THE REPUBLIC OF GHANA
MINISTRY OF MINES & ENERGY

BASIC DESIGN STUDY REPORT
ON
THE PROJECT FOR RURAL ELECTRIFICATION
FOR
ASESEWA AND YEJI AREAS
IN
THE REPUBLIC OF GHANA

JULY, 1996

JAPAN INTERNATIONAL COOPERATION AGENCY
EPDC INTERNATIONAL LTD.

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PREFACE

In response to a request from the Government of the Republic of Ghana, the Government of Japan decided to conduct a basic design study on the project for rural electrification for Asesewa and Yeji areas and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Ghana a study team from February 20 to April 4 ,1996.

The team held discussions with the officials concerned of the Government of Ghana ,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 Ghana in order to discuss a draft basic design, 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 Ghana for their close cooperation extended to the teams.

July, 1996

Kimio Fujita
President
Japan International Cooperation Agency

July, 1996

Letter of Transmittal

We are pleased to submit to you the basic design study report on the project for rural electrification for Asesewa and Yeji areas in the Republic of Ghana.

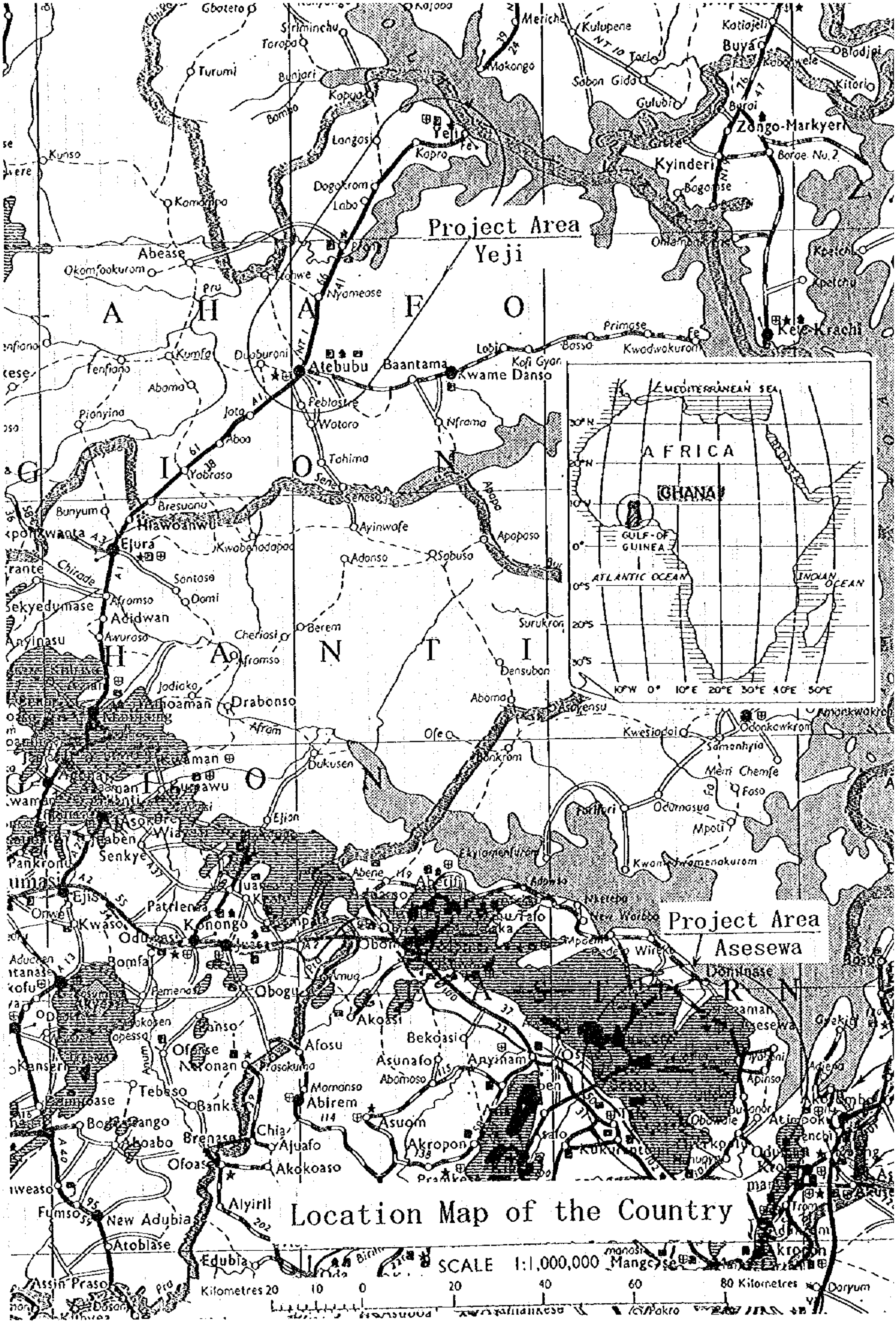
This study was conducted by EPDC International Ltd., under a contract to JICA, during the period from February 15, 1996 to August 14, 1996. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of Ghana and formulated the most appropriate basic design for the project under Japan's grant aid scheme.

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

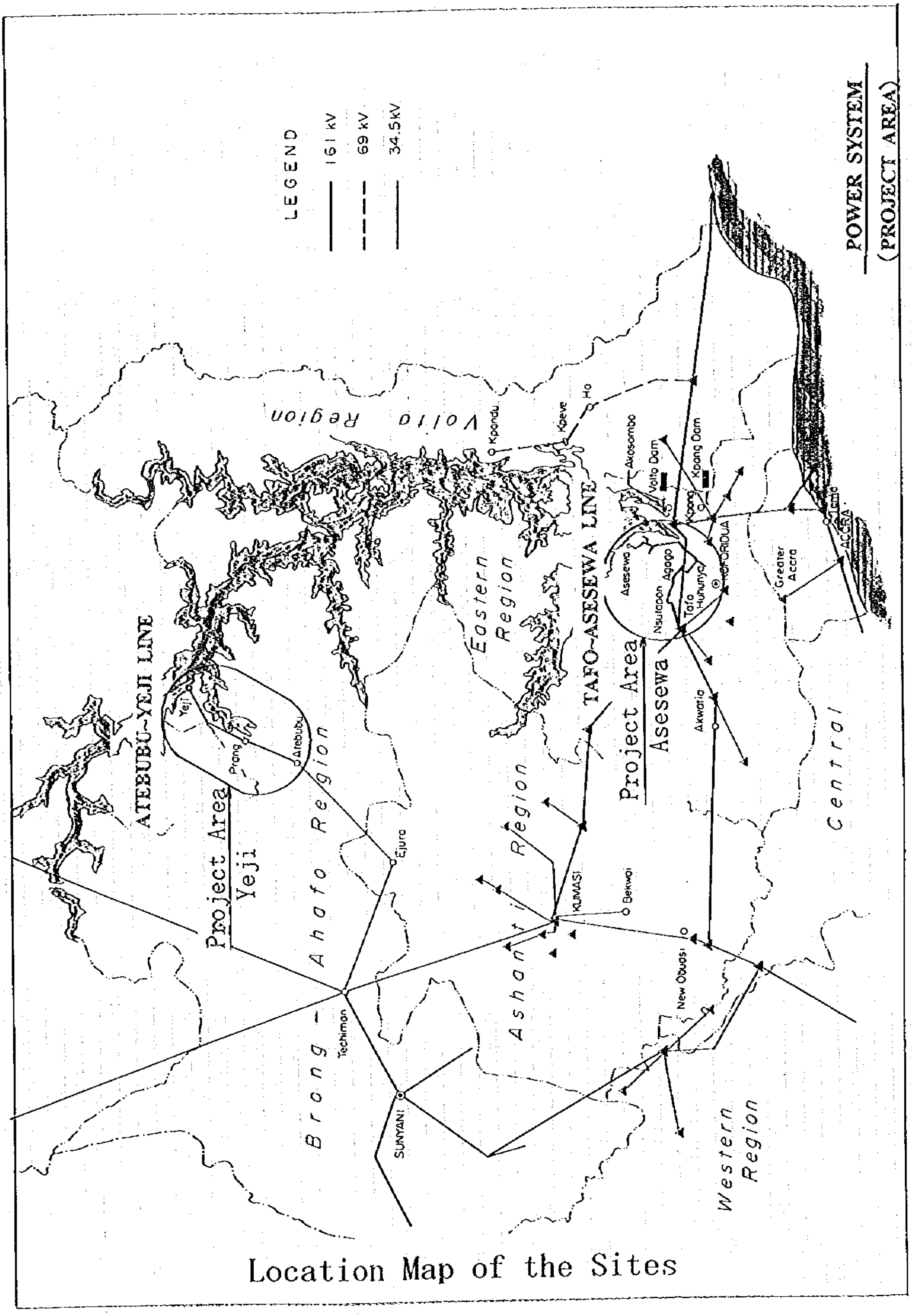
Very truly yours,

T. Ichikawa

Takeshi Ichikawa
Project Manager,
Basic design study team on
The project for rural electrification for
Asesewa and Yeji areas
EPDC International Ltd.



Location Map of the Country



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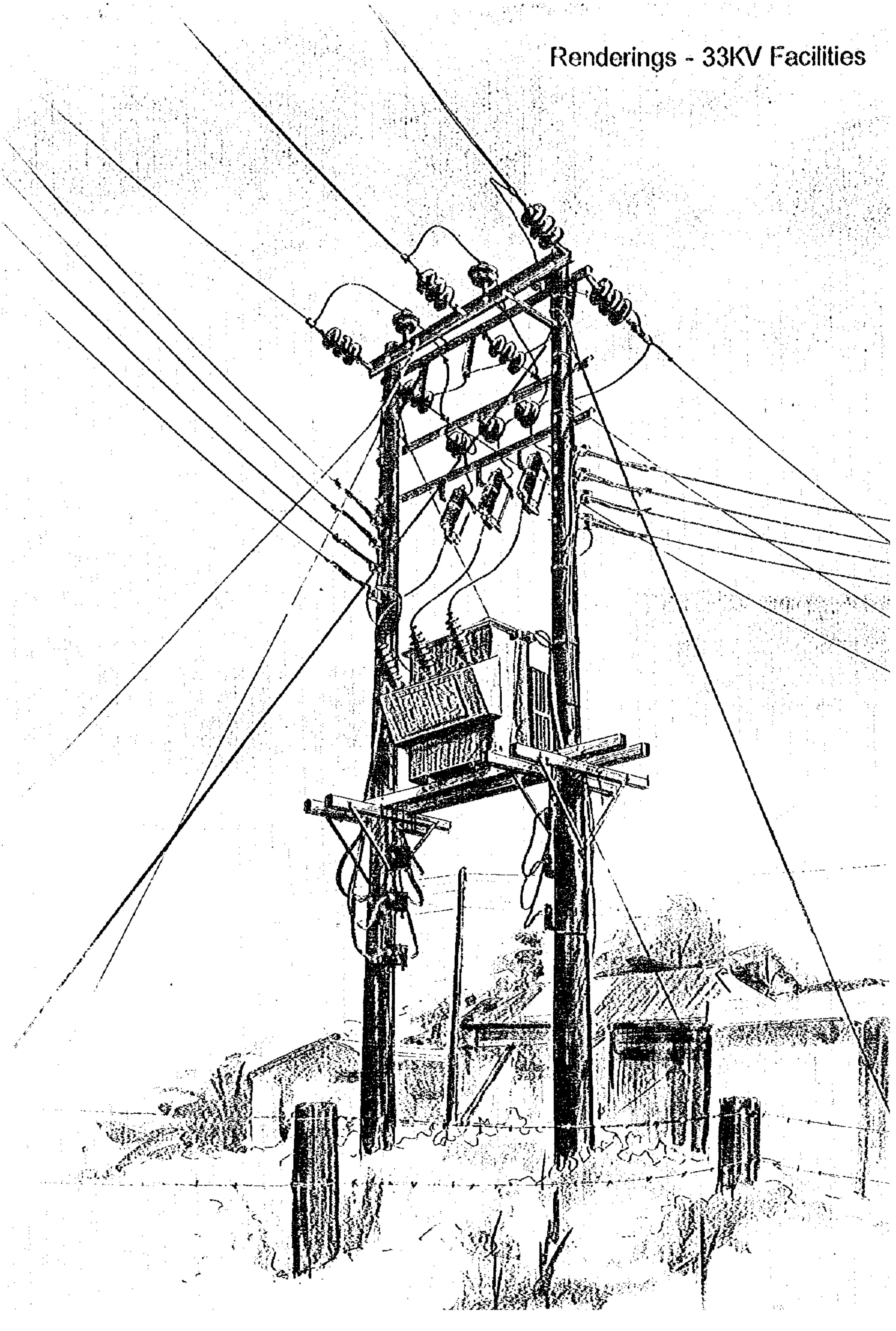

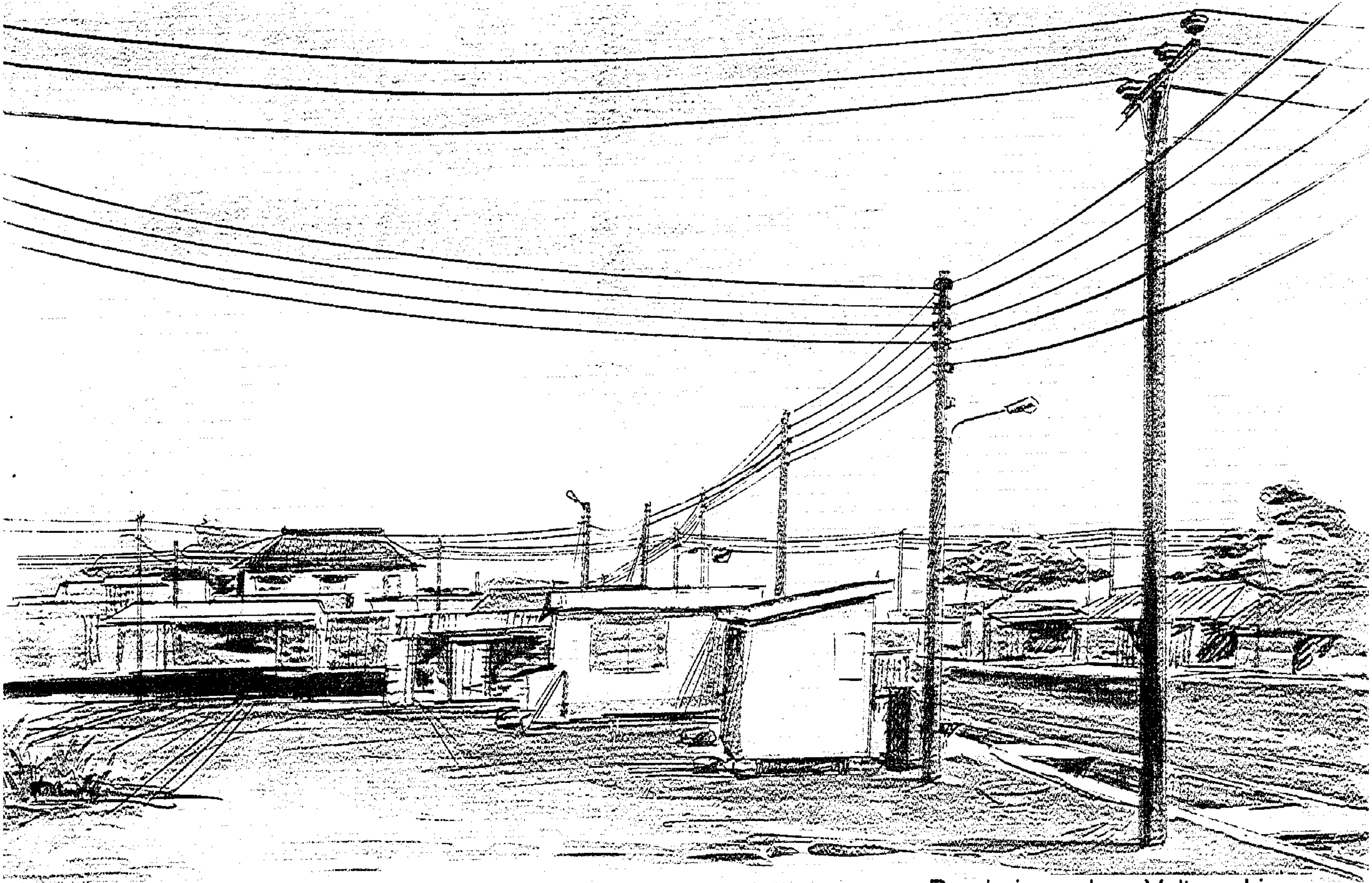

Renderings - Low Voltage Lines

Abbreviations

Agencies

MME	: Ministry of Mines & Energy
MOF	: Ministry of Finance
VRA	: Volta River Authority
ECG	: Electricity Corporation of Ghana
NED	: Northern Electricity Department
EMB	: Embassy
JICA	: Japan International Cooperation Agency
IDA	: International Development Agency
OECF	: Overseas Economic Cooperation Fund
NDF	: Nordic Development Fund
NES	: National Electrification Scheme
NEP	: National Electrification Project
SHEP	: Self-Help Electrification Program
DCEP	: District Capitals Electricfication Programme
GLSS	: Ghana Living Standards Survey
CFC	: Community Fisheries Center
ERP	: Economic Recovery Programme
IPP	: Independent Power Producer

Term

E/N	: Exchange of Notes
GDP	: Gross Domestic Producer
GNP	: Gross National Products
AAC	: All Aluminum Conductor
ACSR	: Aluminum Conductor Steel Reinforced
VHF	: Very High Frequency
FM	: Frequency Modulation
GCB	: Gas-Circuit Breaker
T/S	: Thermal Power Station
BIL	: Besic In-palse Insulation Level
IKL	: Isokerauic Level

Unit

US$	: United States dollar	
¢	: Cedi	
W	: Watt	
kW	: Kilowatt	$= 10^3$ W
kWh	: Kilowatt hour	$= 10^3$ Wh
MW	: Mewgawatt	$= 10^3$ kW
MWh	: Megawatt hour	$= 10^3$ kWh
GWh	: Gigawatt hour	$= 10^6$ kWh
kVA	: Kilovolt Ampere	$= 10^3$ VA
MVA	: Megavolt Amprer	$= 10^6$ VA
kV	: Kilovolt	$= 10^3$ V
Pf	: Power factor	
Hz	: Hertz (cycles per secoond)	

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Chapter 1 Background of the Project

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Ghana is located on the west coast of Africa, about 750 km north of the equator on the Gulf of Guinea, between the latitude of 4-11.5° north. Ghana has a tropical climate, characterized most of the year by moderate temperatures (generally 21-32°C), constant breezes and sunshine. There are two rainy seasons, from March to July and from September to October, separated by short dry season in August and relatively long dry season in the south from mid-October to March. The capital Accra, is on the Greenwich meridian (zero line of longitude). The country has a total land area of 238,540 km^2 and is bounded on the north by Burkina Faso, on the west by Cote d'ivoire, on the east by Togo and on the south by the Gulf of Guinea. The population of Ghana is 17.22 million (1994 estimate).

Despite the continued sluggish economy after 1980, the current political situation shows a sign of stability, thanks to the recovery of the economy after 1984 which was acquired by the structural adjustment programme which started 1983 with the assistance of the World Bank, etc. The Government of Ghana is currently administrating the Public Investment Programme for 1992 - 1996 (1992 - 1996 PIP), which is aimed to strengthen the foundation of the national economy.

In January 1995, the government launched a long-term National Development Policy Framework (NDPF) called "Ghana - Vision 2020", in which they envisage Ghana is to become a middle-income country by 2020. They have started the first step of the "First Five-year Rolling Plan (5YRP)" for the period, 1996-2000, which is coordinated with NDPF. The macro-economic objective for 2000 is to increase GDP per capita to about US$500 and the average growth rate of GDP to nearly 8% per annum.

Ghana's gross national product (GNP) in 1993 was US$7.036 billion and GNP per capita was US$430. The growth rate of economy was 3.8% (1994) and inflation index of commodity was 24.9% (1994). The total trading amounts were, US$1,029.7 million for export and US$1,961.9 million for import in 1993. Main exports are listed to be cocoa, gold, lumber and bauxite, and inports are petrochemicals, consumer goods and foodstuff. In case of bilateral trading between Ghana and Japan, it was US$63 million for export and

US$143 million for import in 1994.

Electricity enterprises in Ghana are operated under the administration and guidance of Ministry of Mines & Energy (MME). The Volta River Authority (VRA) is in charge of power generation and power transmission. In regard to distribution, the Electricity Corporation of Ghana (ECG) is responsible for the southern six (6) Regions and the Northern Electricity Department (NED), a subsidiary of VRA, is responsible for the northern four (4) Regions.

The electric power is supplied from Akosombo Power Station (PS) (912 MW) and Kpong PS (160 MW) which is located in the down stream of the Akosombo, and Tima Diesel PS (30 MW). The transmission lines are interconnected to Togo, Benin and Cote D'ivoire. Due to a rapid growth of domestic consumption in these years (10% annum), import of power from neighboring countries has been taken place during drought season. To remedy this problem, a construction of thermal power plant (300 MW) has started in Takoradi.

The achieved progress of electrification in the whole country is assumed approximately 30% for 1995. The National Electrification Scheme (NES) which aims to electrify the whole country by 2020 has been under progress. In this Scheme, the project is carried out step by step, being divided the 30 years of 1990 - 2020 by every 5 years of 6 Phases. The 110 district capitals were given the priority to be electrified by 1995.

As a part of the NES,with the assistance of IDA, Holland, Denmark, Norway, etc.,National Electrification Project(NEP) is progressing in the 10 regions and 24 district capitals which are unelectrified at present are expected to be supplied power by 1998. However, the following three towns, Asesewa of Eastern Region, Yeji of Brong Ahafo and Worawora-Kwamekrom of Volta Region, were still excluded from the said NEP, just because they are not district capitals.

Asesewa area is a busy commercial center for commodity and distribution center for agricultural products from neighboring villages. Yeji area has a big harbor on the Volta Lake and a fishery center, which is expected to play a vital role, is under construction. It is considered that concentration of population is extremely high in the both areas. Worawora-Kwamekrom area, also the same as Asesewa, is a center of agriculture and a priority area for economic development. In spite of being the areas where the electrification is indispensably required, the above mentioned areas have been remained to be unelectrified because of no practical plans were put into force. Therefore, the Government of Ghana requested the Government of Japan to provide the urgent assistance for electrification of the said areas.

The outline of the request was as follows:

Construction of 33 kV transmission lines with a total length of 175 km. Provision of low voltage distribution line materials for the projected 41 villages and reinforcement of an existing substation, etc. in the sites covering - Asesewa area in Eastern Region, Yeji area in Brong Ahafo Region and Worawora-Kwamekrom in Volta Region. The estimated number of beneficiaries and consumers were 68 thousand and 8.6 thousand in Asesewa area and 40 thousand and 3.4 thousand in Yeji area. The number of beneficiary in Worawora-Kwamekrom was 30 thousand.

As regards Worawora-Kwamekrom area, it was finally withdrawn from the request because the electrification project had planned to be financed by another fund; Nordic Development Fund.

In relation to the above NES, Japan has executed the following two rural electrification projects with Japan's Grant Aid Scheme:

(1) Rural Electrification Project in 1989:
Total grant amount was 860 million yen.
Electrification of towns and villages, those yet electrified and scattered in the Ashanti Region, Western Region and Central Region, and Greater Accra Region and Central Region. Construction of 33 kV transmission lines with total length of 142 km and 11 kV distribution lines with total length of 20 km. Provision of 400/230 V low voltage line materials with 40 km and 38 units of pole transformers.

(2) Electrification Project in lower Volta Area in 1995 & 1996:

Total grant amount was 1,880 million yen.

Electrification of yet electrified areas scattered in Great Accra Region and Volta Region including three district capitals. Construction of 69 kV transmission lines with 40 km length and 33 kV distribution lines with 120 km. Provision of one unit of 69/33 kV transformer, 42 units of pole transformers.

Chapter 2 Contents of the Project

Chapter 2 Contents of the Project

2-1 Objectives of the Project

The purpose of the Project is to electrify the unelectrified areas and objective areas covered by the Project are Asesewa Area in the Eastern Region and Yeji Area in Brong Ahafo Region and the villages scattered around the transmission lines are also included.

Asesewa Area is an important district where the agricultural products from the neighboring area are collected and stored. Yeji Area is also an important district where the harbor facility for Volta Lake and the fishery center are located, together with a heavy population concentration. Considering the urgent needs for electrification in these districts, the Government of Ghana requested Japan for a Grant Aid in regard to both technical and funding.

The estimated beneficially populations and the number of households are approximately 68,000 and 8,600 for Asesewa Area, and 40,000 and 3,400 for Yeji Area respectively.

The purpose of the Project is to supply electricity to Asesewa Area, one of the largest agricultural product markets in the Region and to Yeji Area, the largest fishery and agricultural product market in the Region.

The Project intends not only to improve the storage and marketing facilities of local products but also to supply electricity to ordinary households, stores, hospitals and clinics, schools, factories, flour mills, tele-communication facilities and so on. Some villages in the vicinity of power lines are also to be electrified. In this way the Government of Ghana intends to improve the people's living standards by offering them an incentive to settle in the areas concerned, thereby eventually preventing excess concentration of population in the urban areas.

2-2 Basic Concept of the Project

The items of the Project requested for a Japanese Grant Aid are as follows:

(1) Asesewa Area electrification

a) 33 kV transmission line: approx. 96 km

b) Reinforcement of Tafo Substation and Koforidua Substation

c) Installation of substation equipment

d) Supply of low voltage distribution network materials

(2) Yeji Area electrification

a) 33 kV transmission line: approx. 80 km

b) Installation of substation equipment

c) Supply of low voltage distribution network materials

(3) Other items

Supply of vehicles, tools and measuring instruments

(4) Planning Policy

For the planning of the basic concept of the Project the following items are taken into consideration.

a) For designing the facilities to be newly installed, the points of high-reliability performance and minimal maintenance are taken into consideration.

b) In designing the respective facilities, future demand increase and system expansion shall be taken into consideration.

c) The specifications of the facilities and the materials shall be selected to conform to those of the existing units to facilitate maintenance and interchangeability. Section switches shall be installed to enable sectional disconnection for repair work and other work on the distribution lines.

d) Since power is to be transmitted over a long distance to both Asesewa Area and Yeji Area, voltage drop remedies shall be studied from the technical aspect.

e) Construction of low voltage distribution lines shall be executed by the Ghanaian side, including procurement of wooden poles. (Other materials and equipment except wooden poles shall be provided by Japan side.)

f) After the takeover of the completed facilities from Japan, Ghanaian side shall have full responsibility for maintenance and control of the said facilities.

g) To fulfill the above responsibility, i.e. for maintenance and management on the facility should be performed in good order, technical training of Ghanaian counterpart in Japan will be required. (On this matter a separate request will be made by the Ghanaian side.)

Appendix 6-1 shows the load forecast which is the basis of the Project.

(5) 33 kV transmission line

a) Asesewa Area

The requested 33 kV transmission line to Asesewa starts from the Tafo Substation and leads along the trunk road to Asesewa Area via Koforidua, the district capital. However, there are many villages such as Agogo, Nsutapan and Obawale which require electrification in the area away from the trunk road toward the mountains, while the towns in the 21 km stretch between Tafo Substation and Koforidua are already electrified. Therefore, as there is an 11 kV power system already in the Koforidua area, an alternative route Tafo - Agogo - Asesewa, which offers an additional advantage of smaller voltage drop than the proposed route, was adopted. The total length of this alternative 33 kV line, including feeder lines, is 103 km. Fig. 2-2-1 shows the 33 kV Transmission line: Tafo Substation - Asesewa. Appendix 6-2 shows the Power Flow Study (Tafo-Koforidua-Asesewa) and the result of the technical examination is shown in the following table.

Transmission Line		Original Route (Tafo ~ Koforidua ~ Asesewa)		Alternative Route (Tafo ~ Agogo ~ Asesewa)	Note
Total length (km)		112.9		103.3	
No. of circuit		1	2	1	
Voltage drop (%)	1998	11.9	-	2.8	
	2003	15.2	9.8	4.9	
	2008	-	13.4	8.7	
	2013	-	16,7	11.9	
Power loss per year (MWh)	1998	4,007	-	3,376	
	2003	6,282	3,239	5,044	
	2008	-	5,364	7,762	
	2013	-	8,201	11,763	
Construction		No problem		Partial road repair is necessary approximate 2 km	
Maintenance		No problem		No problem	
Total observation		The alternative have advantage in terms of line length and voltage drop. No remarkable difference is observed in construction costs between them. Thus the alternative is judged advantageous.			

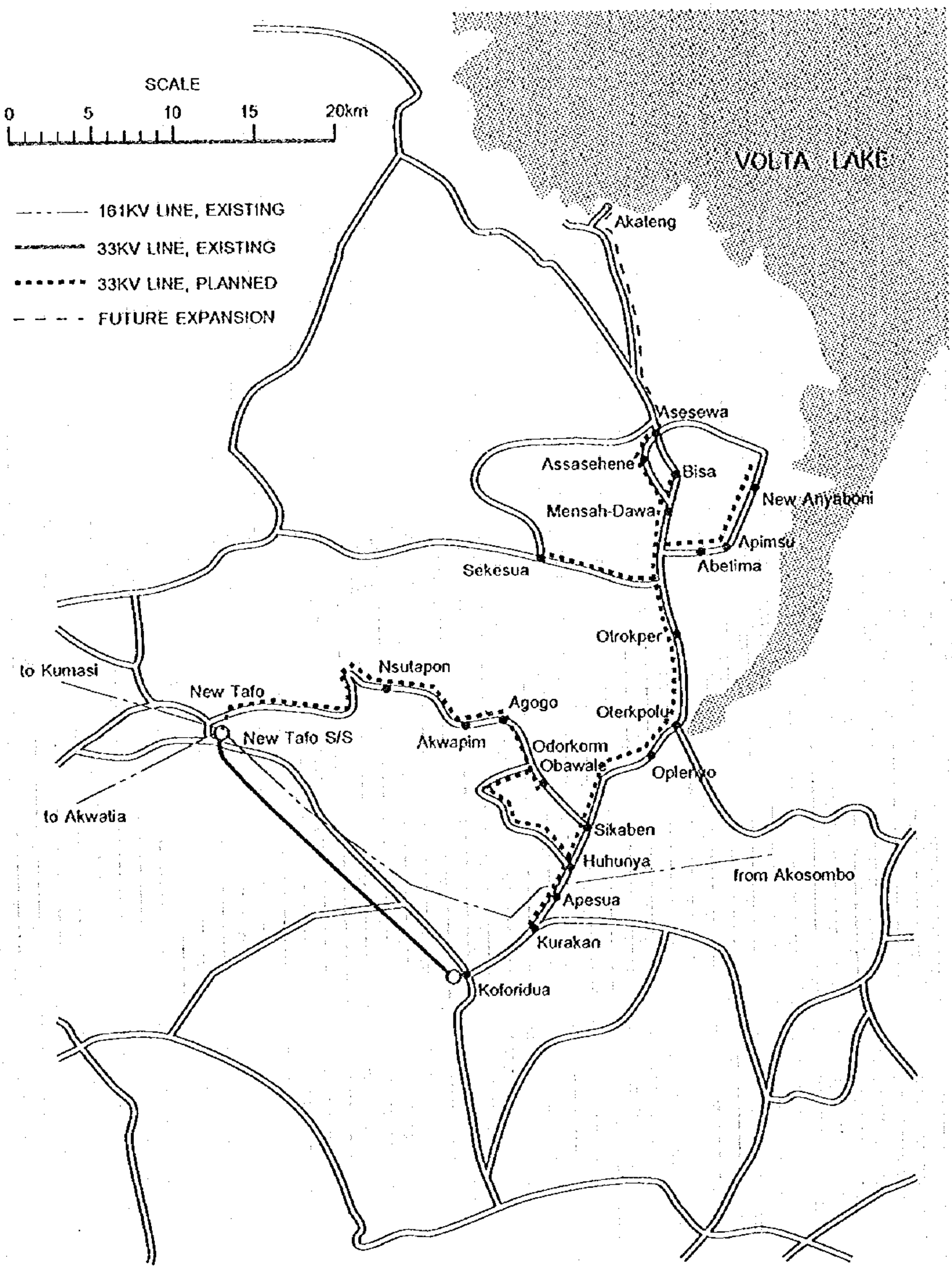


Fig. 2-2-1 33KV LINE ROUTE
TAFO S/S - ASESEWA

The route between Tafo and Agogo was investigated and was found to be free from difficult conditions, although some stretches of the road need to be repaired. On the basis of this finding, this alternative route was agreed as the final route. The route between Obawale and Sikaben was also investigated for possible shortening of the length of the 33 kV transmission line. However, due to the extreme deterioration of the road which involves rock exposure, the Obawale - Hyunya route along the existing road was finally adopted.

The change of the route as described above results in a shortening of the total length of the 33 kV transmission line is by approximately 9.6 (112.9 - 103.3) km.

b) Yeji Area

The 33 kV transmission line route to Yeji is to be constructed from Atebubu, which is the terminal of the existing Techiman - Atebubu line. The distance between Atebubu and Yeji is approximately 80 km. Fig. 2-2-2 shows a 33 kV transmission line: Atebubu - Yeji.
Most part of the line site is covered by tall grasses and bush during rainy season and these grass are burned for vegetation during the dry season. Therefore, wooden poles used in this area would most likely be destroyed by fire. To eliminate such possible damage, steel pipe poles shall be partially applied in this line.

However, because of the necessity of supplying power to the villages in the vicinity of the transmission line, wooden poles must be used in these villages. Therefore, undertaking of appropriate periodic maintenance work such as bush clearing, removal of a climing plant or clearing the line routes is recommended.

(6) Reinforcement of Tafo Substation and Koforidua Substation

Although the capacity of the existing Tafo Substation is found to be insufficient to supply

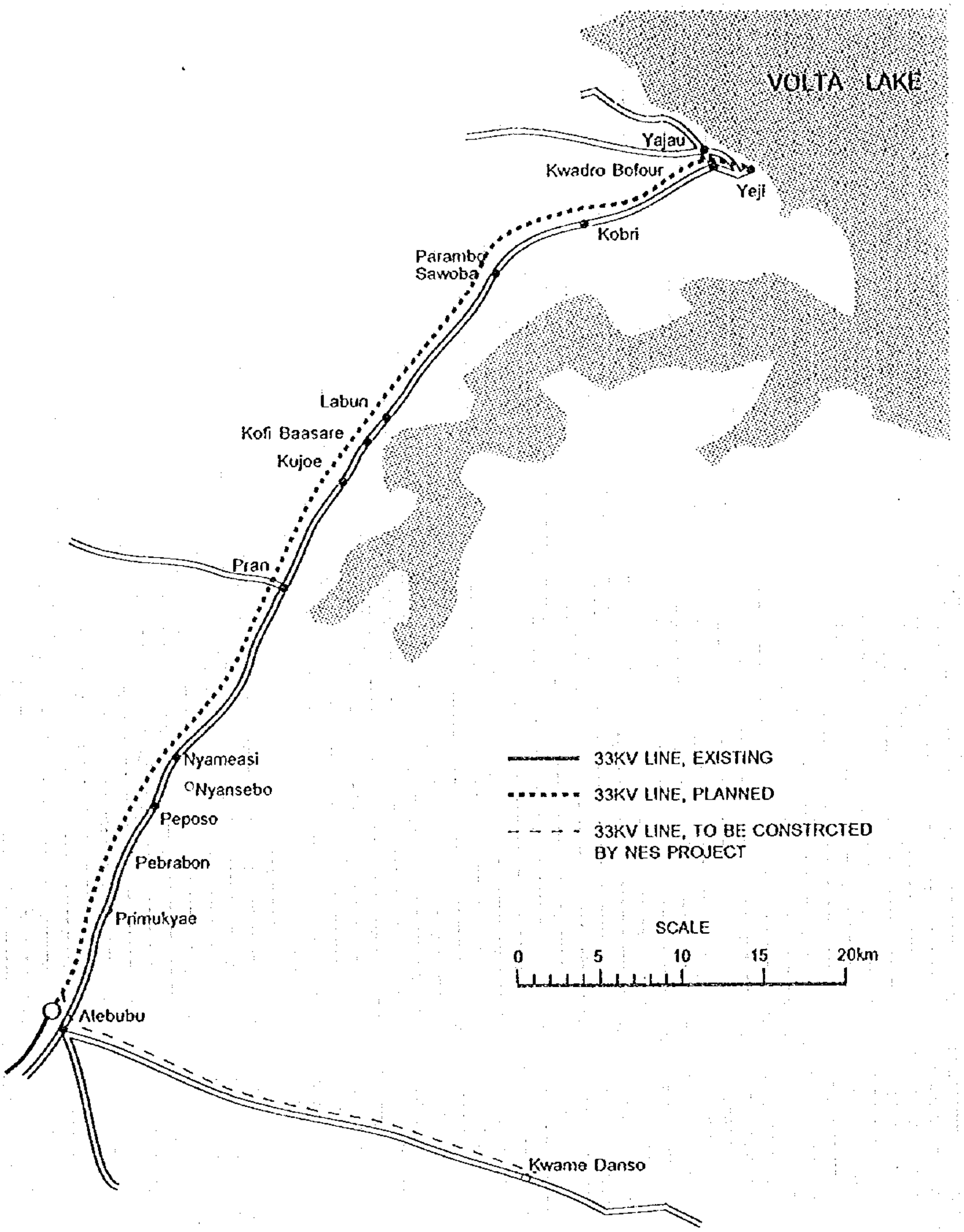


Fig. 2-2-2 34.5KV LINE ROUTE
ATEBUBU - YEJI

power to Asesewa Area, the renewal of the said transformer is being undertaken by the VRA and its commissioning is due within this year (1996). Also it is confirmed that ECG will include the reinforcement works, which is required on his facility for the same purpose, to tenders which is scheduled for issue in July 1996. Therefore, all the works related to the reinforcement of Tafo Substation are to be executed by the Ghanaian side.

It must be noted, however, that since the completion of these substation works is expected to come after the completion of the works to be undertaken by the Japanese parties, the Asesewa line to be newly installed by the Project shall be connected to the existing Kotoridua line temporarily. It was agreed that upon completion of the 33 kV facility expansion works, ECG will reconnect this line to the new 33 kV bus and remove the temporary portion.

Regarding the capacity expansion of Koforidua Substation, because the Asesewa line is to be connected to the Tafo Substation alone, the Koforidua Substation is not included in the project, as described earlier, as no load increase is to be brought to the Koforidua Substation by the Project. Therefore, no reinforcement is required on the 33 kV transmission line that between Tafo and Koforidua.

(7) Countermeasure for voltage drop on the 33 kV line caused by electrification of Yeji Area

Yeji Area is to be supplied from the existing Techiman Substation via Atebubu, 150 km away from Techiman Substation. In this Project, another 80 km extension (Atebubu - Yeji) of 33 kV transmission line is to be constructed.

In addition another electrification project i.e. electrify Kwame Danso from Atebubu within 1996 is scheduled. In that condition, considerable voltage drop is anticipated.
From the result of system calculation, as shown in Appendix 6-3, the following items are clarified.

1) Installation of voltage drop compensator (Booster) will be necessary in 2003.

2) In 2008, as a counter measure against the expecting voltage drop between Techiman - Atebubu, installation of another 33 kV line or 69/161 kV line will be considered.

Since the power flow pass through the booster is calculated 4,094 kVA in 2008 after 10 years, and 5,113 kVA in 2013 after 15 years, 5,000 kVA (5 MVA) was decided for the capacity of the booster so that no supply failure may occurred by the coming 10 years.

By the installation of this 5 MVA booster, quality of electricity in Yeji including Atebubu is greatly improved.

(8) Low voltage line material and equipment (including pole transformers)

To select the villages to which pole transformer(s) are to be installed, the priority as confirmed in the minutes of the meeting and the result of field survey on the population, number of households, schools and other public facilities etc. were taken into consideration. 18 Villages (communities) for Asesewa Area and 9 villages for Yeji Area were finally selected from the prospective beneficiaries.

Besides, supply priority shall be given to the hospital and the job training school in Yeji Area where diesel generator(s) had been installed, and where indoor wiring has been completed, thereby enabling the power supply of the Project to be connected, immediately after completion. Priority shall also be given in Asesewa Area where the wooden poles has been erected under SHEP. Thereby enabling the distribution line to be immediately installed.

The installation plan for distribution transformers is shown on Table A.5 in Appendix 6-1. Fig. 2-2-3 and Fig. 2-2-4 shows the candidate sites for distribution transformer for

Asesewa and Yeji Areas respectively.

The low voltage distribution line materials to be provided by the Project will cover areas in the circle with radius of about 2 or 3 km from the pole transformer(s). Installation of the said materials etc. shall be carried out by the respective organization, ECG or VRA (NED), at its own cost.

(9) Radio communication facilities

As the Project sites of both Asesewa and Yeji Areas are so extensive, radio communication facilities shall be provided to facilitate communication during the construction. After the completion of the Project these facilities shall be used for maintenance work of the line facilities.

The specifications and quantities of these facilities are described in Chapter 2-3.

(10) Procurement of vehicles and tools

The Project area is so wide with many consumers scattered over mountains and hills where the transportation conditions are very poor. For the construction of long length power lines and their maintenance as well as meter reading vehicular mobility is indispensable.

The vehicles to be provided by the Project are; 2 nos. of double-cab pickups, 2 nos. of pickup trucks and 2 nos. of 5-ton trucks equipped with cranes, because the existing vehicles of the relevant maintenance offices are insufficient in number for the new Project. These shall also be used for maintenance and control after the completion of the Project works.

Fig. 2-2-3 Installation Location of the Pole Mounted Transformer

(Tafo S/S~ Asesewa)

(33 kV Line Length ≒ 103 km)

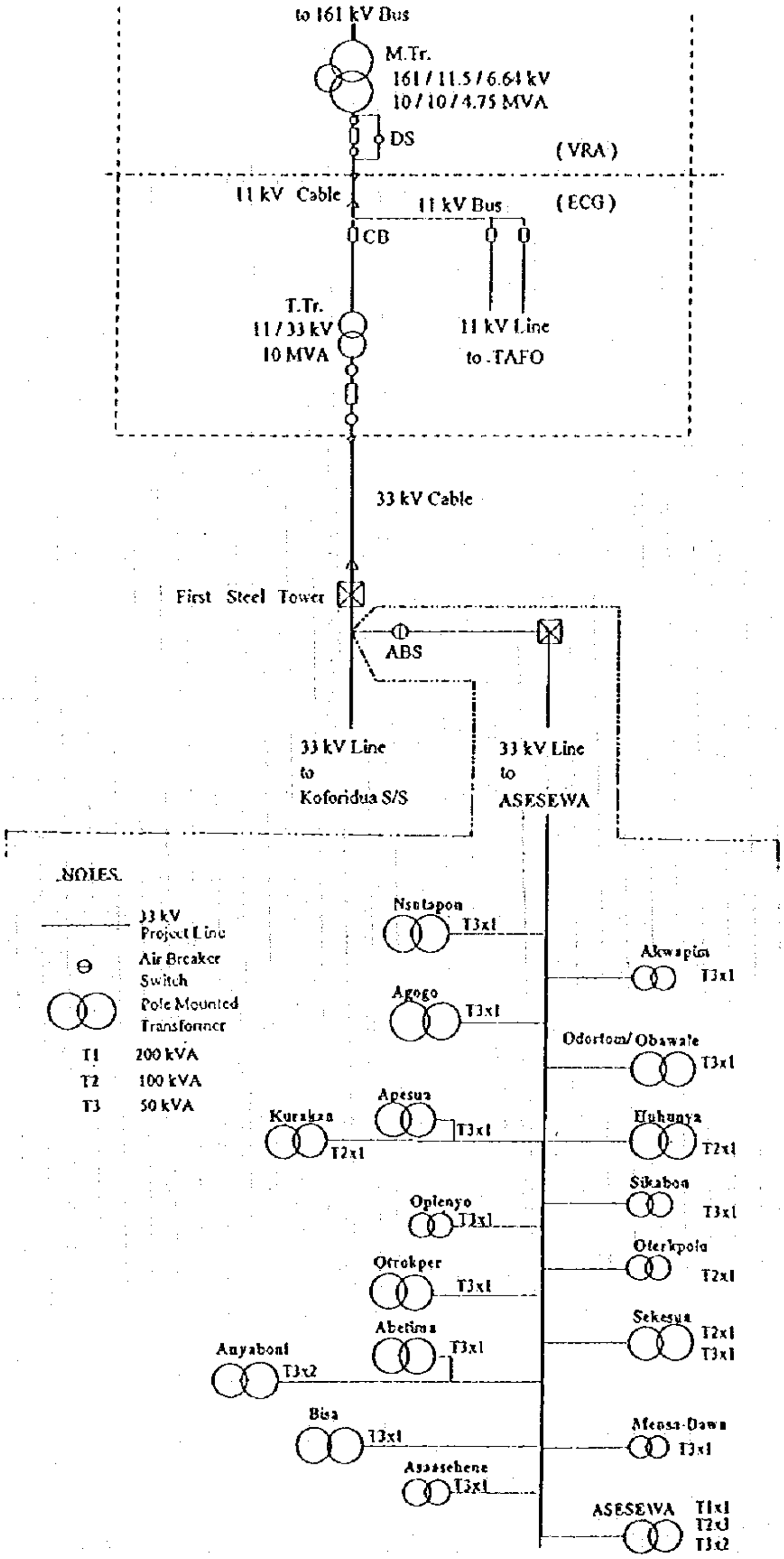
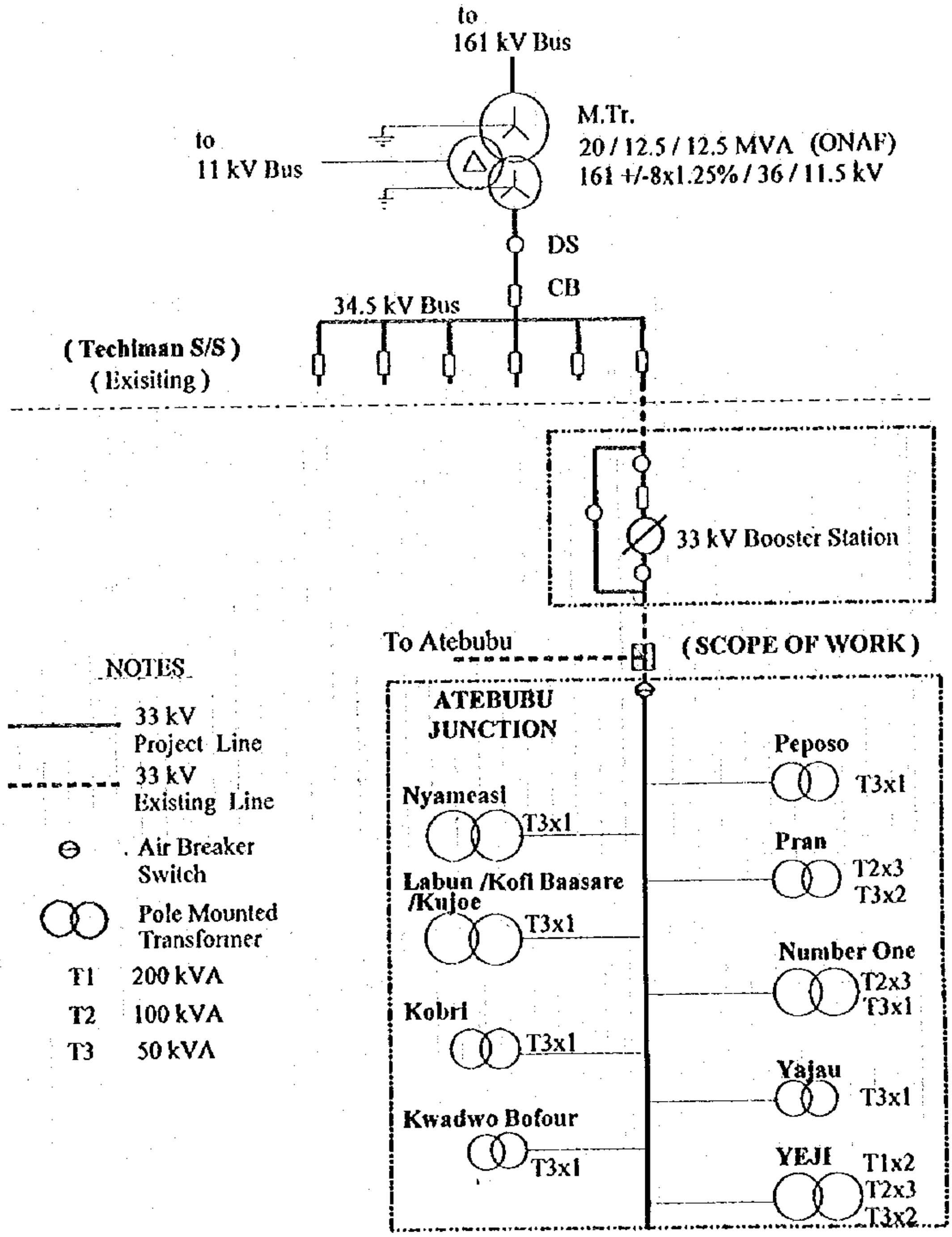


Fig. 2-2-4 Installation Location of the Pole Mounted Transformer

(Atebubu ~ Yeji)

(33 kV Line Length : 80 km)



The quantity and types of vehicles to be provided are as described in Chapter 2-3.

In this Project, installation work of low voltage distribution lines will be carried out by the respective organizations. For the construction of the lines as well as the suitable maintenance of the completed facilities, two sets of conventional tools and measuring instruments shall be supplied. These tools and equipment shall be kept carefully at the Maintenance Office or Regional Office of the organization concerned.

The types and quantities of the supplied tools and measuring instruments are described in Chapter 2-3.

(11) Basic concept of project (summary)

The basic concept for the scale and specifications of the Project is as follows:

a) The facilities installed by the Project shall have enough capacity applicable to the increased demand for the future 10 years, without any replacement or reinforcement.

b) All the facilities shall be of the same type and specifications as the existing units. This will provide effective maintenance and control even with the existing level of technology.

Based on the examinations above, the basic concept of the Project is shown in the table below.

No.	Request	Result of study	
		Asesewa	Yeji
a.	33 kV transmission line: Approx. 176 km Asesewa District: Approx. 96 km Yeji District: Approx. 80 km	Asesewa District: Approx. 103 km	Yeji District: Approx. 80 km
b.	Reinforcement of Tafo substation Reinforcement of Koforidua substation	-	Ghanaian side works. Excluded from the Project Excluded due to Asesewa line route change
c.	Countermeasure against voltage drop caused by Yeji electrification		Voltage compensation (Booster) with switchgear: 5 MVA (1 set)
d.	Low voltage material & facility, 1 set (incl. distribution transformers)	Low voltage distribution line122 km Watthour meter Single phase: 1,400 units 3-phase: 18 units Distribution transformer, 33 kV/415, 240 V 50 kVA: 17 units 100 kVA: 8 units 200 kVA: 1 unit	Low voltage distribution line110 km Watthour meter Single phase: 1,200 units 3-phase: 22 units Distribution transformer, 33 kV/415, 240 V 50 kVA: 11 units 100 kVA: 9 units 200 kVA: 2 unit
e.	Radio communications facility 1 set	VHF/FM Repeater: 1 VHF/FM Transceiver: 10	VHF/FM Repeater: 1 VHF/FM Transceiver: 10
f.	Vehicles and tools 1 set	Phase I Pickup truck: 2 *) Double-cap truck: 2 *) 5-ton truck crane: 1 Tools 1 set Phase II 5-ton truck crane: 1 Tools 1 set Note *) 1 each of Pickup truck and Double-cap truck should be transfered to Yeji Area after completion of the construction of the project in Asesewa Area.	

2-3 Basic Design

2-3-1 Design Concept

In designing these work, the designs and construction plans will be developed with due attention on the condition of the sites and with particular attention on the following matters.

(1) Natural conditions

a) 33 kV transmission line routes of each area are taken into the following consideration that they are a part (about 2 km) of road in the mountains side at Asesewa area and a support structure of the transmission line and a measurement against poor soil condition in Yeji area.

b) The construction schedule will consider a rainy season which will have an effect on construction work at site.

c) The monthly mean maximum & minimum temperatures are 29.3°C & 26.1°C at Asesewa area and 31.6°C & 26.3°C at Yeji area respectively, therefore, equipment design condition for temperature will be applied Standard proctice (40°C).

d) Distribution line routes will be designed such that it will be less necessary to cut trees along the road, so that the environment is protected.

(2) Social conditions

a) In case that newly constructed distribution lines will pass through urban and residential areas, full attention will be paid to secure the public safety.

b) As heavy items will have to be transported for the construction work, the construction plan will be formulated with due consideration on this problem.

c) The route of 33 kV transmission line will be designed along the main road because it is necessary for not only the transportation of materials and the construction but also maintenance work.

d) The load forecast for each project area will consider the population, houses, hospital, clinic, school, etc.

(3) Construction situation and local constructors

The following may be accepted from the experience of the previous projects funded by the Japanese Government.

a) The expertise and experience of the local contractors is adequate for the general construction work.

b) The labor standards are satisfactory in both quality and quantity.

c) Cement and other general work materials can be procured locally.

(4) Utilization of local materials

Wooden poles is procured from Ghana and aluminum conductors are procured from the other country.

(5) Maintenance and management capacity of executive organ

a) The codes and technical standards currently applied in ECG and VRA are taken into account, so that new facilities do not have adverse effect on the standardization efforts.

b) The capacity of both ECG and VRA executive organ will be judged acceptable according to their construction experience for the electrification as same level as this project.

(6) Grade of facilities, equipment, etc.

The grade of facilities, equipment, etc. is set to the existing grade as far as possible.

a) Complicated and sensitive technologies are avoided as much as possible, and introduction of drastically innovative technology in reference to the existing facilities is also avoided. By adopting designs which are coordinated to the existing and current technical levels in Ghana, it is intended to facilitate maintenance and operation of existing facilities.

b) The economical design is set as the target, and facilities will be designed on robust and simple structural manner.

(7) Policy for term of works

The material procurement and construction of 33 kV equipment will be carried out by the Japanese Contractor. Works for low voltage lines to be executed by Ghanaian side, ECG and VRA, are kept on and will be completed by the same time.

(8) Design conditions

Transmission and distribution lines are designed in paying regard to the present standard used by ECG and VRA, also taking into consideration the Japanese standards. Applied standards for equipment and materials are mainly Japanese Standards and IEC, but partly ANSI and BS.

a) Natural conditions

Elevation	:	less than 1,000 m
Atmospheric temperature	:	Highest; 40°C
		Lowest; 10°C
		Average; 32°C

b) Safety factor

The following values are applied according to Ghana Standards.

Support structure	:	1.5
Support structure base	:	1.5
Electric cable	:	1.7
Insulator	:	1.7
Cross arm	:	1.2
Branch wire	:	1.7

c) Conductor temperature

Average operating temperature	:	32°C
Permissible temperature	:	90°C

d) Wind pressure

Wind pressure by which strength of structures are calculated :

For wind pressure on the overhead cable	:	817 N/m^2 (83 kg/m^2)
For wind pressure on the structure	:	1,225 N/m^2 (125 kg/m^2)

c) Height above ground of transmission/distribution line

The following height shall be applied to the overhead cables.

Item	33 kV	LV
Ordinary	5.2 m	5.2 m
Crossing road	5.8 m	5.8 m
Crossing main road	6.9 m	6.6 m
Above low voltage lines	2.0 m	1.0 m

(9) Basic design concept

Upon designing of substation, transmission line and distribution line, basically the following principles are considered.

1) Accommodatability for system enlargement
2) Conciliation with existing facilities
3) Stable supply condition (voltage regulation & small losses)

a) Improvement in supply reliability

In order to raise supply reliability, following measures will be taken:

- For Yeji area, the booster station will be installed near Atebubu in order to control the stabilization of the line voltage
- Using gas circuit breakers (GCB) for out going from the booster station with reclosing device for temporary faults
- Installation of section switches for 33 kV branch points in order to localize outage area in case of line faults
- All distribution transformers, load break section switches, power cable, etc. shall be equipped with a lightning arrester

b) Voltage drop compensation

The voltage fluctuation of the terminal of demand will be limited within 5% as a target.
In the calculation of the power system, the range of the voltage fluctuation of 33 kV power system will be limited from + 5 % to - 10 % approximetry, and the tap for distribution transformer will be selected for the target range mentioned above.

Besides, the voltage fluctuation of existing power system recorded about 10 % during 10 days from February 26, 1996 in this site survey.

c) Supply Mode

Power supply mode is adopted a method of 33 kV/415, 240V direct step down.

d) System Configuration and Section Switch

The system is planned one circuit tree branch type system because power flow is one direction, and load density is small. At branch points of distribution lines, air breaker switches are installed in order to localize outage range upon the faults and for maintenance work. Protection system and reclosing manner in case of line faults will be designed as same as for existing facilities.

(10) Insulation design

a) Insulation Design

In order to protect lines and equipment from an inrush of lightning surge and power frequency abnormal voltage, the design was made by putting a coordinated insulation level among them and applied the following criteria.

- For internal abnormal voltage (switching surge, sustained power frequency abnormal voltage etc.), a protection is made by insulation of equipment itself.
- For external abnormal voltage (lightning surge), a protection is made by an surge arrester or grounding wire.

b) Insulator Type and Number of Discs of Insulator String

The principal idea of insulation design, as mentioned above, flashover may not occur against an internal abnormal voltage. As to internal abnormal voltage, according to the normal practice employed to insulation of transmission line so far, following values are assumed.

- Type of grounding system : direct grounding
- Sustained power frequency abnormal voltage : 0.8 Um
- Switching surge abnormal voltage : 2.8 Um

where Um : maximum system voltage

In deciding number of discs of insulator string, a flashover characteristics of the insulator in wet condition for switching surge, and the same for power frequency are applied.

The required insulation strength against internal abnormal voltage and the electrical characteristics of the insulators are shown in the following tables (a) - (c).

1) Required insulation strength against switching surge

Nominal voltage	34.5 kV
Max. system voltage Um	36.5 kV
Crest voltage to earth $\sqrt{2}/\sqrt{3}$Um	29.8 kV
Multiple coefficient for switching surge n	2.8
Switching surge voltage	83.45 kV
Deterioration factor	1.2
Required insulation strength	100.1 kV

2) Required insulation strength deduced by AC lasting abnormal voltage

Nominal voltage		34.5 kV
Max. system voltage	Um	36.5 kV
Multiple coefficient for abnormal voltage n		0.8
Sustained abnormal voltage		29.2 kV
Deterioration factor		1.2
Required insulation strength		100.1 kV

3) Electrical characteristics of insulators

Strain insulator number of strings	Standard surge	Switching surge		Power frequency	
	50% flash over voltage (kV)	50% flash over (kV)	Withstand (kV)	Flash over (kV)	Withstand (kV)
1	150	85	75	45	40
2	240	155	140	80	70
3	330	225	205	115	105
4	410	295	265	150	135
5	495	360	325	190	170
33 kV Post insulator	200			80	

Note:

i) Characteristics of 250 mm suspension insulators string are based on "The Insulation Design Manual for Overhead Transmission Line -Oct.1966" issued by the Japanese Electrotechnical Committee (JEC).

ii) Characteristics of 33kV Pin Type insulators are based on BS 137.

Comparing a withstand voltage of insulators with the required insulation strength in Tables (a), (b) and (c), and considering some tolerance, type of insulators and number of discs for insulator strings have been selected as following table. On more spare piece have been counted upon determination of the number of 250 mm discs for insulator string taking account of maintenance.

Selection of insulator type and number of insulators

Nominal Voltage	Place	Strain insulator number	33 kV post insulator
33 kV	Straight		o
33 kV	Tension	3 discs	

4) Standard clearance against earth

Standard clearance is assumed as same as rod gap that will flash over by the 50% flush over voltage of insulator string in case standard impulses (positive) are applied.

Nominal voltage	33	kV
Number of strain insulator	3	
50% FOV of insulator string	330	kV
Equivalent rod gap	52	cm
Standard insulation clearance	55	cm

5) Minimum insulation clearance

Minimum clearance shall be born against both switching surge and lasting AC abnormal voltage.

Nominal voltage		33	kV
Max. system voltage	Um	36	kV
Crest AC value against earth		29.4	kV
Multiple for switching surge	n	2.8	
Crest value of switching surge		82.3	kV
Required withstand voltage		99	kV
Required clearance		19	cm
Minimum insulation clearance		25	cm

6) Insulation clearance in abnormal condition

When the maximum wind condition is considered, the clearance shall withstand against maximum system voltage (Um) under the wet condition

Nominal voltage		33	kV
Max. system voltage	Um	36	kV
Crest AC value against earth		20.8	kV
Required withstand voltage		22.8	kV
Required clearance		6.5	cm
Safety clearance		10	cm

7) Minimum clearance between lines

Nominal voltage		33	kV
Max. system voltage	Um	36	kV
Crest voltage against earth		29.4	kV
Multiple switching surge between lines		4.5	
Surge voltage between line		132.3	kV
Withstand voltage between lines		145	kV
Min. clearance between lines		30	cm

8) Determination of Basic Lightning Impulse Insulation Level (BIL) and selection of arrester

Applied BIL for 33 kV system is selected at 170 kV. The reason of said decision is described as below:

Since shielding effect of overhead ground wires and protection by arresters have been anticipated, the BIL shall be selected so as to withstand switching surge as well as lightning surge, by coordinating with protection characteristics of arresters.

That is, assuming that the protection tolerance of arresters and equipment protected against lightning surge to be 20%, BIL should be selected to be of more than arrester's maximum residual voltage. Next table shows the process of decision of BIL by nominal voltages.

1) Arrester

Rated voltage	42 kV
Max. residual voltage	140 kV
Rated discharge current	10 kA

2) Required BIL

Ceiling discharge voltage x 1.2	168 kV
Basic impulse level	170 kV

The above mentioned BIL will be applied for design of new equipment to be installed. This value have also been used for VRA's and ECG's existing facilities.

9) Lightning protection design

In the field survey, accurate observation records on IKL (Isokeraunic level: statistical annual thunder days) were not obtained. But since existing equipment have scarcely been damaged by lightning attack, same design will be adopted for the transmission lines. The over head ground wires and arrester will be set for substations. Arresters will also be installed for distribution transformers and air breaker switches in order to protect those facilities from external abnormal voltage including lightning impulse.

1-3-2 Basic Design

(1) General Plan

a) 33 kV transmission line and distribution facilities

The following gives the quantities to be constructed in both Districts; Asesewa and Yeji.

District	33 kV transmission line	Distribution transformer		
		50 kVA	100 kVA	200 kVA
Asesewa	AAC 100 mm^2 : 103.3 km	17	8	1
Yeji	ACSR 100 mm^2: 80 km	11	9	2

b) Voltage drop compensation facility

To remedy the voltage drop which is derived by electrification of Yeji Area, following equipment are installed.

Main transformer	1 unit
Circuit breaker	1 unit
Disconnecting switch	3 units
Lightning Arrester	6 units
Control cubicle	1 unit

c) Low voltage distribution network

The following materials are supplied.

District	Line length	Watt-hour meter	
		2p	3p
Asesewa	AAC 50 mm^2 : 122 km	1,400	18
Yeji	AAC 50 mm^2 : 110 km	1,200	22

(2) Basic Design

a) 33 kV transmission lines and distribution materials

1) Conductors

For Asesewa District, 100 mm^2 AAC (Hard drawn Aluminum Conductor) which is specified as a standard size by the ECG is adopted. And for Yeji Area, 100 mm^2 ACSR (Aluminum Conductor Steel Reinforced) which is specified as a standard size by VRA is adopted.

2) Conductor alignment and pole configuration

Among the various conductor alignment such as horizontal, vertical and triangular etc., horizontal alignment was adopted to meet with existing lines which has simple cross arms and easier in construction works.

This horizontal alignment has several merits compare than other alignments such as;

- Connection of lead wires from overhead conductors to the terminals of pole transformers etc. are easer.

- Owing to enable to use short length poles, it is much economical.

Therefore this method is widely adopted where the special restriction, say right of way etc. are not existent.
In view of the above and to coordinate the technical particulars of the existing facilities, the horizontal alignment method was adopted in the Project. Fig. 2-3-1 and Fig. 2-3-2 show standard pole cofigulations without transformer and with transformer, respectively.

3) Support Structure

Wooden poles locally available are used in principle by considering the economy and coordination with existing facilities. 10 m length of poles, which are standardized by ECG and VRA, are used. Standard design span is 80 m.

For insulator fittings, pin post type insulators for straight line poles and 250 mm disc insulators 3 pieces string for section and tension poles are used.

In some sections where the fire field vegetation is taken place in Yeji Area, steel pipe poles are adopted to avoid a potential damage from the fire.

Line length of Yeji 33 kV line

Village	Wooden pole (km)	Steel pipe pole (km)
Primukyae	1.5	6.3
Pebirabon	2.0	2.3
Peposo/Nyameasi	4.2	2.0
Pran	2.4	9.4
Labun/Kudjoe	5.5	3.5
Prambo/Sawoba	2.1	9.8
Kobri	1.7	11.8
Yeji	7.2	8.3
Total	26.6	53.4

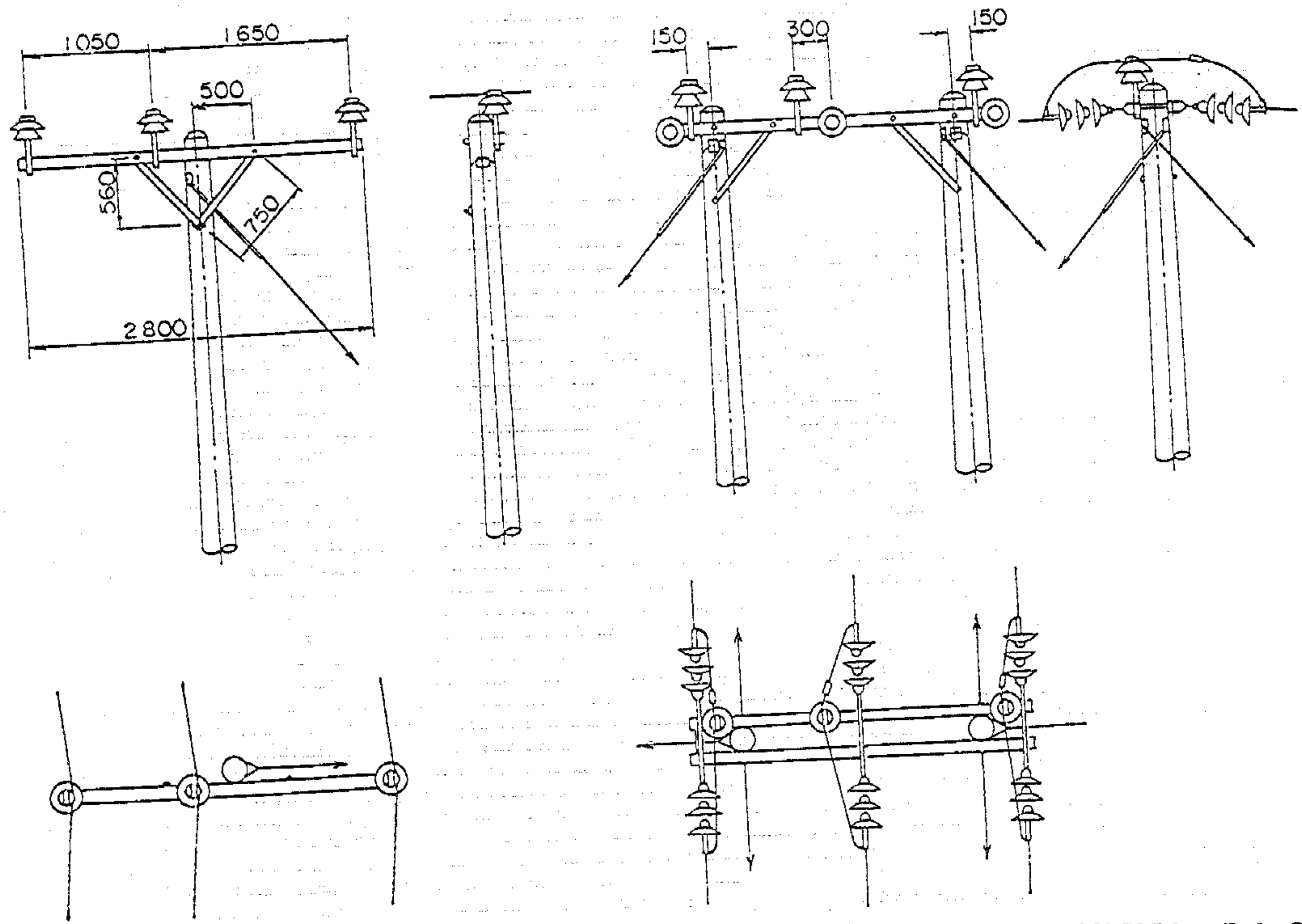
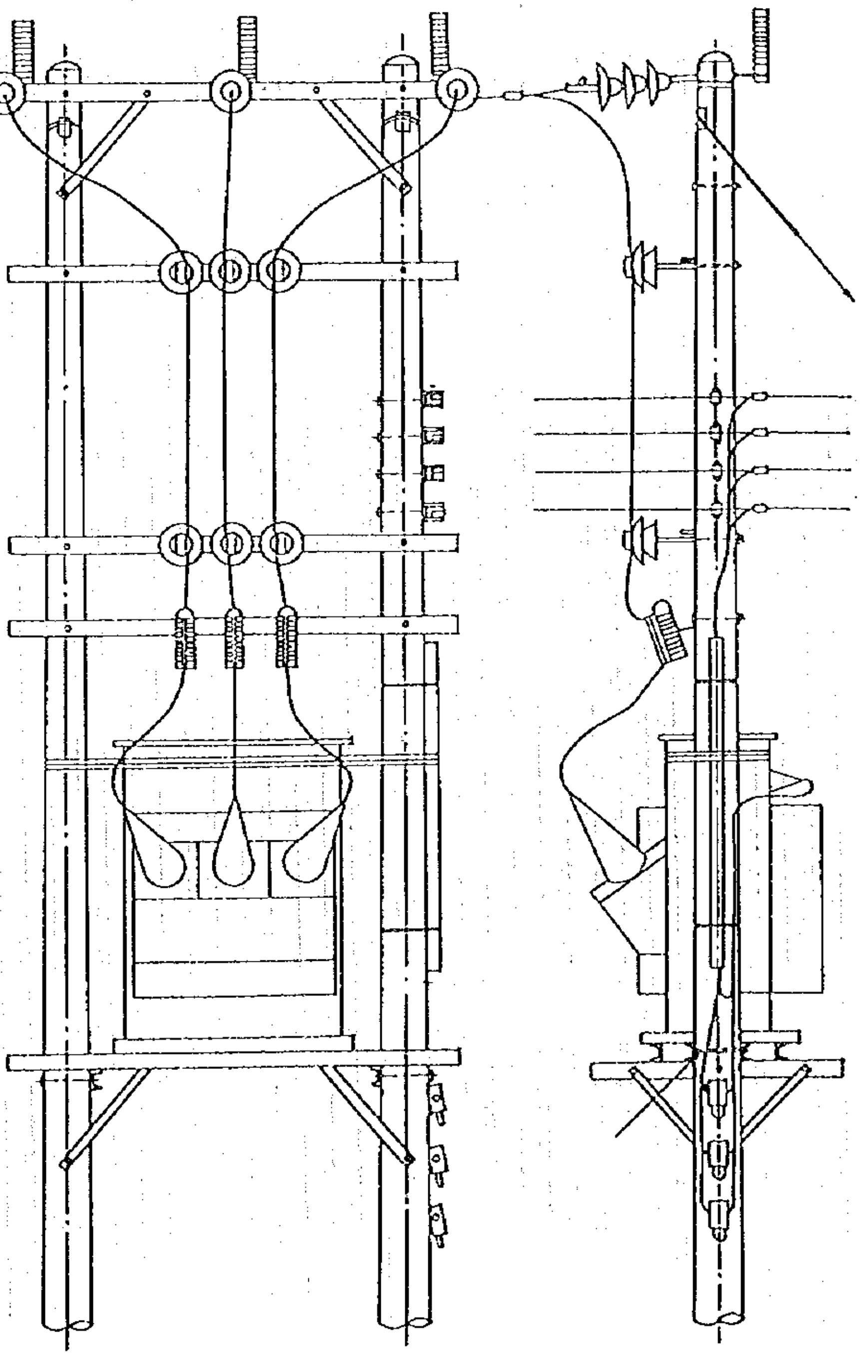


Fig. 2-3-1 33kV Line, Pole Configuration

Fig. 2-3-2 33kV Line, Transformer Platform



4) Stays

The following stays will be installed for single poles and H-poles, and shall be designed to bear one-half of the wind pressure. Stays shall be 45 mm^2 galvanized steel wires and installed with lapped grips.

i) Straight line pole

For places where there is a large difference between the back and the forth spans, a single stay shall be installed on each side. There shall be installed six stays for four direction - back and forth and on the right and left, for every 10 spans.

ii) Angle poles

1 deg. - 15 deg.	:	1 stay
15 deg. - 45 deg.	:	2 stays
45 deg. - 90 deg.	:	3 stays

iii) Section poles : 6 stays

iv) Terminal poles : 2 stays

5) Pole-Mounted Transformers

The standard transformers used shall be three-phase 50 kVA, 150 kVA and 200 kVA. Since the 33 kV lines are constructed along the main roads extended to Asesewa and Yeji, the following points are taken into consideration for installation.

i) Transformers will be installed close to the load centers that are located along the main roads.

ii) To supply the demand center far from the trunk line, high voltage branch line will be extended to that end. At the end of the branch suitable transformer shall be installed to minimize voltage drops.

The following protection will be provided to prevent overloads and short-circuits which may occur after distribution transformers.

iii) To prevent problems resulting from internal short-circuits, transformers will be provided with primary fuse cutout switches.

iv) To prevent problems caused by overload or short-circuits on the low voltage lines, transformers will be equipped with secondary fuse cutout switches.

v) Appropriate fuses shall be provided for the primary and secondary cutout switches.

b) Facility for voltage drop compensation (Transformer)

1) Selection of installation site

In selection of the site, following items shall be taken into consideration.

i) No problem is involved when the connection of the facility to the 33 kV line is taken place.

ii) No hindrance for transportation of materials and equipment is involved.

iii) To be of free from flood and other natural disaster and well enough hard ground.

iv) No to pollute the surrounding environment with the noise of the facilities.

2) Capacity of the facility

5,000 kVA capacity is decided for the voltage drop compensation transformer from the result of demand forecast.

3) Operation and control method

Manual operation and control method is adopted. In this method, technical personnel(s) patrol the site on the request of substation(s) and operate the facility suitably in accordance with line conditions. No operator resides there in usual.

4) Connection method

In the study of wiring, such as system operation condition, frequency of check-up of equipment, frequency of power failure break-out and supply responsibility etc. must be taken into consideration. Satisfy the above requirements at the same time within the range of not losing the power supply ability, simplified wiring was also examined.

5) Minimum insulation distance

Minimum insulation distance; phase - earth and phase - phase are calculated multiplied by 120% and 150% of the equivalent gap length for 50% flash-over voltage, which is based on BIL Standard.

• Nominal voltage	33 kV
• BIL	170 kV

- Minimum insulation distance (phase to earth) 30 cm
- Minimum insulation distance (phase to phase) 48 cm

6) Protection facility

Protection facilities for transmission/distribution lines, buses and transformers are installed in accordance with IEC Standards. Electro-magnetic type relays are adopted for their easy maintenance and control practice.

The wiring of voltage drop compensation transformer, which is conducted from the result of above examination, is shown in Fig. 2-3-3 and the layout of the equipment is shown in Fig. 2-3-4.

c) Low Voltage Lines

Necessary materials and their quantities for construction work of the low voltage lines to be done by ECG and VRA, on the request of customers, are estimated based on the following conditions.

- Standard span : 50 m
- Conductor arrangement : Vertical
- Conductor : AAC 50 sq. mm
- Length of low voltage trunk lines and branch lines

Standard line length for each transformer capacities are as follows:

	Pole transformers		
	50 kVA	100 kVA	200 kVA
Number of spans (spans)	80	120	120
Main line length (km)	2.0	3.0	3.0
Branch line length (km)	2.0	3.0	3.0

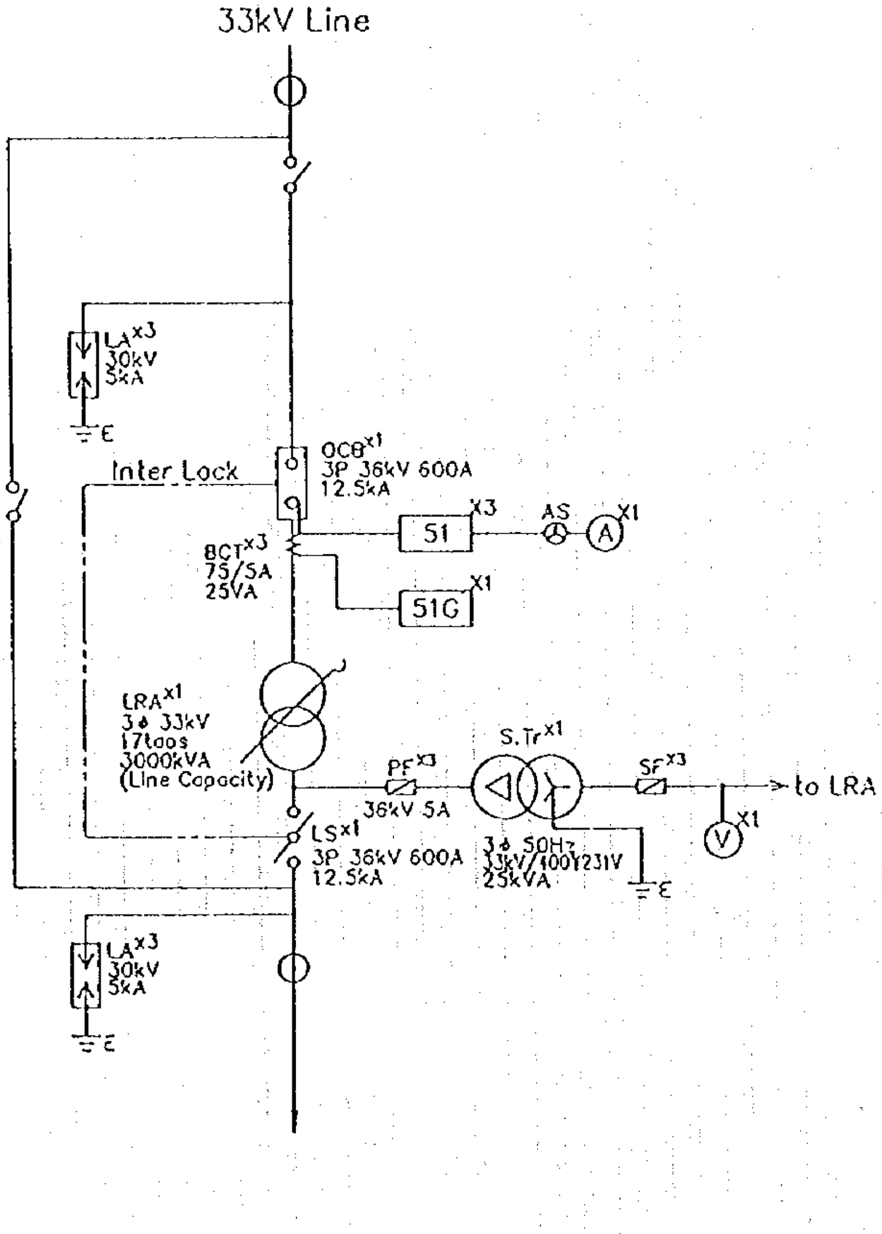


Fig. 2-3-3 33kV Booster Station, Single Line Diagram

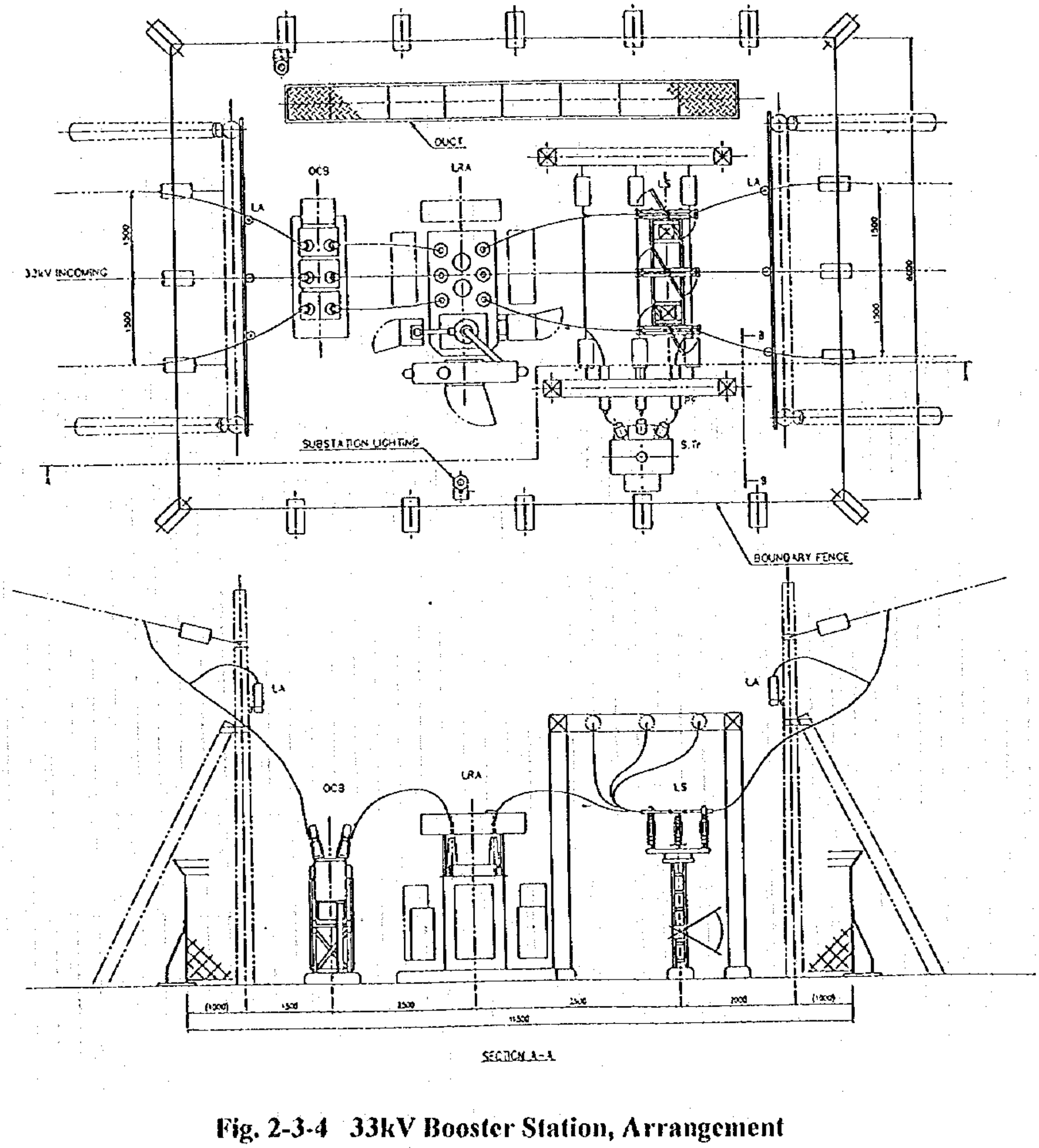


Fig. 2-3-4 33kV Booster Station, Arrangement

Power supply to consumers is made using main line with 3-phase 4-wire system and using branch line with single-phase 2-wire system.

Standard pole configuration are shown in Fig. 2-3-5.

d) Watt-Hour Meters

There is a large possibility that some of the many unelectrified areas near the projected route will wish to tie into the supply, even if at their own expense. However the estimate of real quantity of WHM etc. for consumer-wise (ordinary households, commercial and industry use etc.) are very hard.

However, based on result of site investigation, NEPS data and experience of our former project, it is assumed that the penetration factor in 2-3 years after commissioning is 30-45% for households located in the areas.

Therefore, assuming the new customer connected in within a year to be of 35%, the following quantity of WHMs are counted.

1)	Residential/Commercial (single phase)	:	2,600
2)	Industrial (3 phase)	:	40

(3) Specifications of Main Equipment

a) 33 kV transmission line and distribution line materials

The outline of major materials/equipments to be used in the 33 kV transmission line construction work under the Project is presented below.

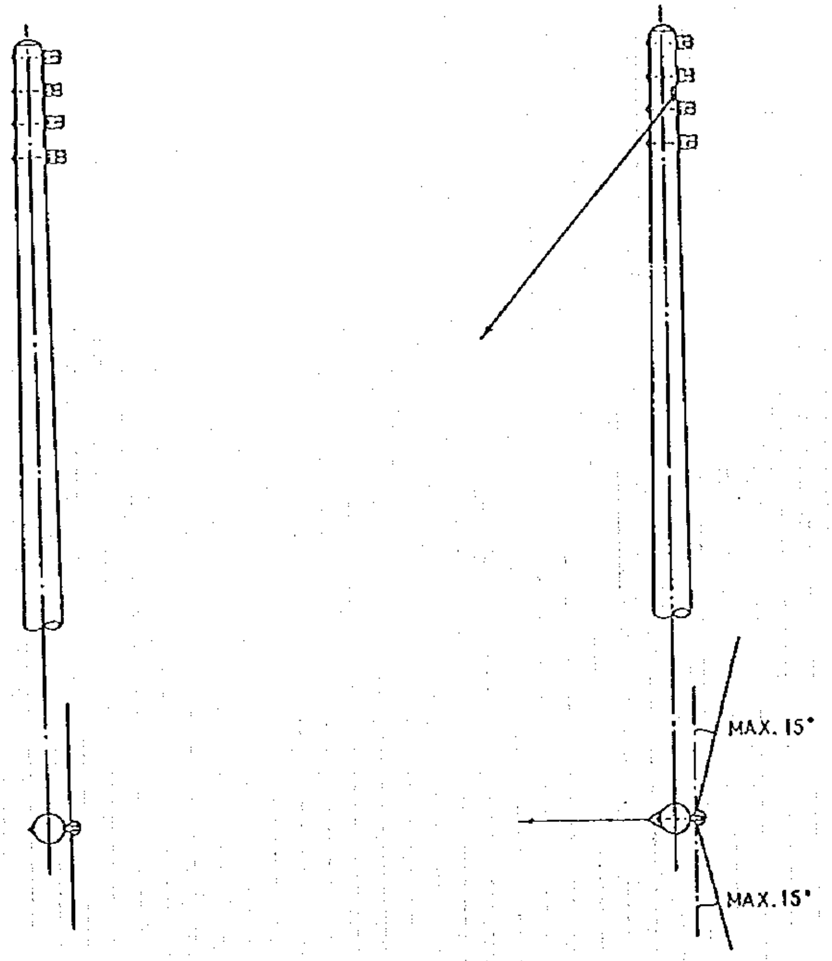


Fig. 2-3-5 Low Voltage Line, Pole Configuration

1) Conductor

Standard	BS 215 part 1	BS 215 part 2
Type & size	AAC 100 mm^2	ACSR 100 mm^2 (Dog)
Stranding	7/4.39	Al 6/4.72 St 7/1.57
Calculated sectional area		
	106.0 mm^2	118.5 mm^2
Diameter	13.17 mm	14.15 mm
Weight	290 kg/km	394 kg/km
Tensile load	16.00 kN (1,630 kg)	32.70 kN (3,330 kg)
D.C resistance (20 C)	0.2702 ohm/km	0.2733 lhm/km

2) Pin type insulator

Standard	BS 137
Nominal voltage	33 kV
Flash-over voltage	
- Power frequency, wet	95 kV
- 50% impulse, positive	215 kV

3) Suspension insulator

Standard	IEC 383
Dimension	254 mm x 146 mm
Flash-over voltage	
- Power frequency, wet	45 kV
- 50% impulse, positive	125 kV
Failing load	4,000 kg

4) Lightning arrestor

Standard	IEC 99, IEC 37
Rated voltage	42 kV

Nominal discharge current	10 kA
Residual voltage	140 kV

5) Pole-mounted transformer

Nominal voltage	33 kV/415, 240 V
Capacity	50, 100, 200 kVA
Type	Out-door use, self cooling
Phases	3
Rated frequency	50 Hz

6) Open fuse cutout switch

Standard	ANSI
Rated voltage	36 kV
Rated current	100 A
Rated frequency	50 Hz
Power frequency withstand voltage	36 kV
Breaking current	8 kA

b) Voltage compensation facility

1) Main transformer

Standard	IEC 76
Capacity	5,000 kVA
Phases	3
Rated frequency	50 Hz
Cooling System	Oil-filled, self cooling
Rated voltage	34.5 kV
Tap voltage (HV)	-15% ~ +5%, 17 taps
Line connection	Star
Phase angle deviation	0 degree

Polarity	Decrease
Place used	Out door
Tap changer	On load tap changer
Altitude	Less than 1,000 m

2) Circuit Breaker

Standard	IEC 56
Rated voltage	36 kV
Type	Out door, SF6
Rated current	800 A
Rated frequency	50 Hz
Rated rupturing current	25 kA
Rated rupturing time	5 cycles
Rated closing voltage	DC 125 V
Rated tripping voltage	DC 125 V
Operation duty	CO-(15 seconds)-CO
Altitude	Less than 1,000 m
Max. ambient temperature	40°C

3) Isolator

Standard	IEC 265
Rated voltage	36 kV
Rated current	800 A
Rated short time current	14 kA
Place used	Out door
Altitude	Less than 1,000 m
Max. ambient temperature	40°C
Operation	Manual

4) Current transformer

Standard	IEC 185
Rated voltage	33 kV
Rated current ratio	200/5 A, 400/5 A
Rated burden	40 VA
Class	5P

5) Arrester

Standard	IEC 99, IEC 37
Rated voltage	42 kV
Rated discharge current	10 kA
Max. residual voltage	140 kV
Earthing	Neutral point direct earthing

c) Low voltage distribution line

1) Conductor

Standard	BS 215 Part 1
Type and size	AAC 50 mm^2
Stranding	7/3.10
Calculated sectional area	52.83 mm^2
Diameter	9.30 mm
Weight	145 kg/km
Tensile load	8.27 kN (840 kg)
DC resistance (20°C)	0.5419 ohm/km

2) Low voltage fuse cutout switch

Rated voltage	415 V
Rated current	400 A
Rated frequency	50 Hz

3) Insulators and fittings

Insulators	Shackle insulator
Hardware	D-iron
Stay	Galvanized steel

4) Watt-hour meter

Type	1P2W	3P4W
Rated voltage	240 V	415/240 V
Rated current	15 (60) A	20 (80) A
Rated frequency	50 Hz	50 Hz
Class	Class 2	Class 2

d) Vehicles and tools

Vehicles and Tools at least required for construction work of this project will be provided, and the vehicles and tools are to be used by the utilities when carrying out this project. The vehicles and tools will be determined by considering the requirement for future maintenance and inspection work after transfer of facilities.

The following vehicles will be supplied for the construction work of this Project.

- 5-ton truck with 3-ton crane : 2
- Pickup truck : 2
- Double-cab pickup truck : 2

e) Communication equipment

In this project, construction work involve dangerous operations such as shutdown of facilities and switching of loads, and all construction team engaged in this work must maintain communication between them in order to assure safety and perform tasks completely.

Since no public telephone is available in the Project areas, exclusive use communication facilities must be required for the purpose of construction as well as operation and maintenance after the Project is completed.

For this purpose, it was decided to equip the construction sites and substations with VHF transceivers. The specification of the equipment is given below.

1) VHF/FM repeater

Type	Station type
Frequency	CH1: 154.05 MHz CH2: 157.5 MHz
RF output	50 W
Antenna	Brown antenna (Non-directional, vertical)
Power supply	AC 240 V, re-chargeable battery

2) VHF/FM transceiver

Type	Portable type
Frequency	CH1: 154.05 MHz CH2: 157.5 MHz
RF output	50 W
Antenna	Whip antenna
Power supply	Re-chargeable nickel-cadmium battery

Chapter 3 Implementation Plan

Chapter 3 Implementation Plan

3-1 Implementation Plan

3-1-1 Implementation Concept

The basic matters and factors requiring special consideration are shown below to execute this project by the Grant Aid system of the Government of Japan.

(1) Implementation Agencies

The Ministry of Mines & Energy (MME) is the organization in charge of the implementation of this project. Regarding the technical matters, ECG is responsible for the power facilities in the Asesewa area and the VRA/NED for the power facilities in the Yeji area, respectively.

While the works for this project are executed practically by two organizations, the MME collectively controls both organizations in consideration of the unification of project execution responsibility and ease of project control. In order to forward all the project works smoothly, the Ghana side must maintain close contact and confer with the Japanese Consultant and Contractor through its responsible person.

(2) Consultant

After the Exchange Notes(E/N) by both the Governments, a Japanese Consultant employed for the Project is engaged in execution implementation design, preparation of bidding documents, bid control and supervision for the construction work including procurement of equipment/materials.

(3) Contractor

A Japanese contractor who, under Japanese law is selected by open tender, shall procure equipment and materials and shall construct facilities according to the Grant Aid system of the Government of Japan.

Even after completion of construction of the project, follow-up including the supply of spare parts and correspondence for troubles are required, therefore, he shall provide sufficient consideration to communication and coordination between Ghana and Japan after the said construction.

3-1-2 Implementation Conditions

(1) The wet season lasts from May to July and may interfere with the works. Therefore, concrete works, laying works, etc. must be done outside this period and such consideration in process planning is required.

(2) Works for this project include the remodeling of existing facilities. Power supply must be maintained as usual even during the course of this work. Therefore, in the case of works which will require power interruption, it is necessary to minimize the said period of time.

(3) A greater part of the transmission line is constructed along the principal road where the volume of traffic is relatively heavy. Therefore, construction must be conducted by paying strict attention to the prevention of traffic hazards and injuries to third parties, etc.

3-1-3 Scope of Works

The scope of works of the Japanese side and the Ghanian side under this project are shown below.

Item	Japan	Ghana	Remarks
Design, manufacture and transportation of equipment	o		
Securing and control of material stock yards		o	Anti-theft measures included
Secure the land for transmission lines, substation and stockyard		o	
Repairing of construction roads		o	
Survey and bush clearing of transmission line route		o	
Construction/erection of 33 kV transmission line	o		
Installation, adjustment and test of substation equipment	o		
Installation of 33 kV distribution transformer	o		
Low-voltage distribution line works		o	Include low voltage side of transformer
Supply of power, water, etc. for works		o	

3-1-4 Consultant Supervision

According to the Grand Aid policy of the Government of Japan, the consultant is based on the object of the basic design and will organize an integrated project team for execution of design work and construction management to execute the project implementation smoothly.

In the construction supervision stage, the consultant shall dispatch a resident supervisor equipped with the proper skills for construction management and liaison. In addition, the consultant shall dispatch a design or test/adjustment engineer for a short period as required according to the progress of the construction for construction supervision and inspection.

3-1-5 Procurement Plan

Equipment and materials necessary for this project are procured by the following method.

a) Primarily, Ghanian products are used where available.

b) Materials readily available in the Ghana domestic market are used.

c) Equipment and materials of foreign manufacturers with agencies in Ghana are primarily used.

d) Japanese equipment and materials are used except as above.

3-1-6 Implementation Schedule

After the E/N, the Project will be implemented through the following steps;

1) Implementation design and preparation of Tender Documents
2) Bidding and selection of the Contractor
3) Procurement of equipment/materials and implementation of construction works.

An outline of each step is provided below.

(1) Detailed design and preparation of Tender Documents

Immediately after the E/N, the Japanese Consultant will conclude a consultancy contract

contract with MME and will initiate the Implementation design.

On the basis of confirmation of the Basic Design and Detailed Design, the Tender Documents(specifications and design documents) are prepared. Meetings with the Ghanian parties concerned in the initial and final stages of the same period of time. The consultant will proceed the bidding procedure after the final approval for the outcomes from the above meetings with concerned authorities. The required work period is expected to be 2.5 months.

(2) Bidding and selection of Contractor

Bidding is done after a specified floating period and immediately after receipt of the bidding documents, it is examined and a conclusion of a construction contract is concluded between MME and a Japanese firm.
The period of the time required for the above is expected to be two(2) months.

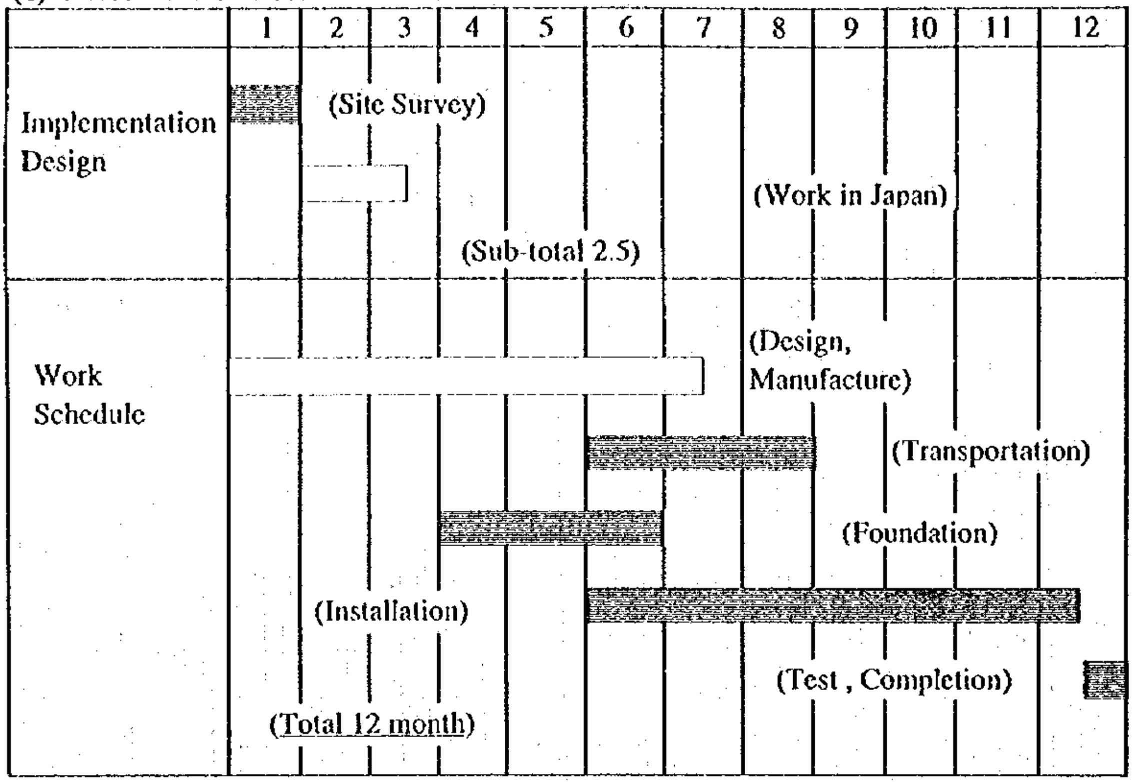
(3) Procurement of equipment/materials and implementation of constuction works

Procurement of the equipment/materials and construction work under this Project is expected to be about 13 months. In order to complete whole the works satisfactory within the period of time specified by the E/N, it is indispensable to perform the works smoothly by not only Japanese contractor but also Ghanian side.

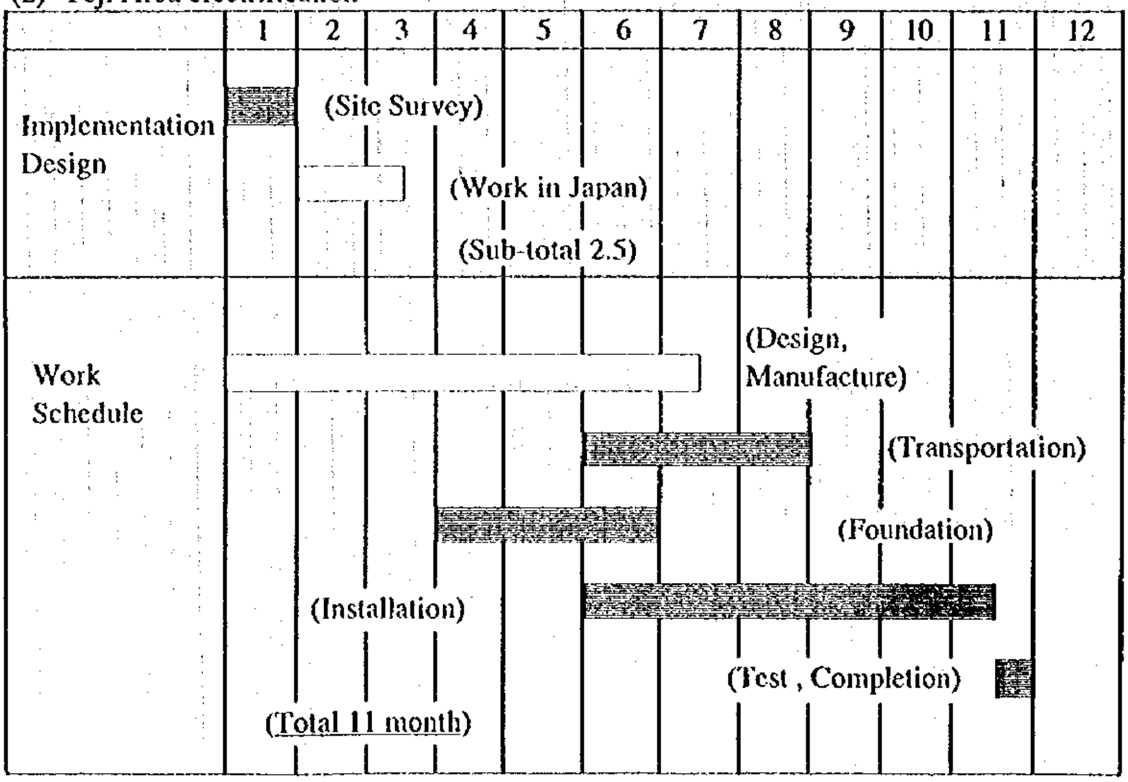
Fig. 3-1-1 shows the implementation schedule proposed.

Fig. 3-1-1 Implementation Schedule

(1) Asesewa Area electrification



(2) Yeji Area electrification



3-1-7 Obligations of Recipient Country

The minutes of the Basic Design was signed in Accra on March 8, 1996.The obligations of the Ghanian Government in ANNEX-IV are shown below.

(1) To provide necessary data and information for the conduct of the study,

(2) To secure the land necessary for sites of the Project,

(3) To provide lands for temporary site offices, warehouses and stockyards during the construction period,

(4) To clear, level and reclaim the sites prior to the commencement of the construction,

(5) To undertake incidental outdoor works such as gardening, fencing, gates and exterior lighting in and around the sites,

(6) To bear advising commission of Authorization to Pay (A/P) and payment commission to Japanese foreign exchange bank for the banking service based on Banking Arrangement (B/A),

(7) To ensure prompt execution for unloading, tax exemption and customs clearance at the port of disembarkation,

(8) To exempt Japanese nationals from customs duties, internal taxes and other fiscal levies which will be imposed in Ghana with respect to the supply of the products and services under the verified contracts,

(9) To accord Japanese nationals, whose services may be required in connection with the supply of products and the services under the verified contracts, such facilities as may be necessary for their entry into Ghana and stay therein for the execution of the Project,

(10) To provide necessary permissions, licenses and other authorization for carrying out the Project,

(11) To take necessary actions to expedite the approval for execution of the Project by authorities concerned in the Government of Ghana,

(12) To maintain and use properly and effectively the facilities constructed and equipment purchased under the Grant Aid,

(13) To bear all expenses other than those covered by the Grant Aid, necessary for construction of the facilities as well as for the transportation and the installation of the equipment,

(14) To construct the low-voltage distribution networks and lead-in lines into each consumer,

(15) To replace the transformer and its auxiliaries at New Tafo substation prior to the commencement of actual operation of the Project,

(16) To coordinate and solve any issues related to the Project, which may be raised from third parties and inhabitants in the Project area during implementation of the Project, and

(17) To take necessary measures against and responsibility for the interruption of electricity transmission during implementation of the Project.

3-2 Operation and Maintenance Plan

The power facilities to be constructed under this project are operated, maintained and controlled by the ECG for the Asesewa area and by the VRA/NED for the Yeji area. Both organizations have owned and operated large scale power facilities and are, therefore, well experienced so their maintenance and operation capabilities provide no problem

After completion of the construction works for this project, maintenance and operation should be carried out by Ghanian side so the following measures should be taken;

(1) To establish the suitable organizations includes operation, maintenance, customer services and collection of the electricity charges,

(2) To prepare the budget for the above activities.

Chapter 4 Project Evaluation and Recommendation

Chapter 4 Project Evaluation and Recommendation

4-1 Project Effect

(1) Direct Effects

The project is to electrify the unelectrified areas, and those who will benefit from the completion of the project are all classes, ranging from public organs such as governmental administrative bodies, hospitals and schools, and industries, to residents in general.
The population of beneficiaries are 68,000 in 8,600 households in Asesewa area and 41,000 in 3,500 households in Yeji area.

The electric energy is to be used as a substitute for other forms of energy currently in use - such as kerosene for lighting and refrigeration, batteries, charcoal, diesel oil, etc.

When the consumption of kerosene and electricity is compared, monthly expenditure for lighting energy per household will be reduced from 9.5% to 2-3.6% of average monthly income.

Rural electrification should bring about many effects on households aside from saving of kerosine cost. The following items can be presented as some of the effects which may be considered to be brought about by conversion of kerosene lamps to electric lights. Improvement in light together with the fact that the electric lights lead to reduced chores such as cleaning or maintenance work of lamps, and prolonged hours for study. And it always give people incentives for the improvement of living standard.

However, since electricity is not distributed to all of the households in the planned areas, it should be noted that many of the effects are to be observed in the electrification of public facilities. In this sense, the aim of the project as a social development program is to electrify public facilities.

(2) Indirect Effects

Asesewa is connected to Accra by well-paved road. Yeji will also certainly be connected by paved roads shortly since the main road rehabilitation work is in progress. Therefore, it is said that Asesewa and Yeji areas belong the Accra economic bloc.

Capturing a big market in Accra area through such development, planned production will become possible. Especially in Yeji, it is anticipated that economic activities will be accelerated considerably by utilizing the functions of CFC which is to handle aquatic products amounting to 5 billion Cedis per year.

4-2 Adequacy of the Project

It is deemed adequate to carry out this project by means of the Grant Aid Program as it will contribute to the development of Ghana and to the improvement of people's life while a lot of effects can be expected. Here, some of the main items are taken individually, and the effects and adequacy of the project will be listed to be justified.

(1) Cost of Lighting

The average household consumption of kerosene, extracted from NEP study report, is estimated at 177 L/yr and 90% of the consumption is assumed to be allocated to lighting. Therefore, monthly household consumption is 13.3 L/mon which amounts to 5,679 Cedis/mon on the household expenditure when the current retail price of 427 Cedis/L is applied.

According to calculation, if 60,000 Cedis/mon is assumed to be an average household cash income in the rural area, a monthly expenditure of kerosene for lighting purpose stands 9.5% of a household economy, which is a fairly high percentage.

The following table shows an average expenditure for electricity based on the annual electricity consumption applied in the load forecast and the latest tariff.

Town Size	Consumption	Expenditure
Rural (population less than 2,000)	920 kWh/yr	1,200 Cedis/mon
Small (population between 2,000 and 5,000)	1,250 kWh/yr	1,346 Cedis/mon
Large (population more than 5,000)	1,540 kWh/yr	2,182 Cedis/mon

When kerosene usage and electricity usage are compared, electricity is much cheaper as shown in the above table; the minimum charge of electricity is 1,200 Cedis/mon while the price of kerosene is 5,676 Cedis/mon.

(2) Hospitals

Both in Asesewa and Yeji areas, there are some well-equipped hospitals which operate their own generators. But for lack of power generating capacity and due to difficulty in the maintenance of their captive generators, they cannot provide sufficient medical care. Presently, other clinics and dispensaries cannot use medical equipment as they do not have diesel generators. Therefore, electrification will provide fruitful results to the said hospitals, clinics or dispensaries in protecting the health and lives of the inhabitants in those areas.

(3) Schools

Providing electric power to schools creates a great possibility for introduction of new materials, especially audio-visual aids. As for the vocational schools, electrification makes it possible to use machine tools in the process of lectures and drills. For example, tools and machines cannot be operated fully at a technical high school in Yeji because of insufficient power supply from their diesel generators, so the people in the area yearn for electricity from the grid. Furthermore, such programs as vocational training and adult schools are made possible through the use of school facilities during the night. As a result, such training programs will improve social skills of young people and will provide them with an advantage of employment opportunity.

(4) Water Supply

The source of water supply in both Asesewa and Yeji areas is the Volta Lake. The people in the areas rely on human power of women or children for carrying water, but there are some places which rely on engine pumps. The electrification leads conversion of carrying water by human powr or pumping by diesel engines to the use of electric pump, which can be considered to improve the basic conditions of the lives of the people; especially for women and children in subject areas.

(5) Planned Production

The planned food production can be practiced by utilizing preservation facilities supported by stable electric power. This will secure stable cash income for the sake of the community and cause effects to prevent urban migration.

4-3 Recommendation

It is judged that this project is significant to implement by Japan's grant aid program as it will contribute to the development of Ghana and to improvement of people's life while a lot of side effects can be expected as has been mentioned above. For the smooth and effective implementation of the project, the necessary matters as mentioned below should be considered by Ghanaian side.

(1) The implementation schedule of the project is tight and it will be necessary to allocate adequate staff and budget and to obtain cooperation from the authorities concerned.

(2) Power facilities will be operated and maintained by ECG or VRA after completion of the construction work, consequently, establishment of new offices in the subject areas should be indispensable to keep reliable supply.

(3) To maintain a long-term healthy operation of 33 kV lines, careful attention should be given to periodic bush clearing, removal of a climbing plant, clearing of the line route, etc.

(4) Two pickup trucks originally planned for Phase-2 of the project will be procured under Phase-1 to make the effective use of those vehicles. After completion of the construction work, all those vehicles are to be allocated to ECG and VRA for operation and maintenance work.

(5) Technical training in Japan for Ghanaian engineer(s) is suggested to execute the perfect maintenance of the power facilities.

Appendices

Appendices

1. Member List of the Survey Team

1-1 Site Survey

1) Leader, Hayao ADACHI
   Development Specialist,
   Japan International Cooperation Agency

2) Coordnator, Yoshihiro IMAMURA
   Grant Aid Division, Economic Cooperation Bureau,
   Ministry of Foreign Affairs

3) Chief Consultant / Maintenance & Operation Planner, Takeshi ICHIKAWA
   EPDC International Ltd. (EPDC I)

4) Electric Transmission & Transformation Planner, Tadao SATO
   EPDC International Ltd. (EPDC I)

5) Electric Distribution Planner, Hisaya NOGUCHI
   EPDC International Ltd. (EPDC I)

6) Cost Estimator / Provision Planner, Mototaro OKADA
   EPDC International Ltd. (EPDC I)

1-2 Member of the Explanation Team for the Draft Basic Design

1) Leader, Hayao ADACHI
   Development Specialist,
   Japan International Cooperation Agency

2) Chief Consultant / Maintenance & Operation Planner, Takeshi ICHIKAWA
   EPDC International Ltd. (EPDC I)

3) Electric Distribution Planner, Hisaya NOGUCHI
   EPDC International Ltd. (EPDC I)

2. Survey Schedule

2-1 Field Survey

No.	Date		Activity	Stay
1	Feb. 20	Tue.	- Leave Narita for London	London
2	21	Wed.	- Leave London for Accra	Accra
3	22	Thu.	- Courtesy visit to EOJ, JICA, MME, ECG and VRA (submitted a inception report and a outline of requested rural electrification project)	Accra
4	23	Fri.	- Meeting with MME about Inspection Report with Schedule and Questionnaire - Courtesy visit to ECG - Site observation of Tokuse S/S (Weija) and 33 kV line & Distribution Transformers (Tokuse, Kasua to Bodwoase)	Accra
5	24	Sat.	- Site observation of Lower Volta area, Sogakope S/S and 33kV line & Distribution Transformers (Sege, Kasseh to Sogakope)	Accra
6	25	Sun.	- Classify data	Accra
7	26	Mon.	- Site survey of Kumasi S/S, Techiman S/S and 33 kV line between Techiman S/S and Atebubu town	Atebubu
8	27	Tue.	- Site survey of Yeji project between Atebubu and Yeji including Pran and Number one communities - Courtesy visit to a Chief (Nana) of Yeji	Kumasi
9	28	Wed	- Inner meeting at Kumasi site and back to Accra - Arrive Mr.Adachi & Mr.Imamura in Accra - Inner meeting at Golden Tulip Hotel	Accra
10	29	Thu.	- Inner meeting at JICA Office - Courtesy visit to EOJ, JICA, MOF, MME, ECG and VRA (explained a schedule and confirmed each project items)	Accra
11	Mar. 1	Fri.	- Site survey of Asesewa project between Asesewa and Koforidua including Sekesua, Agogo, Otekpolu, etc. and Tafo substation	Accra
12	2	Sat.	- Preparation of " Minutes of Discussions "	Accra
13	3	Sun.	- Inner meeting for " Minutes of Discussions"	Accra

14	4	Mon.	- Discussion on the contents of proposed project with MME, ECG and VRA at MME conference room - Data aquisition (detailed map of project area)	Accra
15	5	Tue.	- Discussion on "Minute" and study of population & number of houses in the project area with MME at MME conference room - Data aquisition (detailed map of project area)	Accra
16	6	Wed.	- Meeting with MME on "Minute of Discussions"	Accra
17	7	Thu.	- Confirmation Meeting for minutes with MME, VRA and ECG	Accra
18	8	Fri.	- Signing on the Minutes of discussion by MF, MME, VRA, ECG and JICA at Ministry of Finance - Interim report to EOJ & JICA - Mr. Adachi & Mr. Imamura leave Accra	Accra
19	9	Sat.	- Inner Meeting for Data aquisition	Accra
20	10	Sun.	- Classify data	Accra
21	11	Mon.	- Meeting for modified schedule after today with MME (including completion ceremony of Lower Volta Project) - Meeting for modified schedule after today and for questionnaire with ECG - Meeting with JICA	Accra
22	12	Tue.	- Meeting with VRA and data aaquisition - Meeting with JICA (about completion ceremony of Lower Volta Project)	Accra
23	13	Wed.	- Classify data	Accra
24	14	Thu.	- Data aquisition at MME, MF and ABB Ghana	Accra
25	15	Fri.	- Marketing research on Cable Manufacture and survey for steel tower manufactured by ABB at ECG storage area - Meeting with ECG	Accra
26	16	Sat.	- Classify data	Accra
27	17	Sun.	- Classify data, (Mr. Sato arrived in Accra)	Accra
28	18	Mon.	- Meeting with ECG - Courtesy visit to JICA with Mr. Sato	Accra

29	19	Tue.	- Site survey of Koforidua S/S, Tafo S/S and route survey of transmission line between Tafo S/S & Simlesi and Huhunya - (Osubo, Sutri) - & Simlesi	Accra
30	20	Wed.	- Route survey of transmission line from Sikaben - (Agogo, Anhwiaben) - to Simlesi - Site survey of Bisa, Asesewa and Odometa	Accra
31	21	Thu.	- Data aquisition	Accra
32	22	Fri.	- Completion ceremony of Lower Volta Project (at Sogakope S/S and at Adidome)	Accra
33	23	Sat.	- Inner meeting	Accra
34	24	Sun.	- Classify data	Accra
35	25	Mon.	- Data aquisition - Move to Atebubu town	Atebubu
36	26	Tue.	- Site survey of Yeji project between Atebubu and Yeji - Data aquisition	Kumasi
37	27	Wed.	- Back to Accra - Preparation of " Technical Note " - Data aquisition and Inner meeting	Accra
38	28	Thu.	- Discussions of " Technical Note " with MME, VRA and ECG - Classify data	Accra
39	29	Fri.	- Signing on "Technical Note" by MME, VRA, ECG and Consultant at MME - Data aquisition	Accra
40	30	Sat.	- Site observation of Adfoah town of Lower Volta Project	Accra
41	31	Sun.	- Classify data	Accra
42	Apr. 1	Mon.	- Report to EOJ & JICA	Accra
43	2	Tue.	- Data aquisition - Leave Accra for Amsterdam	Flying overnight
44	3	Wed.	- Leave Amsterdam for Narita	Flying overnight
45	4	Thu.	- Arraive Narita	--

2-2 Member of the Explanation Team for the Draft Basic Design

No.	Date		Activity	Stay
1	May21	Tue.	- Leave Narita for London	London
2	22	Wed.	- Leave London for Accra	Accra
3	23	Thu.	- Courtesy visiit to EOJ, JICA, MME, VRA, ECG	Accra
4	24	Fri.	- Meeting with ECG and VRA for draft report	Acca
5	25	Sat.	- Classify data	Accra
6	26	Sun.	- Site observation of Akosombo & Kpong power stations	Accra
7	27	Mon.	- Discussion on draft report with MME, VRA and ECG	Accra
8	28	Tue.	- Meeting on the Minutes of Discussion with MME, VRA and ECG	Accra
9	29	Wed.	- Signing on " Minutes of Discussion " - Reporting to EMB and JICA	Air
10	30	Thu.	- Leave Accra for London	London
11	31	Fri.	- Leave London for Narita	Air
12	Jun. 1	Sat.	- Narita	---

3. List of Party Concerned in the Recipient Country

3-1 Site Survey

Name	Belongings
Ministry of Finance	
Dr William Adote	Director International Economic relations Division
Kwasi Opoku	International Economic Relations Division
Parliament	
Emmanuel Narte Ansah	Member for Upper Manya
Godwin Jhon Quarshie	Member, Yilo Krobo, Somanya
Meteorological Services Department	
Mr Okanta	
Atebubu-Yeji	
Thomas Takyi	District Chief Executive, Atebubu
Yaw Kagbrese V	Chief of Yeji
Abdulari Zakari	District Co-ordinating Director Atebubu
George Kwasi Baboase	Director, National Commission for Civic Education, Atebubu
Joseph K. Klu	Assembly man
Dr. Rosily	Doctor Matthias Catholic Hospital, Yeji
Ministry of Energy & Mines	
Dr Joe Oteng-Adjei	Ag. Director (Powewr)
Francis Gbeddy	Senior Programme Officer Electricity Planning Dev. & Monitoring Programme
Gabriel Quain	Programme Officer Electricity Planning Dev. & Monitoring Programme

Name	Belongings
Volta River Authority	
E.A.K. Kalitsi	Chief Executive
Gilbert O. Dokyi	Deputy Chief Executive Engineering & Operations
Alex A.Papanko	NED
J.Amoako-Baah	Sr.Electrical Engineer Engineering Dept.(Akuse)
G.D.Boateng	Director,Eng.Design & Construction
Ms T.W.Akffo-Freeman	Director of Personnel
Electricity Corp. of Ghana	
Jhon K. Hagan	Managing Director
Chris Adom	Director of Engineering
B.K.Dapatem	Divisional Manager Special Engineering Duties
Francis R.L.Lawson	Sectional Manager Rural Electrification
W.K.Kyeremateng	Regional Director,Eastern
E.Y.Nyarko	Materials Manager
Albert Sowah	Sectional Manager/Design
Ken Wallace	Senior Consultant ESB International,Ireland
Kwamina Longman	Sectional Manager,Public Relation
S.T.Acch-Addo	Director of Administration
Cephas Gakpo	Divisional Manager Design & Construction
Wilson Kwame Adjiku	Divisional Manager Corporate Planning

3-2 Member of the Explanation Team for the Draft Basic Design

Name	Belongings
MME (Ministry of Energy & Mines)	
Francis Gbeddy	Senior Programme Officer Electricity Planning Dev. & Monitoring Programme
Gabriel Quain	Programme Officer Electricity Planning Dev. & Monitoring Programme
VRA (Volta River Authority)	
Gilbert O. Dokyi	Deputy Chief Executive Engineering & Operations
J.Amoako-Baah	Sr. Electrical Engineer Engineering Dept. (Akuse)
G.D.Boateng	Director, Eng. Design & Construction
Clement G. Abavana	Director, Northern Electricity Department
S. T. Okine	Senior Director,
Arkersti	Manager, Akosombo Power Ststion
ECG (Electricity Corp. of Ghana)	
Jhon K. Hagan	Managing Director
Chris Adom	Dorector of Engineering
B. K. Dapatem	Divisional Manager Special Engineering Duties
Francis R. L. Lawson	Sectional Manager Rural Electrification