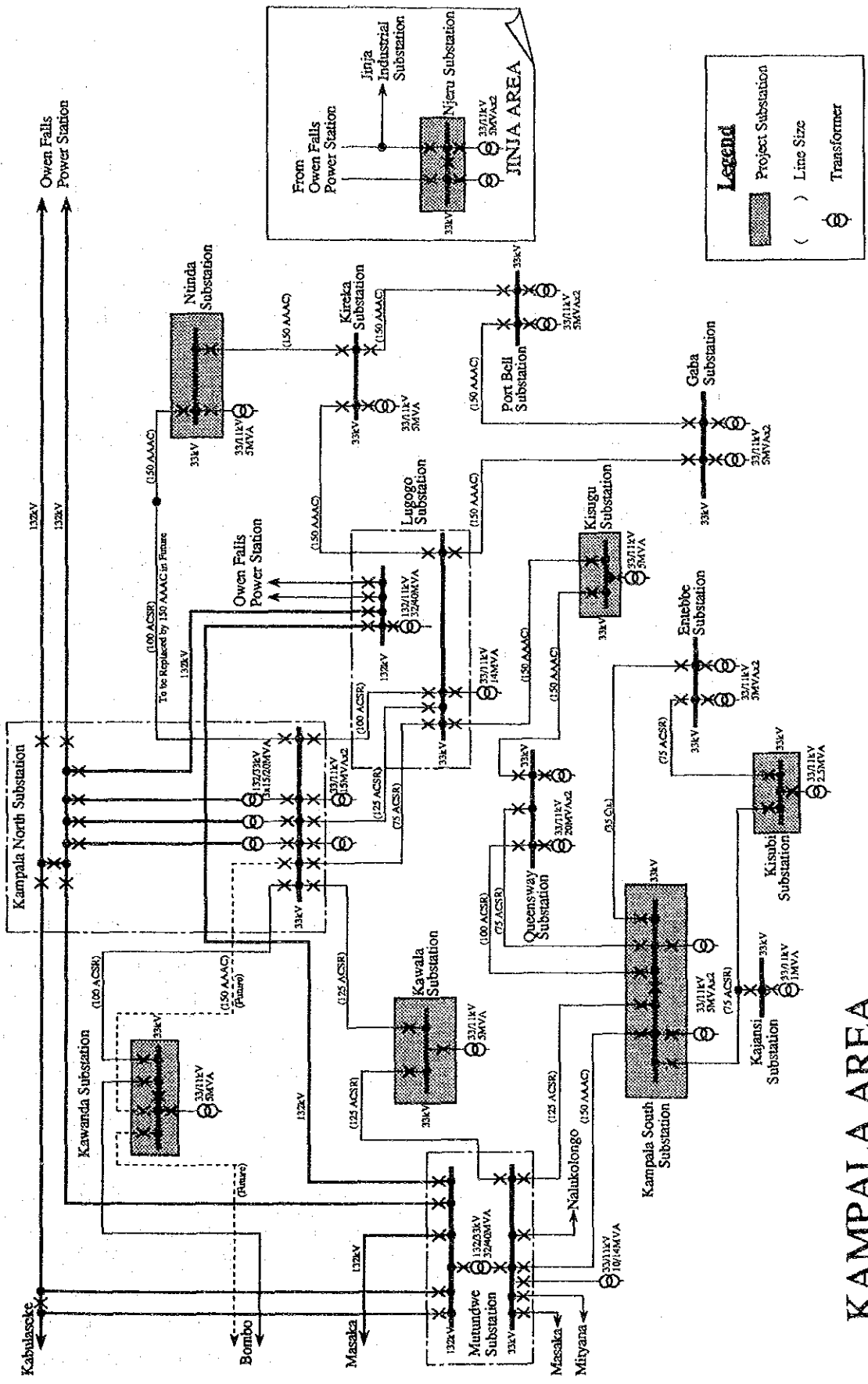
the objectives of the Second Power Project and prepare the ground for the Third Power Project that will develop and expand electric power facilities.

The UEB has examined power demand for the recent past to formulate a future plan for the distribution network in Kampala city and suburbs. The UEB plans to change some connections in the 33kV grid to improve the reliability of the electricity distribution network and provide problem areas with a stable electric supply.

Figure 2-4 shows the 33kV grid plan which includes the substations of the Project.

Table 2-3 Outline of Second Power Project (related to the Project)

Name of Project	Proposed Financier	Expected Project Period	Description of Project
132/33/11kV Kampala North Substation	World Bank	1991 ~ 1993	<ul style="list-style-type: none"> • 132kV feeder (1) • Rehabilitation of 132kV outdoor switchgear • 33kV switchgear (8 bays) • 11kV switchgear (10 bays) • Rehabilitation works for existing electrical installations and civil works
132/33/11kV Lugogo Substation	World Bank	1991 ~ 1993	<ul style="list-style-type: none"> • 132kV consisting of 1 feeder and busbar system • 33kV switchgear (10 bays) • Construction of one transformer 132/11kV 32/40MVA • 11kV switchgear (19 bays) • Construction of one transformer 33/11kV 10/14MVA • Capacitor bank 33kV 5MVar • Construction of substation buildings
132/33kV Mutundwe Substation	World Bank	1991 ~ 1993	<ul style="list-style-type: none"> • 132kV feeder (2) • 33kV switchgear (10 bays) • 11kV switchgear (5 bays) • Capacitor bank 33kV 5MVar • Construction of substation buildings
33/11kV Kireka Substation	World Bank	1991 ~ 1993	<ul style="list-style-type: none"> • Construction of one transformer 132/11kV 10/14MVA • Construction of one transformer 132/33kV 32/40MVA
33/11kV Kireka Substation	World Bank	1991 ~ 1993	<ul style="list-style-type: none"> • 33kV switchgear (4 bays) • 11kV switchgear (7 bays)
33/11kV Port Bell Substation	World Bank	1991 ~ 1993	<ul style="list-style-type: none"> • Construction of one transformer 33/11kV 5MVA
33/11kV Port Bell Substation	World Bank	1991 ~ 1993	<ul style="list-style-type: none"> • Construction of two transformers 33/11kV 5MVA
11kV Kitante Road Substation	World Bank	1991 ~ 1993	<ul style="list-style-type: none"> • 33kV switchgear (5 bays) • 11kV switchgear (8 bays)
11kV Kitante Road Substation	World Bank	1991 ~ 1993	<ul style="list-style-type: none"> • 11kV switchgear (8 bays)
33/11kV Gaba Substation	World Bank	1991 ~ 1993	<ul style="list-style-type: none"> • Construction of two transformers 33/11kV 5MVA
33/11kV Gaba Substation	World Bank	1991 ~ 1993	<ul style="list-style-type: none"> • 33kV switchgear (3 bays) • 11kV switchgear (4 bays)
11kV Underground cable system rehabilitation	World Bank	1990	<ul style="list-style-type: none"> • Approx. 10km underground cable system rehabilitation in Kampala
132kV Overhead Lines Construction	World Bank	1990 ~ 1993	<ul style="list-style-type: none"> • Approx. 5.5km double circuit from Kampala North to Lugogo • Double circuit at Mutundwe
33kV Overhead Lines Construction	World Bank	1990 ~ 1993	<ul style="list-style-type: none"> • Approx. 9km single circuit from Lugogo to Gaba • Approx. 10km single circuit from Gaba to Port Bell • Approx. 3km single circuit from Kireka to Lugogo • Approx. 2km single circuit for rearrangement of Mutundwe
SCADA	Scandinavian Countries	1993	<ul style="list-style-type: none"> • Construction of SCADA system



KAMPALA AREA

Figure 2-4 33kV Lines and Project Substations

2-1-2-3 Project Role

As described in 2-1-2-1, the Government of Uganda enacted the National Development Plan to promote substantial social and economic improvements and independence, and to urgently stimulate the national economy to establish self-reliance.

The objective of the Project is to overhaul the power transmission and distribution networks in Kampala. It is expected to cope with the ever increasing power demand and to ensure the reliable operation of small- and medium-scale plants and public facilities such as hospitals and schools. The overhaul of the distribution facilities in the suburbs, which is part of the Project, is also listed as a basic policy item in the power sector in the Rehabilitation and Development Plan (1991/92-1994/95), and thus, occupies an important position in the recovery of the national economy.

As described in 2-1-2-2, the objective of the Project is to overhaul and rebuild substations and other power facilities in the Kampala suburban area. These measures were to be implemented as part of the Second Power Project for at the urgent rehabilitation of power facilities in the medium-term social and economical recovery of Uganda but later were abandoned due to financial problems. There are also prospective users who are not yet supplied with electricity due to insufficient transformer capacity or because the national project was not able to meet to consumption needs. It is a basic policy of the power sector in the Rehabilitation and Development Plan to promote the electrification of the suburbs the countryside to ensure a stable power supply.

2-2 Outline of the Request

2-2-1 Background of the Project

As stated in Chapter 1, in Kampala regular power cuts occur due to equipment breakdowns at substations, transmission network failures, and because transformer capacity is not capable of meeting the sharply rising demand for electricity. The Owen Falls Power Station, the major supplier of electricity to the capital, must urgently improve capacity by replacing deteriorating equipment and repair other equipment.

The plan for improving the distribution network in Kampala, including the overhaul of the Owen Falls Power Station, is receiving assistance from the British Government, IDA, and other agencies. However, distribution networks and substations that are not part of the project cannot be overhauled unless new loans are obtained as the country is without sufficient financial resources.

The Government of Uganda made a request to the Government of Japan for the provision of Grant Aid for the overhaul of the distribution networks that are not included in the project in order to ensure a stable power supply in Kampala to stimulate industrial,

business and social activities in the capital. In 1991 and 1992, the distribution substations in central Kampala; i.e., the Queensway substation and the Motor Mart switching station, were overhauled under the previous project which greatly improved the power supply situation in the center of the capital. However, the power supply in suburban areas of capital and especially in areas located at long distances from distribution substations, is unstable due to voltage drops and deteriorating transformers. Transformer capacity is inadequate to provide prospective users with electricity, and thus, is a source of public discontent.

The Government of Uganda planned a Project to rehabilitate old facilities or to construct new ones in these areas, excluding the central Kampala area, and made a request to the Government of Japan for the provision of Grant Aid.

2-2-2 Contents of request

The request initially consisted of the following five items. However, in discussions with the Government of Uganda, it was determined that the contents agreed in those discussions (see the Minutes of Discussion in Appendix 4) should also be included.

Initial request placed by the Government of Uganda

- 1) Reconstruction and expansion of the seven (7) distribution substations in the Kampala suburban area.
- 2) Procurement of materials for a low-voltage distribution network.
- 3) Procurement of materials for 11kV, 33kV and 132kV network.
- 4) Procurement of facility for pole treatment plant.
- 5) Procurement of vehicles for maintenance.

Contents of request as the result of discussions with the Government of Uganda

- 1) Construction or Rehabilitation of the seven (7) distribution substations in the Kampala suburban area.
 - ① Construction of a new substation at Kampala South.
 - ② Construction of a new substation at Ntinda.
 - ③ Construction of a new substation at Kisugu.
 - ④ Rehabilitation of the substation at Kawanda.
 - ⑤ Rehabilitation of the substation at Njeru.
 - ⑥ Rehabilitation of the substation at Kisubi.
 - ⑦ Construction of a new substation at Kawala.

Remarks: The priority of construction programs have been determined according the urgency and importance of the programs as indicated by the Government of Uganda.

- 2) Procurement of materials for a Medium-voltage (MV) and Low-voltage (LV) distribution network
- 3) Procurement of vehicles for maintenance

The reasons for abandoning the procurement of materials for a 132kV network and facility for pole treatment plant are given below.

(1) Material for 132kV network

The original request listed the repair of about ten steel towers for a 132kV transmission line that had collapsed because much of the steel composing it had been stolen. However, the objective of the Project is to overhaul distribution network. The team was therefore of the opinion that the repair of the 132kV transmission line should not be included in the Project that was accepted by the Ugandan officials.

(2) Facility for pole treatment plant

An on-site investigation of the pole treatment plant (anti-corrosive injection) at the UEB Lugogo substation has been performed which showed that the equipment used in the facility has deteriorated with age. However, there are a number of private companies in Uganda which can handle anti-corrosive injection for pole treatment and the UEB is currently procuring poles from them when demand cannot be met.

The rising demand for electricity will naturally increase the demand for treated poles and in the near future this demand will far exceed capacity at the UEB plant. Both parties agreed that the best way to cope with the situation was to increase subcontracting and to activate the private companies.

2-3 Outline of the Project Area

2-3-1 Project Area Locations

The Project will be carried out in Kampala, the capital of Uganda, and Jinja city, the country's second largest city. Table 2-4 shows population statistics for both cities as of 1991.

Table 2-4 Population statistics for the cities of Kampala and Jinja

	City area	Population	Population density	Population increase (1980~1991)
Kampala	169 km ²	774,241	4,581/km ²	4.8%/year
Jinja	677 km ²	289,476	428/km ²	2.1%/year

(Source: Population statistics 1991)

2-3-1-1 Kampala City

Kampala city, the capital, the social and economical center of the country, is situated on the shore of Lake Victoria in mid-south Uganda. The area consists of gently rolling hills and the city covers seven hills of some 100m in height with the center of the city on Nakasero Hill.

The Project is scheduled to examine the following six substations. As indicated in the beginning of this report, these substations are located in industrial and residential areas in the outskirts of the city.

Location of examined substations

Kampala South Substation	(Southwest)
Ntinda Substation	(Northeast)
Kisugu Substation	(Central)
Kawanda Substation	(Northwest)
Kisubi Substation	(Southwest)
Kawala Substation	(West)

2-3-1-2 Jinja City

Situated about 80 km to the east of Kampala city, Jinja city developed as a result of the design in 1940 and subsequent construction in 1948 of Owens Falls Power Station at the headwaters of the Nile River. This city is Uganda's largest industrial city and is the headquarters for several large industries such as beer brewing and textiles. As stated at the beginning of this report, the subject substation (Njeru Substation) is on the west bank of the river about 1.2 km south of Owen Falls Power Station.

This substation is at the site of an abandoned diesel-electric power station that served the area before the Owen Falls Power Station began service.

2-3-2 Natural Conditions

2-3-2-1 Climate

Uganda is located between 1°30'S lat. and 4°N lat., and has a virtually consistent temperature throughout the year. Despite being on the equator, Uganda's climate is rather mild because of its high elevation. Both Kampala and Jinja cities are situated on a plateau at a height of 1,200 to 1,300 meters above sea level, and both cities enjoy a good climate with relatively small temperature fluctuations due to proximity to Lake Victoria. According to meteorological statistics, the mean monthly maximum temperature ranges from 25°C to 28°C, while the mean monthly minimum temperature ranges from 16°C to 18°C.

Uganda has two rainy seasons, i.e., a major rainy season from March to May and a minor rainy season from October to December. Mean monthly rainfall of 50-60 mm is recorded in the dry seasons, totaling a relatively high mean annual rainfall figure of 1,180 mm in Kampala City and 1,321 mm in Jinja City. The mean monthly temperatures and rainfall are shown in Table 2-5.

Table 2-5 Mean Monthly Temperatures and Rainfall

Kampala City

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Mean annual
Max. temp. (°C)	28.4	28.3	27.5	26.1	25.4	25.2	25.1	25.6	26.6	27.2	27.2	27.2	26.7
Min. temp. (°C)	18.1	18.1	18.0	17.6	17.5	17.2	16.5	16.4	16.6	16.9	17.3	17.4	17.3
Rainfall (mm)	51	62	113	182	140	75	50	86	101	109	114	97	1,180

(Source: Department of Meteorology, Statistics 1931-1954.)

Jinja City

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Mean annual
Max. temp. (°C)	28.9	28.9	28.7	27.6	27.1	26.9	26.6	27.1	28.0	28.3	28.1	28.2	27.9
Min. temp. (°C)	15.8	16.4	17.3	17.5	17.2	16.2	15.4	15.7	16.0	16.6	16.6	16.1	16.4
Rainfall (mm)	68	84	135	193	140	60	58	77	93	152	166	95	1,321

(Source: Department of Meteorology, Statistics 1955-1970.)

2-3-2-2 Thunderstorms

A strong ascending current is often generated as the air near the ground is heated by the direct sunlight at the equator. This hot air is then cooled and causes rain which is sometimes accompanied by strong wind and/or thunder. The phenomenon where rain is accompanied by thunder is called a thunderstorm. According to statistics of the Department of Meteorology, some 20 thunderstorms a month occur in Kampala and Jinja. The frequency of thunderstorms during the dry seasons is somewhat lower than that in the rainy seasons, still the average annual occurrence is as high as 200 thunderstorms.

The wind velocity is observed twice a day at 06:00 and 12:00 (GMT). The mean monthly wind velocity is reported to be 4-10 knots. Strong local winds tend to occur with the thunderstorms and the strength is basically determined by the scale of a particular thunderstorm.

2-3-2-3 Earthquakes

The African Rift Valley runs south from the Red Sea through East Africa to the Madagascar Channel. Around Uganda, it splits into the Eastern Rift Valley and the Western Rift Valley with Lake Victoria in-between. The Western Rift Valley runs along the border between Uganda and Zaire where there have been many earthquakes (based on observation results between 1950 and 1989). The largest magnitude to be recorded is 6.9 on the Richter scale in 1966. In South Sudan, which is part of the Western Rift Valley, a large earthquake with a magnitude of 7.5 occurred in 1990.

Few earthquakes have been reported inland although a small earthquake (magnitude: 3.8) occurred near Kampala in 1960 in addition to an earthquake (magnitude: 5.7) which occurred at Masaka, a city located some 120 km southwest of Kampala.

Since Kampala and Jinja are a distance of some 250 km and 320 km from the Western Rift Valley, the danger of a large earthquake occurring appears minimal.

2-3-2-4 Geology

The predominant rocks in the area are schist and gneiss which were metamorphosed from granite in the Pre-Cambrian era. Phyllite and shale are distributed in the western part of the country, containing copper, tin, tungsten, and beryllium. Magnetic iron ore generated in the Cretaceous period, rock phosphate, and limestone are distributed in the eastern part of the country. Rock phosphate used by the superphosphate industry and limestone by the cement industry are produced in the Tororo region.

The soil at the distribution substation sites in Kampala and Jinja are composed of laterite, a material formed by the weathering of rocks typical to the tropics. It is brown because it contains iron oxide. The laterite layer at the site consists mainly of loam and is quite solid.

Geological investigations using auger drilling to a depth of 4 meters were made at the Project sites. The results show that the sites are composed of laterite which is solid enough to support up to 5 ton/m² for allowable bearing capacity for permanent load.

2-3-3 Infrastructure

2-3-3-1 Ports

Uganda is a landlocked country and, by definition, has no port facing an ocean. It uses Mombasa in Kenya for external trade. Mombasa has two ports, an older port and a new port. The old port is called Port Mombasa while the new port is called Kilindini Port. The latter is a major port with 13 general cargo piers (2,448m in length) and 3 container piers (569m in length). It has sixteen 40-ton class gate cranes and forty-three 5 to 40 ton class truck cranes and it can accept 15,000-ton class ships. Kilindini Port