No.

BASIC DESIGN STUDY REPORT
ON
THE PROJECT
FOR
RURAL ELECTRIFICATION
IN
THE REPUBLIC OF GHANA

AUGUST, 2002

JAPAN INTERNATIONAL COOPERATION AGENCY

YACHIYO ENGINEERING CO., 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 and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Ghana a study team from February 7 to March 16, 2002.

The team held discussions with the officials concerned of the Government of Ghana, and conducted a filed 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.

August, 2002

Takao Kawakami
President
Japan International Cooperation Agency

August, 2002

LETTER OF TRANSMITTAL

We are pleased to submit to you the basic design study report on the Project for Rural Electrification in the Republic of Ghana.

The study was conducted by Yachiyo Engineering Co., Ltd. under a contract to JICA, during the period from February, 2002 to August, 2002. 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,

Masatsugu Komiya
Chief Consultant
Basic design study team on the
Project for Rural Electrification in
the Republic of Ghana

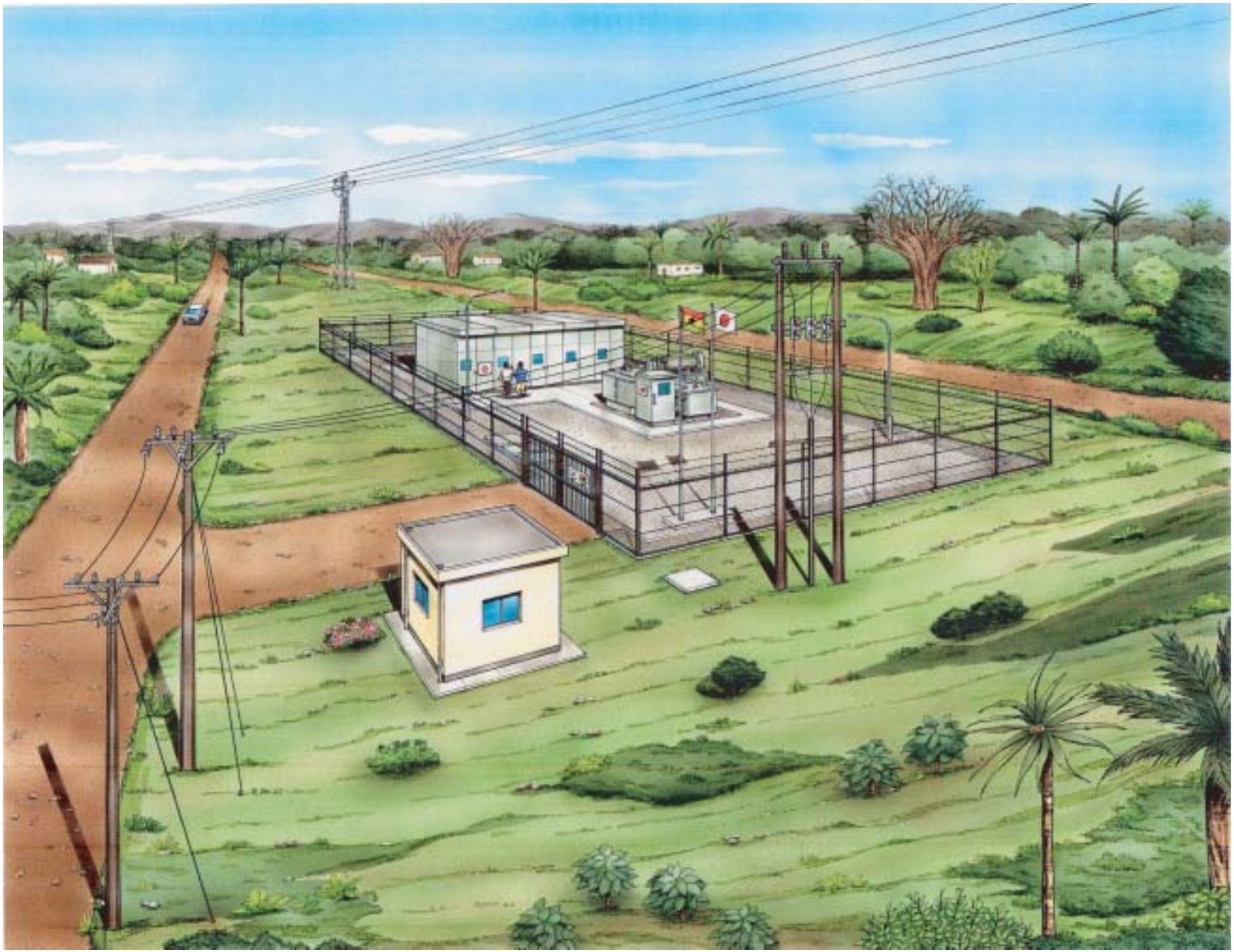
Yachiyo Engineering Co., Ltd.

備考：●印は、我が国の過去の無償資金協力による電化プロジェクト位置を示す。

Remark: Past Rural Electrification Project Sites by Japan's Grant Aid are shown by ● sign.

ガーナ共和国全図
Map of the Republic of Ghana

計画地位置図
Location Map of the Project



The Project for Rural Electrification in the Republic of Ghana

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ABBREVIATIONS

DANIDA	Danish Development Agency
EC	Energy Commission
ECG	Electricity Company of Ghana
E/N	Exchange of Notes
EU	European Union
GDP	Gross Domestic Product
IEC	International Electrotechnical Commission
IMF	International Monetary Fund
IPP	Independent Power Producer
ISO	International Organization for Standards
JCS	Japanese Electrical Wire and Cable Maker's Association Standards
JEAC	Japan Electric Association Code
JEC	Japanese Electrotechnical Committee
JEM	Standards of Japan Electrical Manufacturer's Association
JICA	Japan International Cooperation Agency
JIS	Japanese Industrial Standards
MOE	Ministry of Energy
NED	Northern Electricity Department
NES	National Electrification Scheme
O&M	Operation and Maintenance
OJT	On the Job Training
PRSP	Poverty Reduction Strategy Paper
PURC	Public Utilities Regulatory Commission
SHEP	Self Help Electrification Project
UNDP	United Nations Development Programme
VRA	Volta River Authority

SUMMARY

SUMMARY

The Republic of Ghana (hereinafter referred to as “Ghana”) located in central western Africa between 4° and 11° north latitude, and 3° west and 1° east longitude, faces the Gulf of Guinea to the South, and is bordered by Togo to the east, the Republic of Cote d’Ivoire to the west, and the Republic of Burkina Faso to the north. The population of Ghana is about 18.4 million (FY2000) and has increased at a rate of 2.6% annually over the past 10 years. Its territory is approximately 238,000 km^2 — about 0.6 times of the area of Japan — and is almost completely flat land less than 300 meters above sea level. Its climate is tropical and humid throughout the year with an annual average temperature of about 27C^o to 30C^o. The dry season extends from October to March and the rainy season from April to September. However, annual rainfall varies considerably from region to region, for example, 1000mm in the north and more than 1900mm in the southwest.

Ghana, or Gold Coast as it was known during colonial times, gained its independence in 1957 and became the Republic in 1960. From 1966 however, its economy began to decline due to political instability and short-lived socialist ideology. Then, in the late 1980s the government of Ghana achieved annual economic growth of 5% by promoting economic liberalization in accordance with the structural adjustment policy initiatives of the International Bank for Reconstruction and Development (IBRD) and the International Monetary Fund (IMF). However, poverty in rural areas, accounting for approximately 60% of the total population, is still a major concern. As more and more people from comparatively poor rural areas flock to the cities of the south, slums in urban centers such as the capital Accra continue to grow.

Accordingly, in order to promote sustainable economic growth, poverty reduction, and democratic ideology, long-term comprehensive development guidelines in 1995 entitled “Vision 2020” and in 2002 a final draft of the Ghana Poverty Reduction Strategy Paper (GPRSP) were announced publicly. In addition, the government of Ghana places a high priority on a scheme to supply electricity to rural areas in order to improve the living standard of residents in rural communities and to alleviate poverty. In promoting the project, in 1989 Ghana’s Ministry of Energy (MOE) formulated the National Electrification Scheme (NES) as a goal to supply electricity to all communities with a population of 500 or greater by 2020. Through this scheme, the initiatives of the World Bank, and other donors including Japan, achieved its goal of supplying electricity to all 110 district capitals and other bigger towns by 1998. Furthermore, the Ghanaian government has also promoted the Self Help Electrification Project (SHEP) alongside the NES in order to address the urgent needs of towns and villages who wish to advance year of implementation ahead of the planned date indicated in NES.

However, higher electricity rates (charges) do not cover the increasing cost of supplying electricity due to lower exchange rates or sudden rises in the price of crude oil. In addition, government authorities are concerned about the financial burden and electricity payments left in arrears. Consequently, the electrification rate among households in the metropolitan region (Greater Accra) is approximately 62%; whereas, the average rate in local regions is only about 20%. Therefore, the redress of disparity between urban and rural communities has become an urgent task. Moreover, the Electricity Company of Ghana (ECG), which is implementing an electricity distribution project in six southern regions under the supervision and direction of the Ministry of Energy (MOE), is apprehensive about non-technical losses accounting for 15% of the total distribution loss (approximately 25%) due to surreptitious use of electricity and payments in arrears. Therefore, an appropriate system to collect electricity charges in order to minimize non-technical losses is urgently needed. Under these circumstances, as a part of the NES and after requesting grant aid from Japan in 1998, the Ghanaian government proposed electrification projects for three districts (Nyinahin Area in Ashanti Region, North Assin District in Central Region, and Samreboe District in Western Region) where significant economic growth from agricultural products such as cacao and cassava is anticipated.(hereinafter referred to as “the Project”)

In response to this request, in April 2001 the Government of Japan dispatched the Project Formulation Study Team. As a result, since EU aid for Samreboe District in Western Region had been already allotted the following was confirmed. It was requested that Amansie West District in Ashanti Region become a substitute target district and cost of the beneficial effects in the three target areas would be high in Nyinahin Area, Amansie West District and North Assin District. In due consideration of the report by the said Study Team, JICA dispatched the Basic Design Study Team to Ghana between February 7 to March 16, 2002 to reconfirm the contents of the request and to hold discussions with concerned parties. At the same time, a project survey was carried out and related materials were collected. After returning to Japan, and after carefully examining the need, the socio-economic effects and appropriateness of the Project based on a detailed field survey of the three areas requested, Nyinahin Area and Amansie West District where the beneficial effects of electrification are expected to be high were selected and a basic plan and implementation plan in relation to an optimum plan for both areas were compiled in the Basic Design Study Report. In order to clarify the Basic Design Study Report, JICA dispatched the Basic Design Study Report Explanation Team to Ghana between June 2 and 12, 2002.

In keeping with the goal of the GPRSP which is to “improve the living standards of the poor”, the Project designed with the purpose of carrying out electrification in Nyinahin Area and Amansie West District, important agricultural producing areas in Ashanti Region and the

largest regional population in Ghana, was announced through the National Electrification Scheme (NES) in the interest of "improving the standard of living of local residents and revitalizing local industries". It will provide residents in each target town and village access to electricity for lighting and radio equipment necessary to daily life. At the same time, the living conditions of local residents will be improved through the use of electrical equipment at public welfare facilities such as educational and medical institutions. The scope of target cooperation in the Project includes the procurement and installation of equipment and materials utilizing existing 33kV transmission lines and booster stations, and the procurement of equipment and materials for low voltage distribution lines necessary for electrification in each town and village.

An overview of the Basic Plan based on a field survey and discussions with the Ghanaian side as compiled by the Basic Design Study Team upon its return to Japan is outlined in the following table.

Overview of the Basic Plan

Project Site	**Nyinahin Area in Ashanti Region**	**Amansie West District in Ashanti Region**
Equipment and Materials Procurement and Installation Plan	Procurement and installation of equipment and materials for 33kV transmission lines and booster station (1) Booster station • Installation of new 33kV booster (5MVA) (Bibiani City): 1 set (2) 33kV transmission line • From new booster station (Bibiani City) to Anyinamso Village: approx. 60 km (3) 33kV/433-250V distribution transformer 1) 50kVA: 8 units 2) 100kVA: 16 units 3) 200kVA: 13 units	Procurement and installation of equipment and materials for 33kV transmission line (1) 33kV transmission line • From existing 33kV transmission line terminal (Abrense Village) to Antoakrom Village: approx. 31km (2) 33kV/433-250V distribution transformers 1) 50kVA: 3 units 2) 100kVA: 3 units 3) 200kVA: 8 units
Equipment and Materials Procurement Plan	Procurement of equipment and materials (for 24 towns and villages) (1) LV trunk line (extended): 393.4km (2) Service drop wires for each household (extended length) 1) 10mm^2: 175.0km 2) 16mm^2: 23.2km (3) kWh Meter (with MCCB) 1) Single phase 5(20)A: 3,499 units 2) Single phase 15(60)A: 310 units 3) Three phase 20(80)A: 77 units (4) Spare parts and maintenance tools for procurement of equipment and materials (5) Vehicles for maintenance and control ・3t truck with crane: 1 vehicle	Procurement of equipment and materials (for 10 villages) (1) LV trunk line (extended): 113.6km (2) Service drop wires for each household (extended length) 1) 10mm^2: 70.1km 2) 16mm^2: 9.4km (3) kWh Meter (with MCCB) 1) Single phase 5(20)A: 1,402 units 2) Single phase 15(60)A: 127 units 3) Three phase 20(80)A: 30 units (4) Spare parts and maintenance tools for procurement of equipment and materials (5) Vehicles for maintenance and control ・3t truck with crane: 1 vehicle

In the case of the implementation of the Project with grant aid provided by the Government of Japan, the cost to be borne by the Ghanaian side is approximately ¥98 million. The main component of the work to be conducted by the Ghanaian side will be the installation work of the equipment and materials for LV distribution system which will be procured by the Japanese side. The total length of the Project will be approximately 28.5 months for both Nyinahin Area and Amansie West District, including the detailed design period.

The Ministry of Energy (MOE) will act as the responsible ministry in the implementation of the Project and the Electricity Company of Ghana (ECG) will carry out operation and maintenance of equipment and materials upon its completion as the implementing agency. ECG is a de facto state-run monopoly in southern Ghana with 4,026 employees (FY 2000). Since the specifications for transmission and distribution facilities to be supplied will not exceed the scope of equipment supplied on three previous occasions through Japan's grant aid, ECG is judged to be technically competent to oversee the installation of equipment and materials, and operation and maintenance necessary to the Project. Furthermore, the maintenance and management conditions of Japanese-manufactured transformers are acceptable, so no specific problems associated with the technical competency of either party is anticipated during implementation of the Project.

The following direct effects are expected from the Project.

- Electric power will be newly supplied for nearly 55,000 residents of Nyinahin Area (approx. 39,000 residents) and Amansie West District (approx. 16,000 residents) after implementation of the Project.

- There are 48 schools, 1 hospital and 9 clinics in Nyinahin Area and 20 schools, 2 clinics in Amansie West District to be served electricity through the Project.

- Kerosene for household lighting is expensive (about US$25 annually/household) and is an economic burden for poor residents. However, the average cost of electricity after electrification is estimated to be US$13 annually/household, thus reducing the cost of energy for residents.

Moreover, the following indirect effects are expected.

- From the health and sanitation aspects, the use of electricity will make it possible to introduce medical equipment and refrigerators for pharmaceuticals, improving health and sanitation conditions for local residents.

- From the educational standpoint, by introducing vocational training equipment and lighting in school classrooms, educational activities will be stimulated. Accordingly, the disparity in education standard between rural and urban areas will be alleviated as well as improving the literacy rate in rural areas.

- From the aspect of daily life, a stable supply of electricity will mean electric pumps can be used by local residents to obtain safer, higher quality drinking water. Also it will lead to a reduction of the burden on women and girls presently utilizing hand pumps daily to draw water.

- From the agricultural standpoint, it will be possible to utilize more efficient electric machines which are less costly to run than diesel generators currently being used as a power source for corn mills, promoting modernization and advancements in agriculture and greater agricultural production.

If the target areas are electrified through the Project the major effects mentioned above can be expected. At the same time, it will contribute extensively to improving the basic living conditions of residents, confirming the importance of Japan's grant aid for such projects.

Furthermore, in the interest of the Project, Ghana must ensure that the responsibilities, such as the installation of low voltage distribution facilities, tree clearing on roads alongside transmission and distribution lines, tax exemption and customs clearance are carried out to completion.

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CHAPTER 1

BACKGROUND OF THE PROJECT

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BACKGROUND OF THE PROJECT

Since the late 1980's, the Government of Ghana has achieved about 5% economic growth annually by promoting a policy of economic liberalization in accordance with a structural adjustment policy first introduced in 1983. However, the industrial structure is greatly dependent on agriculture and underground mining resources (gold, aluminium and diamonds), so its economy, which relies greatly on international market prices for imports and exports, remains unstable. Furthermore, with approximately 60% of the total population earning less than US$1 per day and still faced with extreme poverty, and cash crop production in difficulty particularly in the northern savannah, slums in major urban areas such as the capital Accra continue to grow due to an outflow of the population to these areas. Consequently, disparity between the living standards of rural and urban areas has become a serious social concern.

Therefore, in order to reduce poverty in the early stage and ensure sustainable economic growth for the future, Ghana is endeavouring to expand its social infrastructure, including the electricity sector, and social resources development in areas such as education and medical services. Above all, the government is counting on its rural electrification project as one way to redress regional disparity between urban and rural areas. Accordingly, by promoting the National Electrification Scheme (NES) and the Self Help Electrification Project (SHEP) formulated in 1989, the final goal is the electrification of all towns and villages with a population of 500 or more by 2020. However, the average electrification rate of rural households in Ghana is extremely low at about 20%, which has become a major hindrance toward social development.

Under these circumstances, the Government of Ghana has selected three areas for electrification (Nyinahin Area in Ashanti Region, North Assin District in Central Region, and Samreboe District in Western Region) where economic growth from agriculture (such as cacao and cassava) is expected as a part of the NES and Japan's grant aid requested in 1998 for the purpose of improving transmission and distribution networks. (hereinafter referred to as "the Project")

In response to this request, in April 2001 the Government of Japan introduced the Project Formulation Study. As a result, since aid from the EU for Samreboe District in Western Region has been already allotted, the following was confirmed. It was requested that Amansie West District in Ashanti Region become a substitute target district and cost of the beneficial effects in the three target areas would be high in Nyinahin Area, Amansie West District and

North Assin District. The Basic Design Study was implemented based on these results. Although Nyinahin Area and Amansie West District will benefit significantly from electrification, since project target sites in North Assin District in Central Region are dispersed over four regions and the beneficial effects are relatively low compared with the other two areas, through discussions it was agreed that these sites would not be included in the Project.

CHAPTER 2

CONTENTS OF THE PROJECT

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CONTENTS OF THE PROJECT

2-1 Basic Concept of the Project

Despite annual economic growth of about 5% since the late 1980s through economic liberalization in accordance with the structural adjustment policy initiatives of the World Bank and IMF, more than 30% of Ghana's GDP remains dependent on agriculture, forestry and fisheries, so that poverty in rural communities is still a serious concern. Furthermore, since a further decline in economic performance, social conditions including extensive poverty in rural areas, and a lagging social infrastructure is expected, the Government of Ghana is placing a high priority on the electrification project as a means of redressing the disparity between urban and rural areas through direct application of the Ghana Poverty Reduction Strategy Paper (GPRSP) and formulation of "Vision 2020" as a national development plan.

To promote the rural electrification project, in 1989 the National Electrification Scheme (NES) was formulated with the goal of supplying a stable supply of electricity to all communities of 500 residents or more by 2020. Accordingly, the Ministry of Energy (MOE) in Ghana is moving ahead with its plan to supply electricity to preferred un-electrified areas and important commercial centers of prime investment potential, and is currently promoting electrification in rural core cities and important agricultural producing regions. In addition, the Self Help Electrification Project (SHEP) was introduced in response to urgent requests of towns and villages omitted from the NES. Through the initiatives of local residents electrification projects are being planned. However, due to a shortfall in foreign aid and a household electrification rate in rural communities of only about 20%, economic disparity and living standards between urban and rural areas continues to pose a major problem.

Under the supervision and guidance of MOE, a distribution project is being implemented in six southern regions in Ghana including the Project sites. The Electricity Company of Ghana (ECG), the agency in charge of operation and maintenance of the Project is apprehensive about total distribution loss (approximately 25%) and non-technical loss such as the surreptitious use of electricity (approximately 60% of total distribution loss) and electricity payments in arrears. As one step toward management improvement, ECG is promoting the collection of appropriate electric charges by reducing the non-technical distribution loss, particularly through the eradication of surreptitious use of electricity.

Through these steps, the goal is to contribute to “improving the living standards of the poor” which is the aim of GPRSP, and contribute to “improving the living standards of rural residents and revitalizing local industries” as declared in the NES. To accomplish these goals, existing 33kV transmission lines are being branched and extended. The Project is designed to improve distribution networks in Nyinahin Area and Amansie West District which are important agricultural production areas in Ashanti Region, and the most densely populated area yet to be electrified in Ghana.

By ensuring a stable supply of electricity as an important part of the social infrastructure of relevant areas, improvements to the social economy and local standard of living are expected. Faced with these conditions, Japanese assistance was requested in the supply and installation of equipment and materials for 33kV transmission lines, low voltage distribution equipment and materials, and distribution equipment and materials such as kWh meters for each household.

2-2 Basic Design of the Requested Japanese Assistance

2-2-1 Design Policy

2-2-1-1 Basic Concept

In the Project, the scope of the requested Japanese assistance is the procurement and installation of equipment and materials for new 33kV transmission lines to extend existing 33kV transmission lines to the Project sites, and procurement of low voltage equipment and materials necessary for electrification in each town and village.

In addition, to deal with voltage drops expected in five years due to power demand, a booster station is to be constructed at the starting point of the above-mentioned new 33kV transmission lines.

2-2-1-2 Natural Conditions

(1) Temperature

The temperature at the Project sites is constant 20C^{o} to 33C^{o} throughout the year with the hottest month being March and the coolest August. Humidity is over 85% year round, so it is hot and stuffy.

Since the booster station for the Project will be outdoor closed-type distribution panels, the structures should be able to maintain a normal operating temperature, protect the distribution panels from the outside air temperature and direct sunlight, and prevent any disruption in operation and maintenance. In particular, humidity within a closed distribution panel is major concern. In order to prevent dew condensation caused by a drop in temperature, the introduction of space heaters should be examined.

(2) Rainfall and lightening damage

Average monthly rainfall during the rainy season (April to September) is approximately 206mm and there are occasional thunderstorms. Therefore, in order to prevent any disruption in operation and maintenance, the booster station should be installed with proper water drainage.

In addition, since the number of annual thunderstorms exceeds 100 days at the Project sites, sufficient protection from direct lightning strikes or incoming surges from transmission lines should be installed.

2-2-1-3 Social Conditions

Since the social infrastructure of towns and villages along the new 33kV transmission line routes in Nyinahin Area and Amansie West District is still insufficient, accommodation for Japanese engineers is unavailable. Accordingly, a plan is being implemented to secure safe accommodations for the Project work period and to supply communication devices to ensure contact in case of an emergency.

It is important to note that Project sites are located near the second largest city in Ghana, Kumasi, located only three and a half hours from Accra by car. The city has many accommodation facilities where foreigners can stay for extended periods of time and restaurants, etc. In addition, medical facilities and telephones have been improved. Cellular phones can be used in Kumasi City and Bibiani City where a booster station is scheduled to be installed. However, pick-pocketing and other types of robbery are common in some areas, so caution should be taken at night and the use of cellular phones is recommended.

2-2-1-4 Construction and Procurement Conditions

In larger cities such as Accra and Kumasi, the construction industry is flourishing. Many new commercial office buildings are being built by only a handful of general contractors, including electric firms. So work conditions are favourable. However, in rural areas of the

Project sites, since the infrastructure has fallen behind and implementing conditions are bad, when formulating a construction plan, adequate consideration should be given to the method of transporting construction equipment and materials from both cities, and the environment in which a field office is to be built.

In addition, concerning equipment and materials to be supplied in the Project, booster stations and transmission line equipment have already been introduced at existing facilities. Therefore, since the Ghanaian side is accustomed with the operation and maintenance of Japanese-manufactured equipment and materials, such equipment will be mainly examined. For the purpose of promoting local industries, wire and other construction materials should be supplied on-site whenever possible.

2-2-1-5 Effective Use of Local Construction Companies

Since the on-site procurement of workers, transportation vehicles, construction work equipment and materials within Ghana is relatively easy, the foundation work for 33kV transmission lines and the booster station will utilize local contractors effectively.

2-2-1-6 Operation and Maintenance Capacity of Project Implementation Body

In addition to the rural electrification project through Japan's grant aid, Ghana has had a lot of experience in similar-scale projects. Since the specifications of all distribution equipment to be improved and supplied under the Project is expected not to exceed the scope of equipment supplied through previous grant aid, ECG in taking charge of operation and maintenance of the Project is deemed to have the competency to install, operate and maintain existing transmission equipment.

However, the existing transmission and booster stations are in very poor condition. For example, there is a shortage of spare parts and superannuation associated with ECG's financial difficulties and nonconformity. In addition, engineers and operators at ECG may not fully understand the latest booster station technology. Therefore adequate consideration should be given to ensure that facilities to be constructed will be more effectively and efficiently operated through on-the-job training by Japanese engineers on the operation and maintenance of relevant facilities during the construction period of the Project. Moreover, by providing the necessary spare parts, testing devices, maintenance tools, manuals on operation and maintenance, proposals on the operation and maintenance system after commencement of regular operations can be received.

2-2-1-7 Scope of Facilities and Equipment and Grades

In due consideration of the various conditions mentioned above, the scope of procurement and installation of equipment and materials and technical level will be formulated as the following basic policy:

(1) Scope of facility, equipment and materials

Since the target year of the Project is regarded to be five years after completion, the minimum but necessary configuration and specifications of equipment for construction of 33kV transmission lines, booster stations, and the procurement of equipment and materials for low voltage distribution lines to supply stable electricity to local residents of Nyinahin Area and Amansie West District, which are the Project sites and important agricultural producing areas of Ashanti Region, and social/public facilities such as hospitals and schools.

To ensure an economical design, the specifications of equipment and materials will be based on international standards. The types of equipment and materials will be kept to a minimum in order to facilitate the compatibility of equipment and materials as much as possible.

(2) Grades

In designing the 33kV transmission lines, the booster station and low voltage distribution lines to be installed or procured under the Project, special attention will be given not to exceed the technical capacity of ECG which will be responsible for the operation and maintenance of these facilities after completion of the Project. In particular, as distribution equipment and materials for each household such as low voltage distribution lines and watt-hour meters (kWh meters) will be installed by the Ghanaian side, the equipment and materials used for such work should comply with the technical capacity of Ghana.

2-2-1-8 Procurement and Construction Period

The electrification project will be implemented for two areas in Ashanti Region, Nyinahin Area and Amansie West District. However, it is preferable to bisect the construction schedule, and start with Nyinahin Area as shown below in taking the situation of each area, urgency, project scale and effectiveness into consideration.

・Nyinahin Area in Ashanti Region

・Amansie West District in Ashanti Region

2-2-2 Basic Plan (Equipment Plan)

2-2-2-1 Preconditions

(1) Power Demand Forecast for Project Sites

The demand for electricity at the Project sites in 2009, five years after commencement of the electricity supply service, was forecasted in the following manner based on the population and the number of current households, basic consumption units and annual increase.

1) Calculation of Population and Number of Households

Although Ghana conducted a census in 2000, the results have yet to be publicly announced. Consequently, based on the materials presented by MOE, the number of potential electricity users under the Project was compiled after confirming through interviews, a questionnaire survey and field investigation at the Project sites. Furthermore, with respect to the number of general households, a lot of compound housing exists in rural areas, implying than two “households” constitutes a single “house”. Therefore, even though an average “household” is considered a single unit in power demand forecasting at the Project sites, the total number of households was determined by average household size (5.1 persons in Ashanti Region) and village population. For public facilities other than general households, power demand forecast for schools, hospitals and well pumps, etc. at night (18:00 to 22:00) during peak utilization time was taken into consideration.

2) Increase Rate in Maximum Demand

The increase in rate of maximum demand in the Rural Electrification Project may be examined by classifying the increase in power demand per single demand unit by ① the entry rate of consumers to be connected to the electricity system after commencement of the electricity supply service, ② the growth rate of population at the Project sites, and ③ the increase in power demand per single demand unit mainly resulting from the income effects after electrification.

① Entry Rate of Consumers

In rural electrification projects (NES and SHEP) in Ghana, when applying for electricity supply service 18 months or more after electrification in the Project

sites, a consumer is required to pay 1 million Ghana Cedi per single household (approximately ¥1,900; for three phase 2 million Cedi) for a connection charge (for an application for connection within 18 months, 5,000 Ghana Cedi or approximately ¥80). In the past results of rural electrification projects, the majority of consumers applied for electricity supply services immediately after the implementation of electrification. Accordingly, even in power demand forecasting for the Project, it is estimated that all consumers (100%) will have applied for electricity supply service by the year 2004, which will mark the commencement of common use of facilities. As a matter of fact, the entry rate of consumers was underestimated in the past rural electrification projects in Ghana. Consequently, problems such as overloading of pole-mounted transformers less than a year from the start of construction and shortages in the procurement of kWh meters have been pointed out.

② Natural Increase Rate in Population at the Project Sites

The average annual increase in population of 3.4% in the Ashanti Region (2000 statistics) will be applied to an increase in households associated with the population increase from the present (2002) to the commencement of the electricity supply service (2004) of the Project.

③ Increase Rate of Power Demand After the Commencement of Electricity Supply Service

The increase rate of maximum demand (results of long-term demand forecasts up to 2010) at existing substations to which transmission lines are scheduled to be connected during the Project will be applied to the increase rate of power demand after the commencement of electricity supply service in the following manner.

- Nyinahin Area (existing Asawinso Substation) Annual rate 7.4%
- Amansie West District (existing Kumasi Substation) Annual rate 6.5%

3) Units of Maximum Power Demand Forecast

Units of maximum power demand forecast are as follows. Although the said units are based on those adopted in previous ECG rural electrification projects, almost all similar units are adopted in rural electrification projects of other African nations and are therefore judged to be appropriate. The average demand rate will be 85%.

• Unit demand electricity (including demand and diversity factors):

General households	:	250W/household
Schools	:	1kW/building
Hospitals (Nyinahin)	:	30kW/building
Clinics	:	5kW/building
Other public facilities	:	2kW/building

In addition, as for the breakdown of the above-mentioned load for general house from the results of an interview survey at the Project sites, the following electrical appliances necessary to daily life and feasible for use immediately after electrification are anticipated.

• Breakdown for electrical appliances of general housing (per single household)

Lighting	: 80W	(40W×2)
Iron	: 750W	
Radio cassette recorder	: 20W	
Total	850W	

If 40% of the demand factor and 1.3 of the diversity factor are applied to the above total load, general housing load becomes 250W/household (850W×0.4÷1.3=261 250W).

4) Power Demand Forecast for the Target Year

As the target year of the Project is regarded to be 5 years after completion of construction works for transmission and distribution system in Nyinahin Area, various conditions are taken into consideration in power demand forecasting for the Project sites, such as the number of households for electrification at the Project sites and the increase rate of power demand as shown in Table 2.2.2.1-1 and Table 2.2.2.1-2. In these tables, since the maximum power demand for the Project site is estimated to be approximately 4.6MW 5 years from the commencement of joint utilization, by the end of 2001 approximately 0.3% of the generated output is required. Therefore, on a national scale the Project is considered to have an extremely small impact on the balance of electricity demand-supply.

Table 2.2.2.1-1 Results of Estimated Electricity Demand in Nyinahin Area

(Unit: kW)

Increase rate in population → Increase rate in electricity demand →

No.	Site Name	Population	Number of Households	Public Welfare Facilities, etc.				2001	2002 (+3.4%)	2003 (+3.4%)	2004 (+3.4%) Commencement of common use of facilities	2005 (+7.4%)	2006 (+7.4%)	2007 (+7.4%)	2008 (+7.4%)	2009 (+7.4%) Target year	2010 (+7.4%)	2011 (+7.4%)
				Schools	Hospitals	Clinics	Others											
1	Aduenkyia	150	29	0		1		12.4	12.8	13.2	13.7	14.7	15.8	16.9	18.2	19.5	21.0	22.5
2	Nzema Nkwanta	200	39	1				10.8	11.2	11.6	11.9	12.8	13.8	14.8	15.9	17.1	18.3	19.7
3	Kuffuor Camp	890	175	2				45.6	47.2	48.8	50.4	54.2	58.2	62.5	67.1	72.1	77.4	83.1
4	Antwi-Adjei Nkwanta	600	118	1				30.4	31.4	32.5	33.6	36.1	38.8	41.7	44.7	48.0	51.6	55.4
5	Kensakrom	637	125	1				32.2	33.3	34.5	35.6	38.3	41.1	44.1	47.4	50.9	54.7	58.7
6	Akotaa	896	176	1			2	48.9	50.6	52.3	54.1	58.1	62.4	67.0	72.0	77.3	83.0	89.1
7	Takoradi	900	176	1		1	2	54.1	56.0	57.9	59.8	64.3	69.0	74.1	79.6	85.5	91.8	98.6
8	Barniekrom	430	84	1		1		27.1	28.0	29.0	29.9	32.2	34.5	37.1	39.8	42.8	45.9	49.3
9	Otaakrom	1,680	329	4		1	4	99.4	102.7	106.2	109.8	118.0	126.7	136.1	146.1	157.0	168.6	181.0
10	Akurabuokrom	520	102	1		1	3	37.5	38.8	40.1	41.4	44.5	47.8	51.3	55.1	59.2	63.6	68.3
11	Nyinahin	22,890	4,488	15	1		10	1,187.1	1,227.4	1,269.2	1,312.3	1,409.4	1,513.7	1,625.7	1,746.0	1,875.2	2,314.0	2,163.0
12	Akentensu-Nkwanta	115	23	1		1		11.6	12.0	12.4	12.9	13.8	14.8	15.9	17.1	18.4	19.7	21.2
13	Yawbarimakrom	441	86	0				21.6	22.4	23.1	23.9	25.7	27.6	29.6	31.8	34.2	36.7	39.4
14	Agogosu	899	176	3				47.1	48.7	50.3	52.0	55.9	60.0	64.5	69.2	74.4	79.9	85.8
15	Adiembra	2,179	427	3			7	123.8	128.0	132.4	136.9	147.0	157.9	169.6	182.1	195.6	210.1	225.6
16	Adumasa/Amangoase	500	98	1			1	27.5	28.4	29.4	30.4	32.7	35.1	37.7	40.5	43.5	46.7	50.1
17	Mmmoframfadwen	200	39	0			2	13.8	14.3	14.8	15.3	16.4	17.6	18.9	20.3	21.8	23.4	25.2
18	Nkrumah	750	147	3		1	3	50.8	52.5	54.3	56.1	60.3	64.7	69.5	74.7	80.2	86.1	92.5
19	Betinko	891	175	1			5	54.7	56.5	58.5	60.4	64.9	69.7	74.9	80.4	86.4	92.8	99.6
20	Kwanfinfi	732	144	4			3	45.9	47.4	49.1	50.7	54.5	58.5	62.8	67.5	72.5	77.8	83.6
21	Kentenkyiren	160	31			1		12.8	13.3	13.7	14.2	15.2	16.4	17.6	18.9	20.3	21.8	23.4
22	Serebuoso	894	175	1				44.8	46.3	47.9	49.6	53.2	57.2	61.4	65.9	70.8	76.0	81.7
23	Anyinamso No. 2	1,000	196	2			3	57.0	59.0	61.0	63.0	67.7	72.7	78.1	83.9	90.1	96.7	103.9
24	Anyinamso No. 1	500	98	1		1	3	36.5	37.8	39.0	40.4	43.3	46.6	50.0	53.7	57.7	61.9	66.5
	Total	39,054	7,656	48	1	9	48	2,133	2,206	2,281	2,359	2,533	2,720	2,922	3,138	3,370	3,620	3,887

[Basic Indexes]

Increase rate of maximum electricity: 1.074

Number of average constituent members per single household (Ashanti Region): 5.1

Increase rate of population 1.034

Maximum electricity consumption per single consumer (kW)

For households: 0.25

For schools: 1.0

For hospitals: 30

For clinics: 5.0

Others (such as wells): 2.0

Number of households = population ÷ (Average number of constituent members per single household: 5.1)

Table 2.2.2.1-2 Results of Estimated Electricity Demand in Amansie West District

(Unit: kW)

Increase rate in population → Increase rate in electricity demand →

No.	Site Name	Population	Number of Households	Public Welfare Facilities, etc.				2001	2002 (+3.4%)	2003 (+3.4%)	2004 (+3.4%) Commencement of common use of facilities	2005 (+7.4%)	2006 (+7.4%)	2007 (+7.4%)	2008 (+7.4%)	2009 (+7.4%) Target year	2010 (+7.4%)	2011 (+7.4%)
				Schools	Hospitals	Clinics	Others											
1	Nsiana/Besease	2,000	392	2				100.0	103.4	107.0	110.6	117.8	125.4	133.6	142.3	151.5	161.4	171.9
2	Antoakrom	4,000	784	2		1	7	217.1	224.5	232.1	240.0	255.6	272.2	289.9	308.7	328.8	350.2	372.9
3	Yawhemenkrom	202	40					9.9	10.2	10.6	10.9	11.7	12.4	13.2	14.1	15.0	16.0	17.0
4	Omanadwaree/Safokrom	300	59	3			3	23.7	24.5	25.3	26.2	27.9	29.7	31.7	33.7	35.9	38.2	40.7
5	Akropong	1,250	245	2				63.3	65.4	67.7	70.0	74.5	79.3	84.5	90.0	95.8	102.1	108.7
6	Dome	1,200	235	1			3	65.8	68.1	70.4	72.8	77.5	82.5	87.9	93.6	99.7	106.2	113.1
7	Abodon	1,200	235	2				60.8	62.9	65.0	67.2	71.6	76.3	81.2	86.5	92.1	98.1	104.5
8	Mim	2,500	490	2				124.5	128.8	133.2	137.7	146.6	156.2	166.3	177.1	188.6	200.9	214.0
9	Min Dome	550	108	3				30.0	31.0	32.0	33.1	35.3	37.6	40.0	42.6	45.4	48.3	51.5
10	Ankam	2,500	490	3		1		130.5	135.0	139.6	144.3	153.7	163.7	174.3	185.7	197.7	210.6	224.3
	Total	15,702	3,078	20	0	2	13	826	854	883	913	972	1,035	1,103	1,174	1,251	1,332	1,419

[Basic Indexes]

Increase rate of maximum electricity: 1.065

Number of average constituent members per single household (Ashanti Region): 5.1

Increase rate of population 1.034

Maximum electricity consumption per single consumer (kW)

For households: 0.25

For schools: 1.0

For hospitals: 30

For clinics: 5.0

Others (such as wells): 2.0

Number of households = population ÷ (Average number of constituent members per single household: 5.1)

(2) Electrical System Plan

1) 33kV Transmission System Plan

By using 120 mm^2 All Aluminum Conductor (AAC) for all new33kV transmission lines for the Project, the lines will be extended from the existing 33kV transmission system by branching or extending the terminal to each target site through the method shown in Table 2.2.2.1-3, and electricity for low voltage consumers will be distributed by a pole mounted transformer (33kV/433-250V). Since 33kV transmission lines involve a radial system with no connection spot, by installing a load break switches on-route taking line extension and load capacity into account, the electrical system design should make it easy to locate fault points and to interrupt the system. Furthermore, if lateral lines exceed 3km from the trunk line, though it is normal procedure to install a breaker fuses at branch points, lateral lines at the Project sites will be extended from 200 to 600m making such fuses unsuitable. Therefore, only primary breakers will be installed on the primary side of pole-mounted transformer.

Table 2.2.2.1-3 Connection Method between New and Existing 33kV Transmission Lines

Project Site	Connection Method
Nyinahin Area	T branch by raising underground cable from new booster station to the existing 33kV transmission tower (No. Bibiani-115). ECG implements final connection between cable terminal and transmission lines.
Amansie West District	Extension from the dead-end of the existing transmission line (Abrense Village)

2) Measures for Voltage Drops

Measures for voltage drop are indispensable because one of the Project sites, Nyinahin Area, is far from a key power substation (161/33kV), and many consumers receive electricity from existing transmission lines. Material 8 and Table 2.2.2.1-4 gives the results of voltage drops at each Project site as analyzed by computers by applying the results of power demand forecast mentioned in the preceding paragraph (1). Incidentally, no particular problems were encountered in Amansie West District.

Table 2.2.2.1-4 Voltage Drop Calculation Results

Project Site	Line End Voltage (kV)	Voltage Drop (kV) (Potential drop rate in rated voltage)
Nyinahin	24.7	-8.3 (-25.0%)
Amansie West	31.0	-2 (-6.1%)

Note: Tolerance for voltage fluctuation of 33kV system based on ECG standards is 7.5%.

As illustrated in the above table, the potential drop rate of transmission line end in Nyinahin Area is 25.0%, greatly exceeding the 7.5% tolerance for voltage fluctuation, so measures for voltage drops should be taken. Extension of transmission lines from the existing 33kV transmission tower (No. Bibinani-115) through T branch is planned during the Project. However, steps will be taken to maintain voltage at the transmission end within appropriate limits by installing automatic voltage regulators (boosters: 5MVA) at relevant locations and by setting the voltage fluctuation of on-load tap changers (OLTC) within +0～-30% (13 taps). Incidentally, although the automatic voltage regulators (boosters) are an outdoor variety, in the interests of facility and safety, 33kV vacuum circuit breakers (VCB) and low voltage circuit breakers and protective devices should be installed in each cubicle.

2-2-2-2 General Plan

The flowing conditions have been set to determine the scope and specifications of facilities, equipment and materials for the Project.

(1) Climatic and Site Conditions

	Nyinahin Area	Amansie West District
(a) Altitude: Site average	230m	202m
(b) Climate: Dry season	October to March	October to March
Rainy season	April to September	April to September
(c) Ambient temperature: Maximum	33ºC	33ºC
(d) Relative humidity: Maximum	98%	98%
(e) Rainfall: Monthly average	124mm	124mm
Rainy season maximum	206mm	206mm
(f) Foggy days annually	30 days	30 days

(g) Average wind direction			
	Northwest	September to March	September to March
	Southeast	April to August	April to August
(h) Gust		120km/h	120km/h
(i) Thunderstorm days annually (IKL)		113 days	113 days
(j) Seismic factor		Not considered	Not considered
(k) Long-term allowable bearing capacity		10ton/m^2	10ton/m^2

(2) Electrical System

① Transmission voltage:	33kV, three phase/three wire (maximum: 36kV)		
② Distribution voltage:	433-250V, three phase/four wire (maximum: 438-253V)		
③ Frequency:	50Hz		
④ Interrupting capacity:	33kVsystem	25kA (1sec)	
	Low voltage system	6kA (1sec)	
⑤ Earthing system:	33kV system	effectively earthed system	
	Low voltage system	effectively earthed system	
⑥ Basic insulation level: (BIL)	33kV system	BIL 170kV	(Commercial frequency withstand voltage of 70kV)
	Low voltage system	–	(Commercial frequency withstand voltage of 3kV)
⑦ Creepage distance:	20mm/kV		
⑧ Line capacity (per cable):	33kVtransmission line	15MVA	
	Low voltage distribution line	50kVA	
⑨ Color coding:	IEC standards (red, yellow, blue, black)		
⑩ Insulator quality and color:	Ceramic, brown		
⑪ Protection class and plate thickness for switchgear panels			

Table 2.2.2.2-1 Protection Class and Plate Thickness for Switchgear Panels

Plate Type	Plate Thickness	Protection Class
Outdoor use	Not less than 2.3mm	IP43

⑫ Safety factor

Table 2.2.2.2-2 Safety Factor for Transmission and Distribution Equipment and Materials

Target Item	Safety Factor
Supports, support foundations	2.0
Conductors, cross arm	2.5
Insulators, connectors and terminals	2.0

Note: Based on ECG standards

⑬ Clearance for transmission and distribution conductors

Table 2.2.2.2-3 Clearance for Transmission and Distribution Conductors

Item	33kVTransmission Line	LV Distribution Line
1. Minimum Clearance		
1) Phase to phase	370mm	300mm
2) Phase to earth	320mm	200mm
2. Minimum Height		
1) Road Crossing	7.0m	6.0m
2) Roadside	6.0m	5.0m
3. Clearance for Joint Pole H & LV lines	1,500mm	

Note: Based on ECG standards

(3) Applicable Codes/Standards and Units

In regard to the Project design, as shown below, taking into consideration the conformity with existing facilities in Ghana, relevant international standards such as IEC and ISO and Japanese standards will be applied to major equipment and facilities. As for procurement of equipment and electrical works, the latest ECG standards revised in 1998 which are currently valid in ECG will be applied. The International System of Units (SI) will be used.

① International Electrotechnical Commission (IEC): Applied to main equipment functions of electrical goods in general

② International Standardization Organization (ISO): Applied to evaluate performance of industrial products in general

③ Japanese Industrial Standard (JIS): Applied to industrial products in general

④ Japanese Electrotechnical Commission (JEC): Applied to industrial products in general

⑤ Standards of Japan Electrical Manufacturer's Association (JEM): Same as above

⑥ Japanese Electrical Wire and Cable Marker's Association Standards (JCS): Applied to electrical wire and cables

⑦ Other related Japanese and international standards: Applied to electrical work in general

⑧ Standards of Ghana Standard Board: Same as above

⑨ Electricity Company of Ghana (ECG) Standards: Same as above

⑩ British Standards (BS): Applied to part of electrical equipment

(4) Overview of the Basic Plan

Overview of the Basic Plan of the Project based on the above-mentioned basic design concept described (Refer to 2-2-1) is shown in Table 2.2.2.2-4.

Table 2.2.2.2-4 Overview of the Basic Plan

Project Site	Nyinahin in Ashanti Region	Amansie West in Ashanti Region
Equipment and Materials Procurement and Installation Plan	Procurement and installation of equipment and materials for 33kV transmission lines and booster station (1) Booster station • Installation of new 33kV booster (5MVA) (Bibiani City): 1 set (2) 33kV transmission line • From new booster station (Bibiani City) to Anyinamso Village: approx. 60 km (3) 33kV/433-250V distribution transformer 1) 50kVA: 8 units 2) 100kVA: 16 units 3) 200kVA: 13 units	Procurement and installation of equipment and materials for 33kV transmission line (1) 33kV transmission line • From existing 33kV transmission line terminal (Abrense Village) to Antoakrom Village: approx. 31km (2) 33kV/433-250V distribution transformers 1) 50kVA: 3 units 2) 100kVA: 3 units 3) 200kVA: 8 units
Equipment and Materials Procurement Plan	Procurement of equipment and materials (for 24 towns and villages) (1) LV trunk line (extended): 393.4km (2) Service drop wires for each household (extended length) 1) $10mm^2$: 175.0km 2) $16mm^2$: 23.2km (3) kWh Meter (with MCCB) 1) Single phase 5(20)A: 3,499 units 2) Single phase 15(60)A: 310 units 3) Three phase 20(80)A: 77 units (4) Spare parts and maintenance tools for procurement of equipment and materials (5) Vehicles for maintenance and control ・ 3t truck with crane: 1 vehicle	Procurement of equipment and materials (for 10 villages) (1) LVtrunk line (extended): 113.6km (2) Service drop wires for each household (extended length) 1) $10mm^2$: 70.1km 2) $16mm^2$: 9.4km (3) kWh Meter (with MCCB) 1) Single phase 5(20)A: 1,402 units 2) Single phase 15(60)A: 127 units 3) Three phase 20(80)A: 30 units (4) Spare parts and maintenance tools for procurement of equipment and materials (5) Vehicles for maintenance and control ・ 3t truck with crane: 1 vehicle

2-2-2-3 Equipment and Materials Plan

(1) Booster Station Construction Plan

Construction for a booster station to be implemented by the Japanese side under the Project is a site at Nyinahin Area in Ashanti Region. The contents of equipment and materials to be utilized in the construction work will be selected in accordance with the following basic issues and outline of facilities.

1) Basic Issues

In selecting facilities, equipment and materials necessary to constructing a booster station, the facility and safety of operation and maintenance of facilities after the completion of the relevant facilities should be taken into account. At the same time, in order to promote a shorter installation period for these facilities, equipment and materials, and extra-high voltage switchgear panels for outdoor will be adopted. Substation facilities will be monitored and operated on-site by ECG maintenance personnel. Therefore, appropriate outdoor lighting facilities for monitoring will be installed.

Meteorological conditions at the Project sites should be taken into account in the design of automatic voltage regulators (boosters) and extra-high voltage switchgear panels. In addition, in order to protect substation facilities from lightning, lightning arrestors should be installed at receiving and distributing sections at 33kV substation facilities. However, overhead grounding wires will not be applied to 33kV transmission lines in accordance with ECG standards. Furthermore, in due consideration of the safety of local residents, fences around the booster station will be installed.

2) Overview of Automatic Voltage Regulator (Booster)

① Capacity

The capacity of Automatic Voltage Regulator (Voltage Booster) to be installed at a booster station under the Project will be 5,000kVA after taking into account the power factor of the load based on the maximum power demand forecast in the target year of the Project.

② Function

In due consideration of the lowest voltage (28kV) ever recorded at existing transmission terminal substations, the voltage adjusting limit of the automatic voltage regulator will be 33kV＋0% to－30%（2.5%×13 taps）.

3) Overview of 33kV Incoming Facilities

The power source is derived from the existing 33kV transmission tower (No. Bibiani-115) via underground power cables. In order to protect equipment from lightning, lightning arrestors and circuit breakers (vacuum circuit breaker, 36kV, 600A, 25kA) will be installed. In addition, in order to supply power in the facilities, and to monitor and protect the system, station transformer, disconnecting switches, measuring instruments and protective relays will also be installed and housed in cubicles. A re-closing system will be adopted for 33kV distribution feeders to improve the reliability of the power supply. Circuit breakers on the distribution side will throw automatically a second time even in a minor grounding fault. The switchboard is a 5-sided cubicle configuration housing equipment as shown in Table 2.2.2.3-1 and Table 2.2.2.3-10.

ECG is responsible for confirming the intensity of the existing transmission tower and work to connect cables to transmission lines.

Table 2.2.2.3-1 Outline of Configuration of Switchboard

No.	Cubicle Name	Equipment
1	Auxiliary Panel	Station transformer (25kVA), AC power supply panel, DC power supply panel
2	Circuit Breaker Panel	Vacuum circuit breaker, lightning arrestor, current transformer, auto re-closing relay, ground relay, voltage detector
3	Isolator Panel (by-pass)	36kV by-pass isolator
4	Isolator Panel	36kV isolator, voltmeters, ampere meters, integrating watt-meters, maximum demand Watt-meter (effective), maximum demand Var-meter (reactive)
5	Voltage Transformer & Current Transformer Panel for measuring instruments	Current transformers, voltage transformers, voltage control relay, under voltage relay

4) Overview of Station (House) Facilities

Auxiliary facilities inside the booster station (such as outdoor lighting) to be constructed under the Project should be of energy saving type. In addition, to deal with a leakage of insulation oil in a booster emergency, the environmental consequences should be fully taken into account by installing an oil separation tank at the station. Appropriate drainage facility should also be installed. The specifications for high voltage cables between transformers and existing transmission facilities are as follows.

Table 2.2.2.3-2 Specifications for Inside Booster Station and Connecting Cables for Existing Transmission Lines

Interval	Cable Specifications	Remarks
Between 33kVtransmission lines and 33kV switchboards	19/33kV, Aluminum conductor, XLPE insulation, PVC sheath, 240mm^2 (single core) with armor	To meet a line capacity of 15MVA
Between 33kV distribution switch panels and booster (primary)	Same as above	Same as above
Between booster (secondary) and 33kV distribution switch panels	Same as above	Same as above
Between 33kV distribution panels (feeder panels) and 33kV take-off pole	Same as above	Same as above

Note: XLPE: cross-linked polyethylene insulated wire; PVC: polyvinylchloride

(2) 33kV Transmission Line Plan

In procuring and installing equipment and materials for 33kV transmission lines to be implemented by the Japanese side during the Project, the design will be based on the following basic issues and overview of equipment and materials.

1) Basic Issues

Facilities will be designed in accordance with ECG standards. In addition, whenever possible specifications for equipment and materials to be procured by the Japanese side should be compatible with existing equipment owned or utilized by ECG in order to ensure unified management.

2) Overview of the Transmission Line Plan

① Selection of Routes

After examining a preliminarily Route Map of Transmission Line and Map, routes for each transmission line were determined through actual field surveys together with ECG engineers and by confirming obstructions, target objects and special local conditions. In particular, since 98% of all transmission lines parallel major trunk roads in Nyinahin Area, in order to prevent faults from broken wires caused by large-scale vehicles, spot crossings will be kept to a minimum. The basic routes are shown in Attachment TL-01.

② Selection of Spans

Although the line size will determine the pole span, the line tensile load and intensity of electric poles, etc., wooden poles based on ECG standards and manufactured in Ghana will generally be used. Accordingly, the design will incorporate the spans in accordance with ECG standards.

- Standard span for 33kV electric pole: 100m
- Standard interval arrangement for intermediate connecting poles: every 10 spans

③ Type of Conductors for Overhead Transmission Lines

With respect to the specifications for conductors used for overhead transmission lines in the Project, All Aluminum Conductor (AAC) of the following size will be adopted based on ECG standards.

- 33kV transmission line: AAC 120mm^2

With respect to the quantity of conductors for overhead transmission lines, the quantity of equipment and materials plan will be determined by multiplying the plane distance (design quantity) to be forecasted through the drawings by 1.13 of the margin rate (line sag length: 3%, construction supplementing quantity rate: 10%). Incidentally, the quantities for installation of 33kV transmission lines as a Japanese responsibility will be determined by multiplying the design quantity by 1.03 of the margin rate. Accordingly, the quantity of conductors for overhead transmission lines to be constructed or procured in the Project is shown in Table 2.2.2.3-3.

④ Type and Shape of Electric Poles

Wooden poles manufactured in Ghana complying with the latest standard of ECG (year1998) will be generally used. The length of wooden poles will be 11m as a 33kV class standard.

Since the target construction sites are not susceptible to salt damage, standard 20mm/kV will be adopted for surface leakage distance of pin insulators and suspension insulators used for 33kV transmission lines. In addition, iron L-shape galvanized cross arms for installing insulators under ECG standard specifications will be adopted.

Types, application and quantity of electric poles are shown in Table 2.2.2.3-4.

⑤ Capacity and Quantity of Distribution Transformers

(a) Selection of Capacity and Quantity

Distribution transformers will be installed in order to lower the voltage of 33kV transmission lines to a low distribution voltage for connecting to individual consumers at the Project sites. Assuming that the maximum power demand for the target year will be satisfied, the capacity and number of transformers to be procured in the Project will be selected from ECG standard transformer capacity. In addition, distribution transformers should be located as near as possible to areas with high load density, in particular public facilities such as schools and hospitals with a large power load in order to ensure a supply of high quality electricity.

Incidentally, in order to maintain the voltage fluctuation for low voltage consumers within ±7.5%, distribution transformers to be procured for the Project will have ±2.5% and ±5% taps (switching over during no voltage) on the primary side while the secondary (low voltage) side will use a three phase, four-wire system for economic and distribution efficiency.

The capacity and number of distribution transformers at the Project sites are shown in Table 2.2.2.3-5. Total number of distribution transformers to be procured for the Project is 51.

(b) Installation Method

All distribution transformers will be installed in a pole-mounted method on the H-type electric poles.

Table 2.2.2.3-3 Quantity of Conductors for 33kV Transmission Lines

Item		Nyinahin	Amansie West	Total
33kV transmission lines [AAC 120mm^2]	① Transmission line extension	60km	31km	91km
	② Design quantity（three phase、①×3）	180km	93km	273km
	③ Quantity for procurement plan（②×1.13）	204km	106km	310km
	④ Quantity for installation work plan（②×1.03）	186km	96km	282km

Table 2.2.2.3-4 Quantity by Type of Poles for 33kV Transmission Lines

Pole Type	Application	Pole Material	Pole length (m)	⑤ Number of poles per set（unit）	⑥ Procurement rate by application ※	Nyinahin			Amansie West			Number of sets Number of poles in ( )
						⑦ Standard span: 100m		Subtotal (Set)	⑦ Standard span: 100m		Subtotal (Set)	
						⑧Design quantity {(①/⑦)x⑥}	⑨ Supplementary quantity (⑧x0.1)		⑧Design quantity {(①/⑦)x⑥}	⑨Supplementary quantity (⑧x0.1)		
A	Intermediate pole (0–4º)	Wood	11	1	65%	357	36	393	186	19	205	598 (598)
B	Light angle pole (4–20º)			1	13%	72	8	80	38	4	42	122 (122)
C	Medium angle pole (20–60º)			1	8%	44	5	49	23	3	26	75 (75)
D	Heavy angle pole (less 60 – 90º)			2	4%	22	3	25	12	2	14	39 (78)
E	Section pole (90º)			1	Actual quantity	1	1	2	1	1	2	4 (4)
F	Double anchor pole			1	10%	55	6	61	29	3	32	93 (93)
G	T-off pole			1	Actual quantity	5	1	6	3	1	4	10 (10)
H	Terminal pole			2	Actual quantity	6	1	7	4	1	5	12 (24)
I	LBS pole			2	Actual quantity	3	1	4	2	1	3	7 (14)
J1	Transformer pole（50kVA）			2	Actual quantity	8	1	9	3	1	4	13 (26)
J2	Transformer pole (100,200kVA)			2	Actual quantity	29	3	32	11	1	12	44 (88)
Total						602	66	668	312	37	349	1,017 (1,132)

Remarks: ※The design quantity was calculated by applying the relevant rate to the actual total quantity of E, G, H, I, J by pole type subtracted from the total number of sets.

Table 2.2.2.3-5 Capacity and the Number of Distribution Transformers for Procurement

(Unit: Unit)

Area	No.	Site Name Requested for Electrification	Number of Distribution Transformers to be Procured		
			50kVA	100kVA	200kVA
Nyinahin	1	Adienkyia	1		
	2	Nzema Nkawanta	1		
	3	Kuffuor Camp		1	
	4	Antwi-Adjei Nkawanta		1	
	5	Kensakrom		1	
	6	Akota		1	
	7	Takoradi		1	
	8	Barniekrom		1	
	9	Otaakrom		2	
	10	Akurabuokrom		1	
	11	Nyinahin			11
	12	Akentensu-Nkwanta	1		
	13	Yawbarimakrom	1		
	14	Agogosu		1	
	15	Adiembra		1	1
	16	Adumasa/Amangoase	2		
	17	Mmmoframfadwen	1		
	18	Nkrumah		1	
	19	Betinko		1	
	20	Kwanfinfi		1	
	21	Kentenkyiren	1		
	22	Serebuoso		1	
	23	Anynamso No.2			1
	24	Anynamso No.1		1	
	Subtotal		8	16	13
Amansie West	1	Nsiana/Besease			1
	2	Antoakrom			2
	3	Yawhemenkrom	1		
	4	Omandwaree/Safokrom	2		
	5	Akropong			1
	6	Dome			1
	7	Abodon			1
	8	Mim		1	1
	9	Mim Dome		1	
	10	Ankam		1	1
	Subtotal		3	3	8
Total for Both Areas			11	19	21
Grand Total for Both Areas			51		

⑥ Installation of Load Break Switches

For maintenance and inspection of 33kV transmission lines at the Project sites, load break switches to allow a break in the current will be installed at an appropriate distance for long-distant lines, at the connecting points and junctions for the existing 33kV transmission lines. The locations subject to installation are as follows.

(a) 33kV Transmission Lines in Nyinahin

- In Kensakrom Village (No. 5) on route to Akotaa Village (No. 6)
- Near the National Hospital in Nyinahin Town (No. 11) on route to Akentensu-Nkwanta (No. 12)
- Immediately after the T-off branch point in Nkumah village (No. 18) on route to Betinko village (No. 19)

(b) 33kV Transmission Lines in Amansie West

- Connecting point with existing 33kV transmission lines in Abrense
- T-off branch point in Antoakrom Village (No. 2) (west line side)

⑦ Installation of Primary Cutout Switches

Primary cutout switches will be installed in order to protect circuits from overloading transformers and short-circuit faults, and to open the primary circuits for maintenance of distribution transformers to be procured for the Project.

⑧ Installation of Lightning Arrestors

Lightning arrestors will be installed on the 33kV side to protect the distribution transformers from lightening strikes.

(3) Low Voltage Distribution Lines Plan

In procuring equipment and materials for 433-250V low voltage distribution lines to be implemented by the Japanese side, the design will be based on the following basic issues and overview of equipment and materials.

1) Basic Issues

The equipment should be designed in accordance with relevant ECG standards, and whenever possible the specifications of equipment and materials to be procured by the

Japanese side should be compatible with existing equipment owned or used by ECG for uniformity of management.

2) Overview of Distribution Lines Plan

① Selection of Routes

As a result of examining the Route Map of Transmission Line and Map preliminarily prepared, routes for distribution lines per town and village (34 locations in total by combining both districts) were decided by actually conducting a field survey together with ECG engineers and by confirming density of houses, obstructions, target objects and special features of local natural conditions.

② Selection of Spans

Although pole spans will be determined by the conductor size, its tensile load and intensity of electric pole, etc., wooden poles based on ECG standards and manufactured in Ghana will be used in principle. Accordingly, the design will be made by adopting the spans in accordance with ECG standards.

- Standard span of low voltage distribution poles: 46m
- Standard interval arrangement of intermediate connecting poles: every 10 spans

③ Type and Shape of Electric Poles

Wooden poles manufactured in Ghana conforming to ECG standards will be used in principle. The length of wooden poles will be 9m for low voltage class.

Standard 20mm/kV will be adopted for the surface leakage distance of shackle insulators and spool insulators used for 33kV transmission lines. The type of clamps for insulators should conform to the relevant ECG standard specifications and hot-dip galvanized mild steel will be adopted for materials.

The rate by application of each electric pole as grounds for determining the type and quantity of equipment and materials for electric poles is shown in Table 2.2.2.3-6.

Table 2.2.2.3-6 Rate of Procurement of Various Low Voltage Electric Poles

Low Voltage Electric Pole Type	Rate of Procurement by Application
1. Intermediate pole (straight route)	40%
2. T-off pole	30%
(A type)	(10%)
(B type)	(10%)
(C type)	(5%)
(D type)	(5%)
3. Terminal pole	30%

④ Type of Conductors for Low Voltage Overhead Distribution Lines

With respect to the specifications and ECG standards of conductors used for overhead distribution lines, All Aluminum Conductor (AAC) and the following size will be adopted.

• Low voltage distribution lines: AAC 50mm^2

With respect to the quantity of conductors for low voltage overhead distribution lines, the quantity of equipment and materials plan will be calculated by multiplying the plane distance (design quantity) to be forecasted on the drawings by 1.13 of the margin rate (line sag length: 3%, construction supplementing quantity rate: 10%). Incidentally, the quantity of installation work plan of low voltage distribution lines to be procured by the Japanese side will be calculated by multiplying the design quantity by 1.03 of the margin rate. Accordingly, the quantity of conductors for LV overhead distribution lines to be procured by the Japanese side and the quantity of LV poles to be procured by the Ghanaian side are shown in Table 2.2.2.3-7.

Table 2.2.2.3-7 Quantity of Equipment and Materials for Low Voltage Distribution System (Low Voltage Distribution Lines, Electric Poles)

(1/2)

No.	Town and Village Requested for Electrification	Number of Units of Distribution Transformers by Capacity (Unit)			① Length of LV Distribution Lines (m)	② Quantity of LV Distribution Lines Procurement Plan (AAC50mm^2) (m) (①×1.13 ×4 lines)	Breakdown of Quantity by Application of LV Distribution Poles (Unit) *1						
		50kVA	100kVA	200kVA			LV Intermediate Pole	LV T-off Pole A	LV T-off Pole B	LV T-off Pole C	LV T-off Pole D	LV Terminal Pole	Total
	Nyinahin District												
1	Adienkyia	1			506	2,290	5	1	0	1	0	5	12
2	Nzema Nkwanta	1			1,472	6,660	11	5	0	3	1	13	33
3	Kuffuor Camp		1		2,944	13,310	26	11	1	5	1	18	62
4	Antwi-Adjei Nkwanta		1		2,300	10,400	20	12	0	1	2	15	50
5	Kensakrom		1		2,898	13,100	25	15	0	2	0	21	63
6	Akotaa		1		2,760	12,480	23	7	0	7	1	23	61
7	Takoradi		1		1,886	8,530	7	9	0	2	8	15	41
8	Barniekrom		1		1,702	7,700	21	3	0	3	0	11	38
9	Otaakrom		2		6,578	29,740	53	31	2	6	4	47	143
10	Akurabuokrom		1		2,806	12,690	16	14	0	4	3	24	61
11	Nyinahin *2			11	36,320	164,170	316	79	79	40	40	237	791
12	Akentensu-Nkwanta	1			736	3,330	5	1	0	2	2	7	17
13	Yawbarimakrom	1			1,104	4,990	4	6	0	1	3	10	24
14	Agogosu		1		3,220	14,560	27	12	1	2	9	20	71
15	Adiembra		1	1	2,392	10,820	25	5	0	3	3	12	48
16	Adumasa/Amangoase	2			3,036	13,730	37	6	3	1	5	14	66
17	Mmmoframfadwen	1			782	3,540	4	3	0	1	1	8	17
18	Nkrumah		1		1,610	7,280	15	7	0	0	4	9	35
19	Betinko		1		2,116	9,570	11	9	0	2	8	16	46
20	Kwanfinfi		1		1,426	6,450	12	5	0	1	4	10	32
21	Kentenkyiren	1			1,564	7,070	6	10	0	0	4	14	34
22	Serebuoso		1		1,748	7,900	12	6	0	2	5	13	38
23	Anyinamso No. 2			1	3,588	16,220	27	15	0	5	4	27	78
24	Anyinamso No. 1		1		1,518	6,870	13	5	0	1	4	10	33
	Subtotal	8	16	13	87,012	393,400	721 (72)	277 (28)	86 (9)	95 (10)	116 (12)	599 (60)	1,894 (191)

No.	Town and Village Requested for Electrification	Number of Units of Distribution Transformers by Capacity (Unit)			① Length of LV Distribution Lines (m)	② Quantity of LV Distribution Lines Procurement Plan (AAC50mm^2) (m) (①×1.13 ×4 lines)	Breakdown of Quantity by Application of LV Distribution Poles (Unit) *1						
		50kVA	100kVA	200kVA			LV Intermediate Pole	LV T-off Pole A	LV T-off Pole B	LV T-off Pole C	LV T-off Pole D	LV Terminal Pole	Total
	Amansie West District												
1	Amansie West District			1	3,220	14,560	14	14	1	6	5	30	70
2	Nsiana/Besease			2	5,014	22,670	55	15	2	2	11	23	108
3	Antoakrom	1			966	4,370	6	4	0	2	0	9	21
4	Yawhemenkrom	2			2,760	12,480	18	16	0	1	4	21	60
5	Omanadwaree/Safokrom			1	2,346	10,610	11	12	0	1	9	18	51
6	Akropong			1	1,012	4,580	4	0	0	5	2	11	22
7	Dome			1	2,668	12,060	29	9	0	1	6	13	58
8	Abodon		1	1	3,082	13,930	15	15	0	2	12	23	67
9	Mim		1		1,058	4,790	8	4	0	0	3	8	23
10	Mim Dome		1	1	2,990	13,520	30	6	0	6	3	21	66
	Subtotal	3	3	8	25,116	113,570	190 (19)	95 (10)	3 (1)	26 (3)	55 (6)	177 (18)	546 (57)
	Total	**11**	**19**	**21**	**112,128**	**506,970**	**911 (91)**	**372 (38)**	**89 (10)**	**121 (13)**	**171 (18)**	**776 (78)**	**2,440 (248)**

(Remarks) *1: The quantity of low voltage distribution poles in the Table is the design quantity (excluding reserve quantity), and numerical figures in ( ) indicate the reserve quantity based on the design quantity.
The Ghanaian side is responsible for procuring low voltage distribution poles; whereas, the Japanese side is responsible for procuring materials for electric poles.
*2: The quantity of low voltage distribution poles in Nyinahin Town was calculated by the rate in the preceding Table 2.2.2.3-6.

⑤ Equipment and Materials for Service Drop Wires for Low Voltage Consumers

(a) Quantity of Procurement of Equipment and Materials for Consumers Service Drop Wires

The quantity of service drop wires, watt-hour meters and molded case circuit breakers (MCCB) to be procured as equipment and materials used for consumers service connections shall be 50% of the total households in the target areas.

(b) Type and Standard Length of Each Service Drop Wire

The following two types will be adopted for conductors used for each service drop wire in the Project according to contract capacity.

- 600V PVC insulated, copper conductor, 10mm^2 and 16mm^2

The standard length of service drop wire to each household will be 25 m/phase.

(c) Molded Case Circuit Breakers (MCCB) for Incoming Service Drop Wires

In order to protect customer wiring from current surges, molded case circuit breakers (MCCB) for incoming service drop wires will be installed near the first anchor point of service drop wire. The said breaker should be installed in the primary side of a watt-hour meter in accordance with relevant ECG standards. Three types of breakers will be adopted, 2P5A、2P10A、3P30A depending on the consumer's contract capacity.

(d) Watt-hour Meters (kWh Meters)

In accordance with ECG standards, 3 types of watt-hour meters will be adopted and used depending on the consumer's contract capacity.

- Single phase 5(20)A: For general consumers (small load)
- Single phase 15(60)A: For general consumers (medium load)
- Three phase 20(80)A: For commercial and industrial load consumers

(e) Percentage of Procurement of Equipment and Materials

The combining method and procurement rate of equipment and materials for service drop wires for each low voltage consumer are shown in Table 2.2.2.3-8.

Table 2.2.2.3-8 Combining Method of Equipment and Materials for Service Drop Wires for Low Voltage Consumers

Item	A Type	B Type	C Type
Service Drop Wire Size	10 mm^2	16mm^2	16mm^2
Type of kWh Meter	Single phase 5 (20)A	Single phase 15 (60)A	Three phase 20 (80)A
Capacity of Molded Case Circuit Breaker (MCCB)	2P 5A	2P 10A	3P 30A
Procurement Rate	90%	8%	2%

Remark: The procurement rate is based on the actual results of the ECG Rural Electrification Project.

Furthermore, the quantity of equipment and materials for service drop wires for low voltage customers mentioned earlier in (a) to (d) is shown in Table 2.2.2.3-9.

Table 2.2.2.3-9 Quantity of Equipment and Materials for Low Voltage Distribution System (kWh Meters and Service Drop Wires)

No.	Project Site Name	A: Number of all households subject to consumption (general houses and public facilities) (Household)	B: 50% of the total number of households (A×50%) (Household)	C: kWh Meter (Unit) [Procurement rate ※]			D: Molded case circuit breakers (Unit)			E: Low voltage service drop wire 〔m〕					F: Clamp for service drop wires (bolted type) (pieces)				
				① Single phase 5(20)A	② Single phase 15(60)A	③ Three phase 20(80)A	MCCB 2P5A (applied to ①)	MCCB 2P10A (applied to ②)	MCCB 3P30A (applied to ③)	Service drop wire 10mm² (25m×2) (applied to ①)	Service drop wire 16mm² (25m×2) (applied to ②)	Service drop wire 16mm² (25m×4) (applied to ③)	Service drop wire 10mm²	Service drop wire 16mm²	Aluminum wire 50mm²/ copper wire 10mm² (2 pieces for each household , applied to ①)	Aluminum wire 50mm² copper wire 16mm² (2 pieces for each household, applied to ②)	Aluminum wire 50mm²/ copper wire 16mm² (4 pieces for each household, applied to ③)	Aluminum wire 50mm²/ copper wire 10mm²	Aluminum wire 50mm²/ copper wire 16mm²
				[90%]	[8%]	[2%]							Total	Total				Total	Total
	Nyinahin																		
1	Adienkyia	30	15	14	1	0	14	1	0	700	50	0	**700**	**50**	28	2	0	**28**	**2**
2	Nzema Nkwanta	40	20	18	2	0	18	2	0	900	100	0	**900**	**100**	36	4	0	**36**	**4**
3	Kuffuor Camp	177	89	80	7	2	80	7	2	4,000	350	200	**4,000**	**550**	160	14	8	**160**	**22**
4	Antwi-Adjei Nkwanta	119	60	54	5	1	54	5	1	2,700	250	100	**2,700**	**350**	108	10	4	**108**	**14**
5	Kensakrom	126	63	57	5	1	57	5	1	2,850	250	100	**2,850**	**350**	114	10	4	**114**	**14**
6	Akotaa	179	90	81	7	2	81	7	2	4,050	350	200	**4,050**	**550**	162	14	8	**162**	**22**
7	Takoradi	180	90	81	7	2	81	7	2	4,050	350	200	**4,050**	**550**	162	14	8	**162**	**22**
8	Barniekrom	86	43	39	3	1	39	3	1	1,950	150	100	**1,950**	**250**	78	6	4	**78**	**10**
9	Otaakrom	338	169	152	14	3	152	14	3	7,600	700	300	**7,600**	**1,000**	304	28	12	**304**	**40**
10	Akurabuokrom	107	54	49	4	1	49	4	1	2,450	200	100	**2,450**	**300**	98	8	4	**98**	**12**
11	Nyinahin	4,514	2,257	2,031	181	45	2,031	181	45	101,550	9,050	4,500	**101,550**	**13,550**	4062	362	180	**4062**	**542**
12	Akentensu-Nkwanta	25	13	12	1	0	12	1	0	600	50	0	**600**	**50**	24	2	0	**24**	**2**
13	Yawbarimakrom	86	43	39	3	1	39	3	1	1,950	150	100	**1,950**	**250**	78	6	4	**78**	**10**
14	Agogosu	179	90	81	7	2	81	7	2	4,050	350	200	**4,050**	**550**	162	14	8	**162**	**22**
15	Adiembra	437	219	197	18	4	197	18	4	9,850	900	400	**9,850**	**1,300**	394	36	16	**394**	**52**
16	Adumasa/Amangoase	100	50	45	4	1	45	4	1	2,250	200	100	**2,250**	**300**	90	8	4	**90**	**12**
17	Mmmoframfadwen	41	21	19	2	0	19	2	0	950	100	0	**950**	**100**	38	4	0	**38**	**4**
18	Nkrumah	154	77	69	6	2	69	6	2	3,450	300	200	**3,450**	**500**	138	12	8	**138**	**20**
19	Betinko	181	91	82	7	2	82	7	2	4,100	350	200	**4,100**	**550**	164	14	8	**164**	**22**
20	Kwanfinfi	151	76	68	6	2	68	6	2	3,400	300	200	**3,400**	**500**	136	12	8	**136**	**20**
21	Kentenkyiren	32	16	14	1	0	14	1	0	700	50	0	**700**	**50**	28	2	0	**28**	**2**
22	Serebuoso	176	88	79	7	2	79	7	2	3,950	350	200	**3,950**	**550**	158	14	8	**158**	**22**
23	Anyinamso No. 2	201	101	91	8	2	91	8	2	4,550	400	200	**4,550**	**600**	182	16	8	**182**	**24**
24	Anyinamso No. 1	103	52	47	4	1	47	4	1	2,350	200	100	**2,350**	**300**	94	8	4	**94**	**12**
	Subtotal	7,762	3,887	3,499	310	77	3,499	310	77	174,950	15,500	7,700	174,950	23,200	6,998	620	308	6,998	928

Remarks: ※ The procurement rate of watt-hour meters is 50% of the number of total households in the target areas (private homes and public facilities).

No.	Project Site Name	A: Number of all households subject to consumption (general houses and public facilities) (Household)	B: 50% of the total number of households (A×50%) (Household)	C: kWh Meter (Unit) [Procurement rate ※]			D: Molded case circuit breakers (Unit)			E: Low voltage service drop wire (m)					F: Clamp for service drop wires (bolted type) (pieces)				
				① Single phase 5(20)A	② Single phase 15(60)A	③ Three phase 20(80)A	MCCB 2P5A (applied to ①)	MCCB 2P10A (applied to ②)	MCCB 3P30A (applied to ③)	Service drop wire 10mm² (25m×2) (applied to ①)	Service drop wire 16mm² (25m×2) (applied to ②)	Service drop wire 16mm² (25m×4) (applied to ③)	Service drop wire 10mm²	Service drop wire 16mm²	Aluminum wire 50mm²/ copper wire 10mm² (2 pieces for each household , applied to ①)	Aluminum wire 50mm² copper wire 16mm² (2 pieces for each household, applied to ②)	Aluminum wire 50mm²/ copper wire 16mm² (4 pieces for each household, applied to ③)	Aluminum wire 50mm²/ copper wire 10mm²	Aluminum wire 50mm²/ copper wire 16mm²
				[90%]	[8%]	[2%]							Total	Total				Total	Total
	Amansie West District																		
1	Nsiana/Besease	394	197	178	16	4	178	16	4	8,900	800	400	**8,900**	**1,200**	356	32	16	**356**	**48**
2	Antoakrom	794	397	357	32	8	357	32	8	17,850	1,600	800	**17,850**	**2,400**	714	64	32	**714**	**96**
3	Yawhemenkrom	40	20	18	2	0	18	2	0	900	100	0	**900**	**100**	36	4	0	**36**	**4**
4	Omanadwaree/Safokrom	65	33	30	3	1	30	3	1	1,500	150	100	**1,500**	**250**	60	6	4	**60**	**10**
5	Akropong	247	124	112	10	2	112	10	2	5,600	500	200	**5,600**	**700**	224	20	8	**224**	**28**
6	Dome	239	120	108	10	2	108	10	2	5,400	500	200	**5,400**	**700**	216	20	8	**216**	**28**
7	Abodon	237	119	107	10	2	107	10	2	5,350	500	200	**5,350**	**700**	214	20	8	**214**	**28**
8	Mim	492	246	221	20	5	221	20	5	11,050	1,000	500	**11,050**	**1,500**	442	40	20	**442**	**60**
9	Mim Dome	111	56	49	4	1	49	4	1	2,450	200	100	**2,450**	**300**	98	8	4	**98**	**12**
10	Ankam	494	247	222	20	5	222	20	5	11,100	1,000	500	**11,100**	**1,500**	444	40	20	**444**	**60**
	Subtotal	3,113	1,559	1,402	127	30	1,402	127	30	70,100	6,350	3,000	**70,100**	**9,350**	2,804	254	120	**2,804**	**374**
	Total	**10,875**	**5,446**	**4,901**	**437**	**107**	**4,901**	**437**	**107**	**245,050**	**21,850**	**10,700**	**245,050**	**32,550**	**9,802**	**874**	**428**	**9,802**	**1,302**

Remarks: ※ The procurement rate of watt-hour meters is 50% of the number of total households in the target areas (private homes and public facilities).

(4) Basic Specifications of Equipment and Materials

Equipment and materials used in the above-mentioned (1) to (3) are shown in Tables 2.2.2.3-10 to 2.2.2.3-12.

Table 2.2.2.3-10 Booster Station Plan (Procurement and Installation)

No.	Item/Equipment	Specifications	Quantity
B-1	Construction of Facilities on Premises	(Area: 12m×24m (288㎡))	
	(1) Gravel		1 set
	(2) Fence and gate door		1 set
	(3) Cable pits and rainwater drainage, etc.		1 set
	(3) Earthing mesh		1 set
	(4) Outdoor lighting	(Mercury lamps: 2)	1 set
	(5) Foundations of equipment		1 set
	(6) Oil/water separator		1 set
B-2	33kV automatic voltage regulator		1 unit
	(1) Applicable standard	IEC	
	(2) Type	Outdoor type, oil-filled self cooling (ONAN) on load tap changer (OLTC)	
	(3) Number of phases	Three phase	
	(4) Rated frequency	50Hz	
	(5) Rated primary voltage	33kV	
	(6) Rated secondary voltage	33kV	
	(7) Rated capacity	5,000kVA	
	(8) Tap voltage	33kV +0% to -30%	
	(9) Number of taps	13 taps	
	(10) Step voltage	2.5%	
B-3	33kV switchgear panels		5 cubicles
	(1) Panels		
	1) Type	Outdoor use metal-enclosed cubicle type with space heater	
	2) IP level	IP43	
	(2) Circuit breaker (CB)		
	1) Type	Vacuum circuit breaker (VCB), draw-out type	
	2) Rating	3 phase, 36kV, 600A, 25kA	
	(3) Current transformer (CT) for measuring instruments		
	1) Type	Indoor use, molded type	
	2) Rating	100/5A	
	(4) Voltage transformers (VT) for measuring instruments		
	1) Type	Indoor use, molded type	
	2) Rating	3 phase, 33kV/$\sqrt{3}$／110/$\sqrt{3}$／110/3V	
	(5) Earthing switch (ES)		
	1) Type	Manual operation	
	(6) Disconnecting Switch (DS)		
	1) Type	Motor operation	
	2) Rating	3 phase, 36kV, 600A	
	(7) Primary cutouts	36kV	
	(8) 33kV station transformer		
	1) Type	Indoor oil-filled type	
	2) Rating	3 phase, 50Hz, 33kV/415-240V, 25kVA	

No.	Item/Equipment	Specifications	Quantity
	(9) Auto voltage regulator	5kVA	
	(10) DC power supply unit		
	1) Battery cell		
	(a) Type	Nickel cadmium alkaline	
	(b) Rating	10AH, DC125V	
	2) Battery charger		
	(a) Type	10A, DC125V	
	3) Circuit breaker		
	(a) Type	Molded type	
	(b) Rating	3-poles, 660V	
	(11) Measuring instruments and control devices	Ampere meter, voltage meter, voltage detector, control switch, fault indicator, demand meter (effective, ineffective), kWh meter	
	(12) Protective relay	- Over current relay - Earth fault relay - Voltage regulating relay - Under voltage relay - Auto re-closing relay	
	(13) Lightning arrestor		
	1) Applicable standard	IEC or equivalent	
	2) Type	Indoor use, gapless metal oxide type	
	3) Nominal voltage	33kV	
	4) Rated voltage	36kV	
B-4	33kV power cable and accessories		
	(1) 33kV power cable		450m
	1) Applicable standard	IEC or equivalent	(3 phase)
	2) Type	19/33kV XLPE insulation, Aluminum conductor with armored cable PVC sheath、	
	3) Size	$240mm^2$	
	(2) Cable termination materials		
	1) Type	- Outdoor use, heat shrinkable type (line side)	7 sets
		- Outdoor use, heat shrinkable type (Tr, SWGR)	
B-5	Low voltage power and control cables		
	(1) Low voltage power cables		1 set
	1) Applicable standard	IEC or equivalent	
	2) Type	600V XLPE insulation, PVC sheath, copper cable	
	(2) Control cables		1 set
	1) Reference standard	IEC or equivalent	
	2) Type	600V PVC insulation, copper cable, shielded with copper tape screen	
B-6	Modification on existing 33kV transmission tower (No. Bibiani-115)		
	(1) Station post insulators		6 pieces
	1) Applicable standard	IEC or equivalent	
	2) Type	Porcelain glazed brown	
	3) Nominal system voltage	33kV	
	4) BIL	170kV	
	(2) Cable termination (Heat shrinkable)	Applicable cable: 19/33kV XLPE insulation, Aluminum conductor with armored cable PVC sheath	1 set
	(3) Structures and brackets	Hot-dip galvanized steel	1 set
	(4) Other fittings	- Cable bracket: non-ferrous material	
		- Protective pile for cable: PVC pipe with armor	1 set
B-7	33kV take-off poles		
	(1) Electric poles		2 units
	1) Material	Wood	
	2) Length	11m	

No.	Item/Equipment	Specifications	Quantity
	3) Type	Terminal pole (H type)	
	(2) Lightning arrestor		3 units
	1) Applicable standard	IEC or equivalent	(1 unit/phase)
	2) Type	Outdoor use, gapless metal oxide type	
	3) Nominal system voltage	33kV	
	4) Rated voltage	36kV	
	(3) Other fittings	- Stay wire assembly	1 set
		- Cable support: non-ferrous materials	
		- Protective pile for cable riser: :PVC pipe	
B-8	Earthing materials		
	(1) Earthing wire	38～100mm^2 bare copper wire or equivalent	1 set
	(2) Earthing rod	Copper clad core rod, lead terminal, D14mm× L1,500mm or equivalent	1 set

Table 2.2.2.3-11 33kV Transmission Lines Plan (Procurement and Installation)

No.	Item/Equipment	Specifications	Quantity	
			Nyinahin	Amansie West
H-1	33kV Transmission line poles			
	(1) Material	Wood		
	(2) Length	11m		
	(3) Type			
	1) A: Intermediate pole	Line angle : 0– 4 deg.	393 sets	205 sets
	2) B: Light angle pole	〃 : 4–20 deg.	80 sets	42 sets
	3) C: Medium angle pole	〃 : 20-60 deg.	49 sets	26 sets
	4) D: Heavy angle pole	〃 : 60-90 deg. H type	25 sets	14 sets
	5) E: Cross pole	〃 : 90 deg.	2 sets	2 sets
	6) F: Section pole	Installed in every ten (10) spans	61 sets	32 sets
	7) G: T-off pole		6 sets	4 sets
	8) H: Terminal pole	H type	7 sets	5 sets
	9) I: LBS pole	H type	4 sets	3 sets
	10) J1: Transformer pole	H type: 50kVA	9 sets	4 sets
	11) J2: Transformer pole	H type: 100,200kVA	32 sets	12 sets
H-2	33kV overhead line conductor		204 km	106 km
	(1) Applicable standard	IEC or equivalent		
	(2) Type	Hard drawn, All Aluminum Conductor (AAC)		
	(3) Size	120mm^2		
H-3	Insulators			
	(1) Pin insulator		1 set	1 set
	1) Applicable standard	IEC or equivalent		
	2) Type	Porcelain glazed brown		
	3) Nominal system voltage	33kV		
	4) BIL	170kV		
	(2) Strain insulator		1 set	1 set
	1) Applicable standard	IEC or equivalent		
	2) Type	Porcelain glazed brown, disc type		
	3) Nominal system voltage	33kV		
	4) Creepage distance	320mm / disc		
	5) Dry impulse withstand	110kV		
H-4	Pole fitting materials			
	(1) Cross arm		1 set	1 set
	1) Material	Mild steel		
	2) Coating	Hot-dip galvanized		
	3) Section shape	L-shape		

No.	Item/Equipment	Specifications	Quantity	
			Nyinahin	Amansie West
	(2) Anchor shackle		1 set	1 set
	1) Type	Bolt type		
	2) Material	Steel		
	(3) Ball clevis/ball eye & socket link		1 set	1 set
	1) Material	Ductile iron or steel		
	2) Coating	Hot-dip galvanized		
	(4) Dead end clamp		1 set	1 set
	1) Material	Body: Spheroidal graphite iron casting Holder: Aluminum alloy casting		
	2) Conductor size	120mm^2		
	(5) Stay wire		1 set	1 set
	1) Material	Stranded galvanized steel		
	2) Size	45mm^2 (2.90mm×7) or equivalent		
	(6) Stay insulator		1 set	1 set
	1) Line voltage	33kV		
	2) Material	Porcelain glazed brown		
	(7) Stay plate/anchor		1 set	1 set
	1) Material	Concrete block or steel plate or driving type		
	2) Draw force	6 tons		
	(8) Turnbuckle		1 set	1 set
	1) Material	Mild steel		
	2) Coating	Hot-dip galvanized		
	(9) Kicking block		1 set	1 set
	1) Material	Wood or concrete		
	2) Application	For section poles		
	(10) Indication plates	Danger plate	1 set	1 set
H-5	Load break switches (LBS)		3 units	2 units
	(1) Applicable standard	IEC or equivalent		
	(2) Type	3-poles, 600A, outdoor use, manual operation		
	(3) Nominal system voltage	33kV		
	(4) Rated voltage	36kV		
	(5) BIL	170kV		
H-6	Lightning arrestors		120 units	48 units
	(1) Applicable standard	IEC or equivalent	(1 unit/phase)	(1 unit/phase)
	(2) Type	Outdoor use, gapless metal oxide type		
	(3) Nominal system voltage	33kV		
	(4) Rated voltage	36kV		
H-7	Primary cutout switches		111 units	42 units
	(1) Applicable standard	IEC or equivalent	(1 unit/phase)	(1 unit/phase)
	(2) Type	Outdoor use 100A		
	(3) Nominal system voltage	33kV		
	(4) Rated voltage	36kV		
H-8	Pole mounted transformers			
	(1) Applicable standard	IEC or equivalent		
	(2) Type	Oil immersed, outdoor use		
	(3) Phase	- Three phase three wires (HV side) - Three phase four wires (LV side)		
	(4) Frequency	50Hz		
	(5) Capacity	- 50kVA	8 units	3 units
		- 100kVA	16 units	3 units
		- 200kVA	13 units	8 units
	(6) Rated voltage	33kV/433-250V		

No.	Item/Equipment	Specifications	Quantity	
			Nyinahin	Amansie West
H-9	Earthing materials for LA and transformers			
	(1) Earthing wire	38mm^2 bare copper wire or equivalent	1 set	1 set
	(2) Earthing rod	Copper clad core rod with lead terminal, D14mm×L1, 500mm or equivalent	1 set	1 set
H-10	Transformer primary and secondary materials		1 set	1 set
	(1) Primary			
	1) Primary drop conductor	22mm^2 XLPE insulation, copper wire (PDC)		
	(2) Secondary			
	1) LV cable	70mm^2 XLPE insulation copper cable		
	2) LV fuse cutouts			
	(a) Applicable standard	BS or equivalent		
	(b) Type	Porcelain type		
	(c) Fuse	Cartridge fuses		
H-11	Connector and binding wire for O/H line		1 set	1 set
	(1) Connector			
	1) Type	Bolted type		
	2) Material	Aluminum alloy casting		
	(2) Straight sleeve	AAC 120 mm^2 application		
	(3) Binding wire			
	1) Material	Aluminum		
	2) Size	4.0mm diameter or equivalent		
	(4) Jumper wire			

Table 2.2.2.3-12 Low Voltage Distribution System Plan (Procurement)

No.	Item/Equipment	Specifications	Quantity	
			Nyinahin	Amansie West
L-1	LV overhead line conductor		393.4 km	113.6 km
	(1) Applicable standard	IEC or equivalent		
	(2) Type	Hard drawn, All Aluminum Conductor (AAC)		
	(3) Size	50mm^2		
L-2	Insulator		1 set	1 set
	(1) Shuckle insulator			
	1) Applicable standard	IEC or equivalent		
	2) Type	Porcelain glazed brown		
	3) Wet withstand voltage	3kV		
L-3	Pole fitting materials		1 set	1 set
	(1) Wire supporting clamp assembly			
	1) Material	Mild steel		
	2) Coating	Hot-dip galvanized		
	(2) Stay wire			
	1) Material	Standard galvanized steel		
	2) Size	38mm^2 (2.60mm×7) or equivalent		
	(3) Stay insulator			
	1) Line voltage	425V		
	2) Material	White glazed porcelain, tensile strength 6 tons		
	(4) Stay plate/anchor			
	1) Material	Concrete block or steel plate or driving type		

No.	Item/Equipment	Specifications	Quantity	
			Nyinahin	Amansie West
	2) Draw force	6 tons		
	(5) Turnbuckle			
	1) Material	Mild steel		
	2) Coating	Hot-dip galvanized		
	(6) Indication plates	Danger plate		
L-4	Earthing materials		1 set	1 set
	(1) Earthing wire	22mm^2 PVC insulated copper wire or equivalent		
	(2) Earthing rod	Copper clad core rod with lead terminal, D14mm×L1, 500mm or equivalent		
L-5	Connector and binding wire for LV O/H line		1 set	1 set
	(1) Connector			
	1) Type	Bolted type		
	2) Material	Aluminum alloy casting		
	(2) Straight sleeve	AAC 50 mm^2 application		
	(3) Binding wire			
	1) Material	Aluminum		
	2) Size	4.0mm dia. or equivalent		
	(4) Jumper wire			
L-6	Service drop wires			
	(1) Applicable standard	IEC or equivalent		
	(2) Type	600V PVC insulated stranded copper conductor		
	(3) Size	-10mm^2 (for single phase kWh meter: 5(20)A)	175.0km	70.1km
		-16mm^2 (for single phase kWh meter: 15(60)A and three phase kWh meter: 20(80)A)	23.2km	9.4km
L-7	Insulator for service drop wires		1 set	1 set
	(1) Coach screw insulator	Porcelain glazed brown		
	(2) Spool insulator	Porcelain glazed brown, double groove spool type		
L-8	Fittings for service drop wires		1 set	1 set
	(1) Connector			
	1) Type	Bolted type		
	2) Material	Aluminum alloy casting		
L-9	kWh meter			
	(1) Applicable standard	IEC or equivalent		
	(2) Type	Conventional type		
	(3) Rated current	- Single phase: 5A(20A)	3,499 pieces	1,402pieces
		- Single phase: 15A(60A)	310 pieces	127 pieces
		- Three phase: 20A(80A) * 4-wire type	77 pieces	30 pieces
L-10	Molded case circuit breaker（MCCB）			
	(1) Applicable standard	IEC or equivalent		
	(2) Type	Indoor use, molded type		
	(3) Current rating (Interrupting capacity: Min)	- 2P 5A (7.5kA)	3,499 pieces	1,402pieces
		- 2P 10A (7.5kA)	310 pieces	127 pieces
		- 3P 30A (7.5kA)	77 pieces	30 pieces
	(4) Rated voltage	400/230V		

2-2-3 Basic Design Drawings

The basic design drawings for the Project are as follows.

(1) 33kV Transmission Line Route and System Drawings

Drawing No.	Title	Scale
TL-01	Rout Map of 33kVTransmission Line for the project [Nyinahin and Amansie West District]	As shown in the drawing
TL-02-1	33kV Transmission Line System Drawing [Nyinahin (1/2)]	―
TL-02-2	33kV Transmission Line System Drawing [Nyinahin (2/2)]	―
TL-03-1	33kV Transmission Line System Drawing [Amansie West (1/2)]	―
TL-03-2	33kV Transmission Line System Drawint [Amansie West (2/2)]	―

(2) Bibiani Booster Station

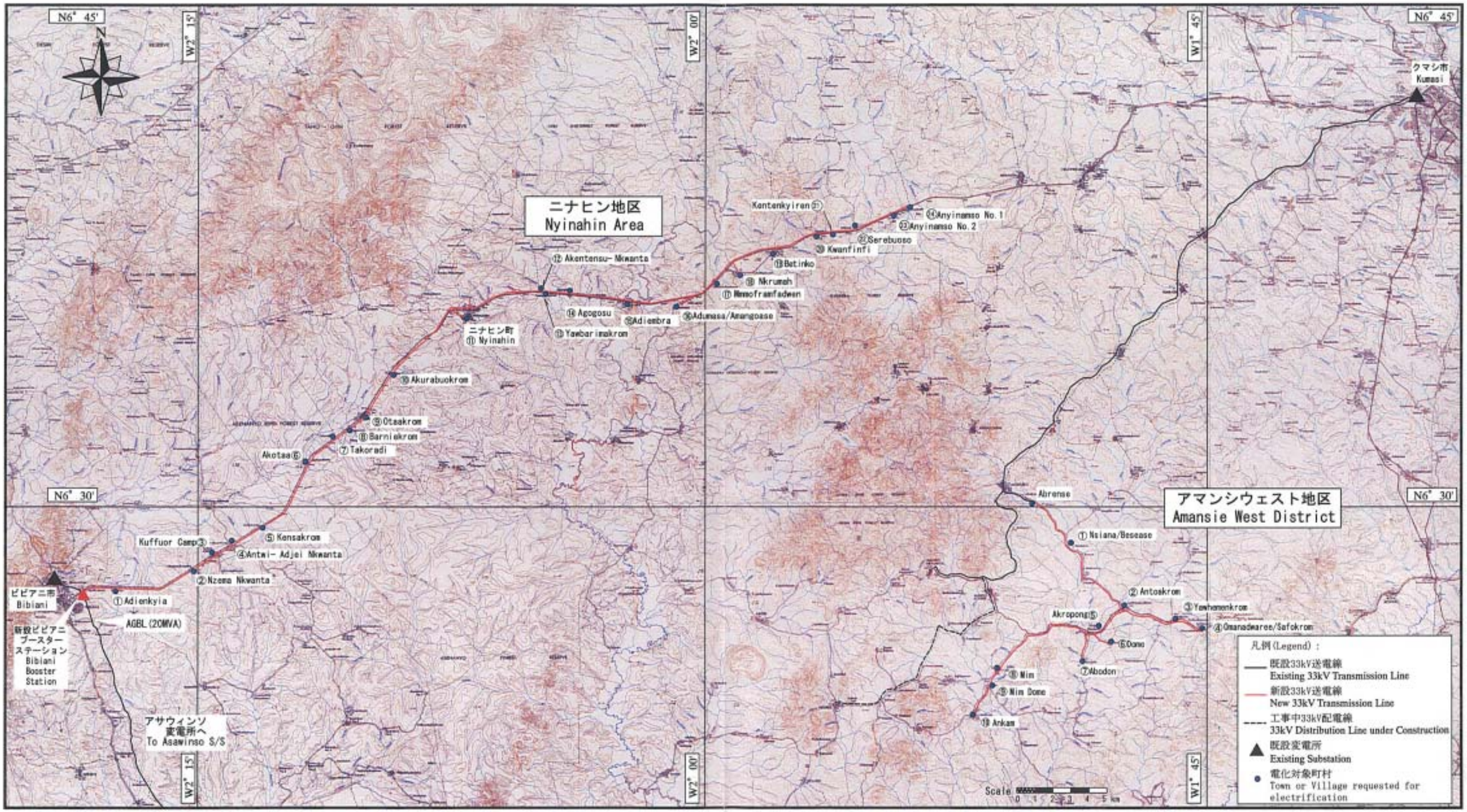
Drawing No.	Title	Scale
BS-01	Single Line Drawing	―
BS-02	Equipment Layout	1/200
BS-03	Arrangement of Outdoor Switchgear Cubicles	―
BS-04	Arrangement of Perimeter Fence and Entrance Gate	―
BS-05	Outline of the Existing 33kV Transmission Line Connection	1/100

(3) Assembly Drawings for 33kV Transmission Lines and Low Voltage Distribution Lines

Drawing No.	Pole Type	Title	Scale
TPA-A	A	33kV Intermediate Pole (Line Angle 0 to 4 deg.)	―
TPA-B	B	33kV Light Angle Pole （Line Angle 4 to 20 deg.）	―
TPA-C	C	33kV Medium Angle Pole (Line Angle 20 to 60 deg.)	―
TPA-D	D	33kV Heavy Angle Pole (Line Angle 60 to 90 deg.)	―
TPA-E	E	33kV Cross Pole (Line Angle 90 deg.)	―
TPA-F	F	33kV Section Pole	―
TPA-G	G	33kV T-off Pole	―
TPA-H	H	33kV Terminal Pole	―
TPA-I	I	33kV LBS Pole	―
TPA-J1	J1	33kV Transformer Pole (50kVA)	―
TPA-J2	J2	33kV Transformer Pole (100,200kVA)	―
TPA-K	K	HV and LV Combination Pole	―
TPA-LA	LA	LV Intermediate Pole	―
TPA-LB	LB	LV Terminal Pole	―
TPA-LCA	LCA	LV T-off Pole A	―
TPA-LCB	LCB	LV T-off Pole B	―
TPA-LCC	LCC	LV T-off Pole C	―
TPA-LCD	LCD	LV T-off Pole D	―

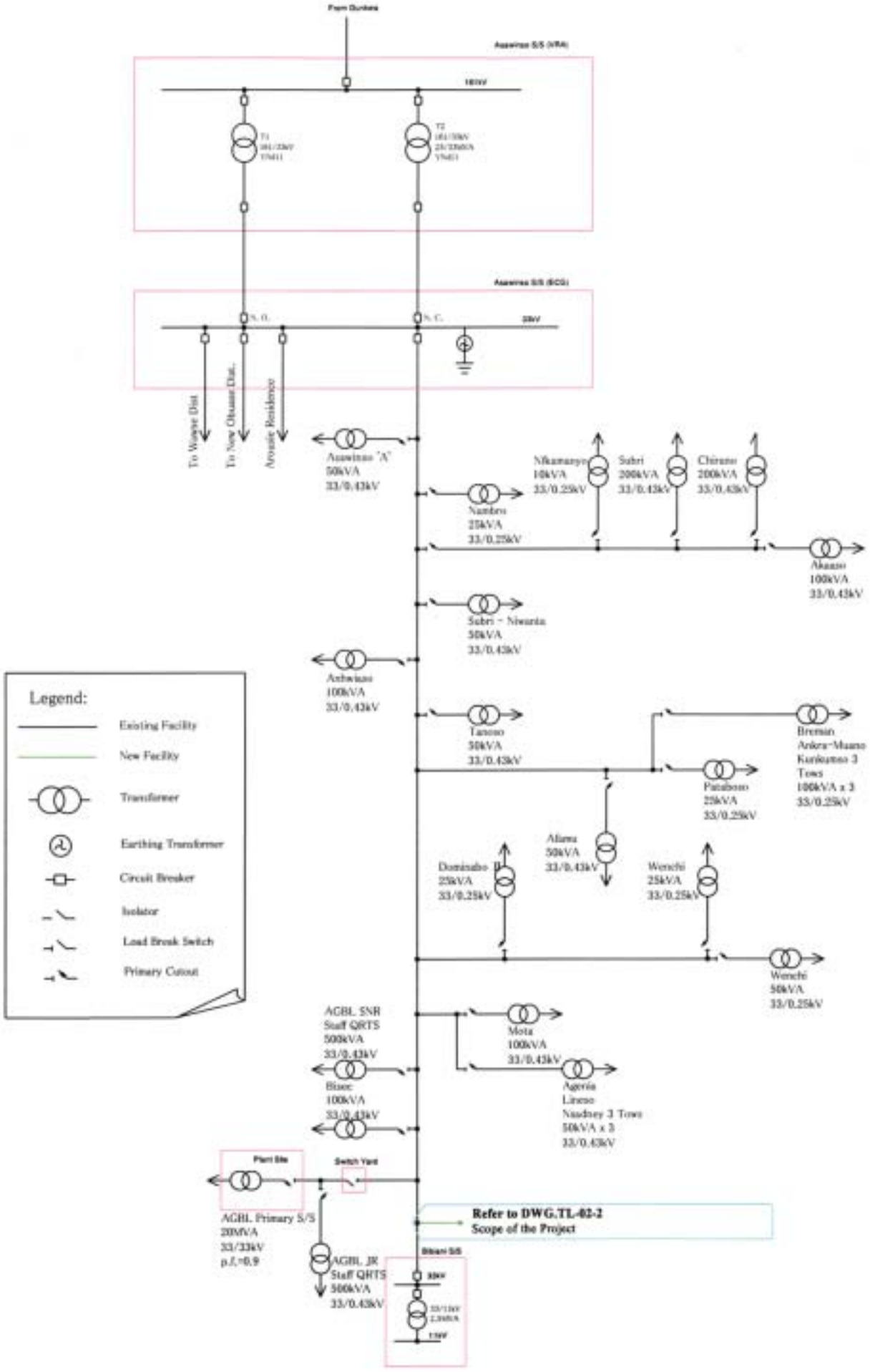
(4) Low Voltage Distribution Equipment and Materials Installation Plan Drawing

Drawing No.	Title	Scale
LV-G01	LV Distribution Equipment and Materials Installation Plan Drawing	―

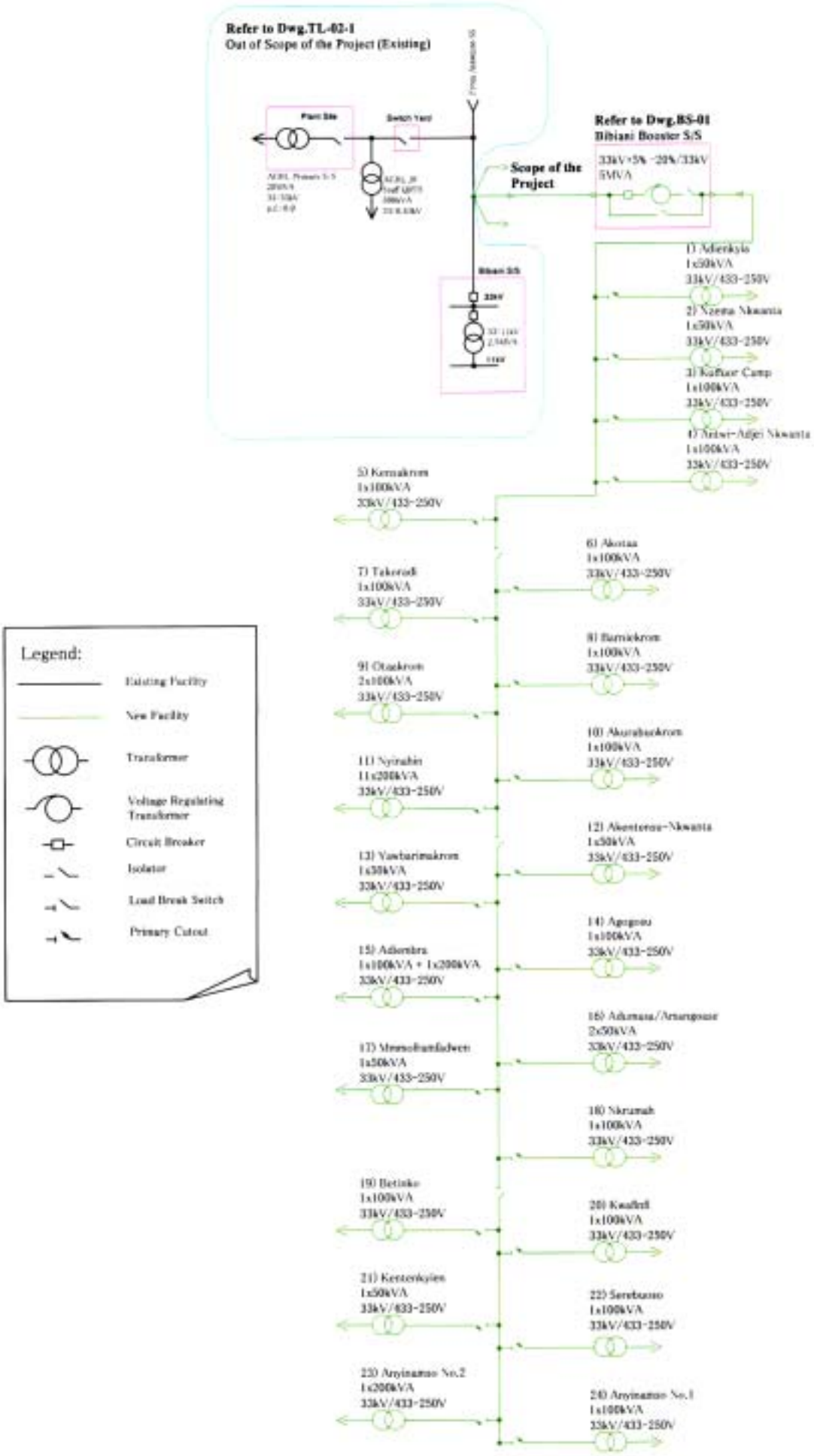


TL-01 本計画対象地区33kV送電線ルート図

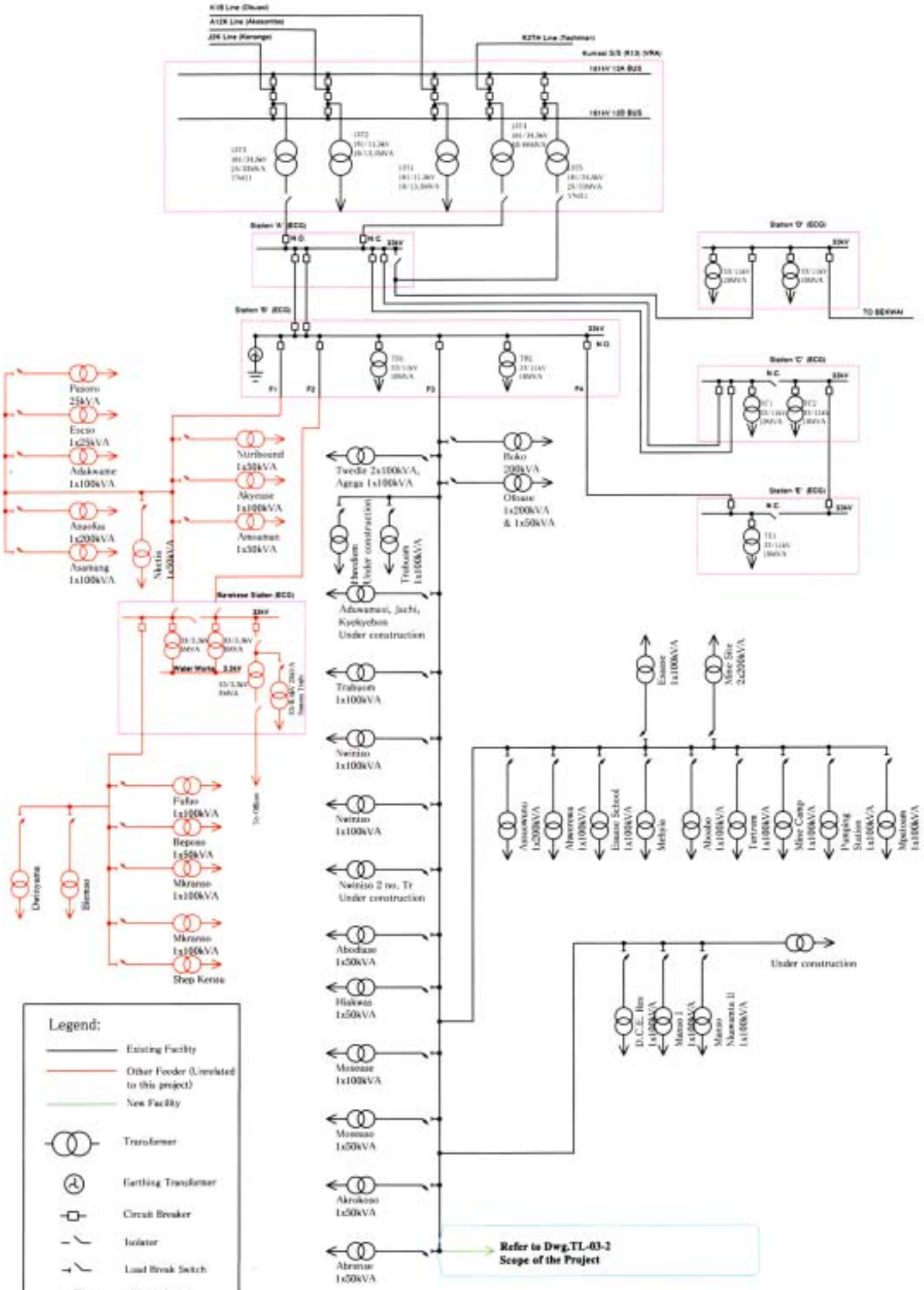
Route Map of 33kV Transmission Line for the Project



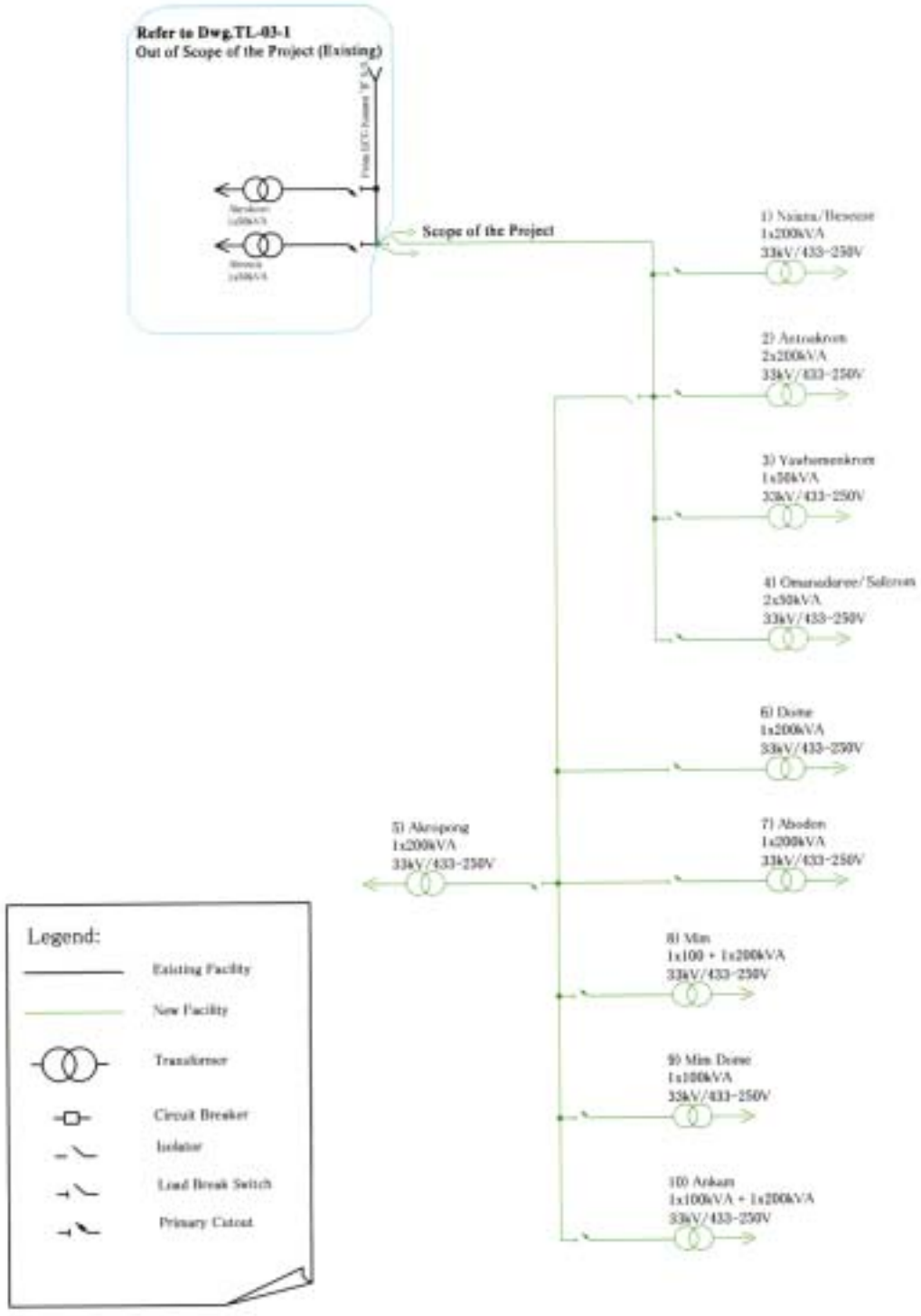
Dwg.No.TL-02-1: 33kV送電線系統図[ニヒナン地区(1/2)]
33kV Transmission Line System Drawing [Nyinahin (1/2)]



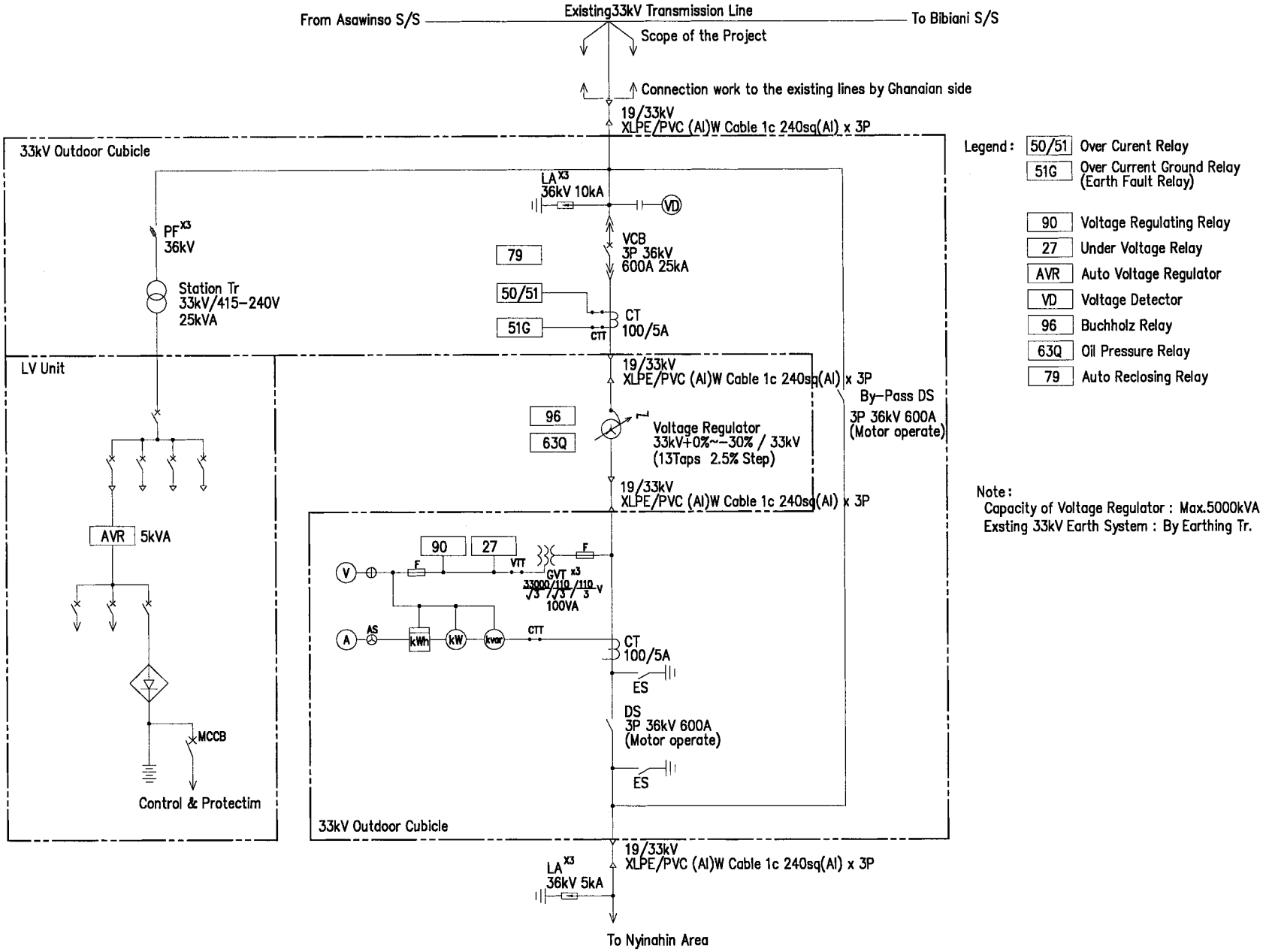
Dwg.No.TL-02-2: 33kV送電線系統図[ニヒナン地区(2/2)]
33kV Transmission Line System Drawing [Nyinahin (2/2)]



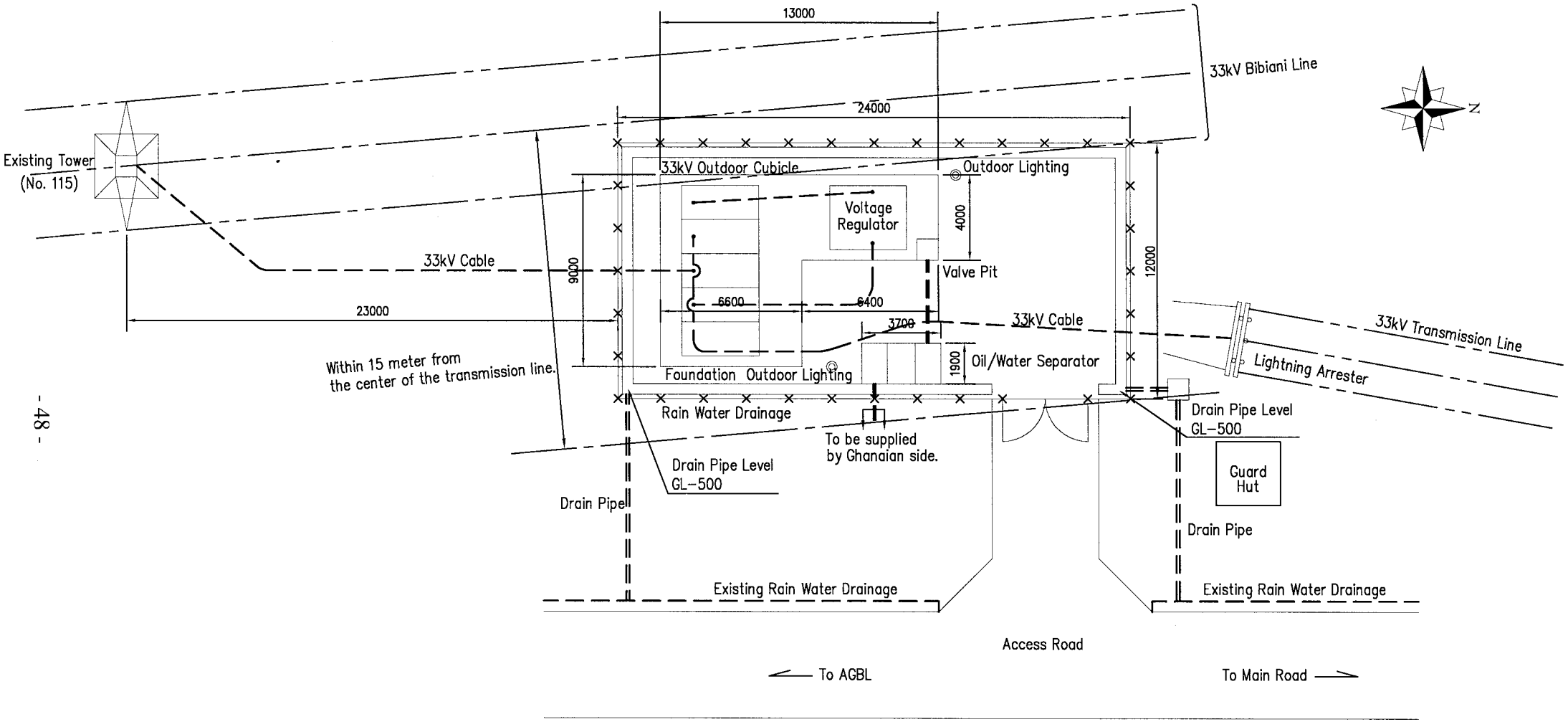
Dwg.No.TL-03-1: 33kV送電線系統図[アマンシウェスト地区(1/2)]
33kV Transmission Line System Drawing [Amansie West (1/2)]



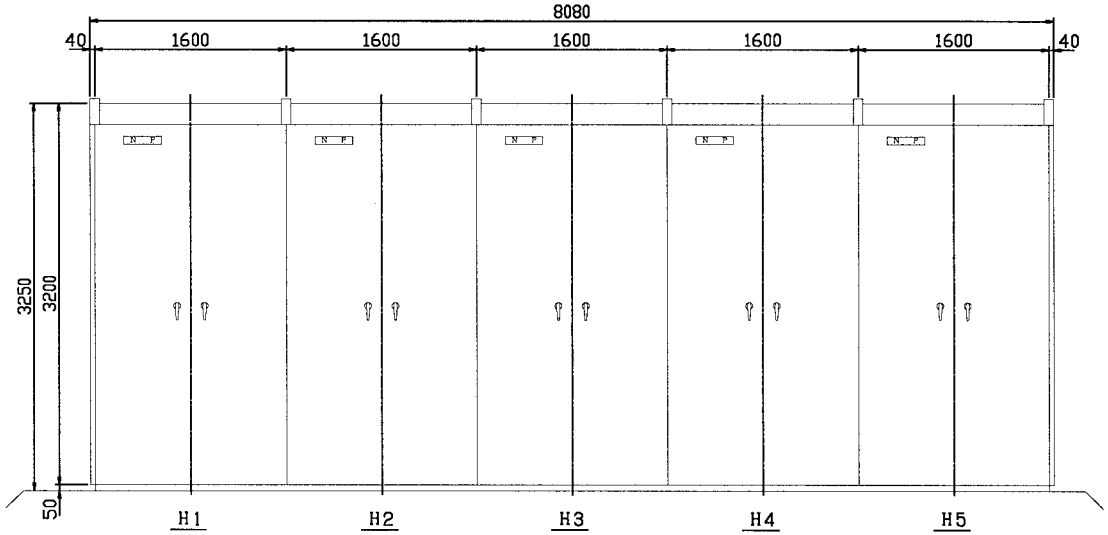
Dwg.No.TL-03-2: 33kV送電線系統図[アマンシウェスト地区(2/2)]
33kV Transmission Line System Drawint [Amansie West (2/2)]

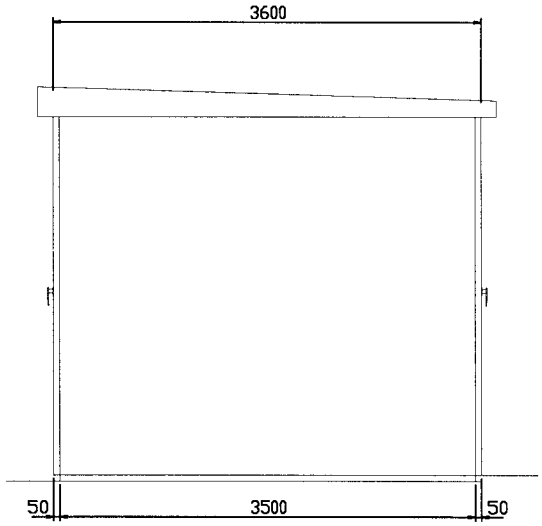


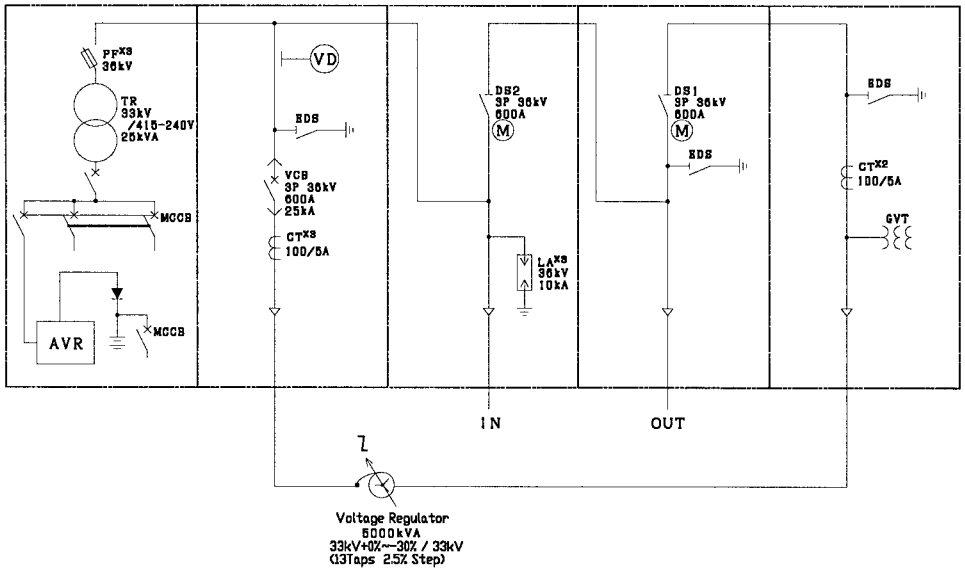
Dwg.No.BS-01: 単線結線図
Single Line Diagram



Dwg.No.BS-02: 機器配置図
Equipment Layout



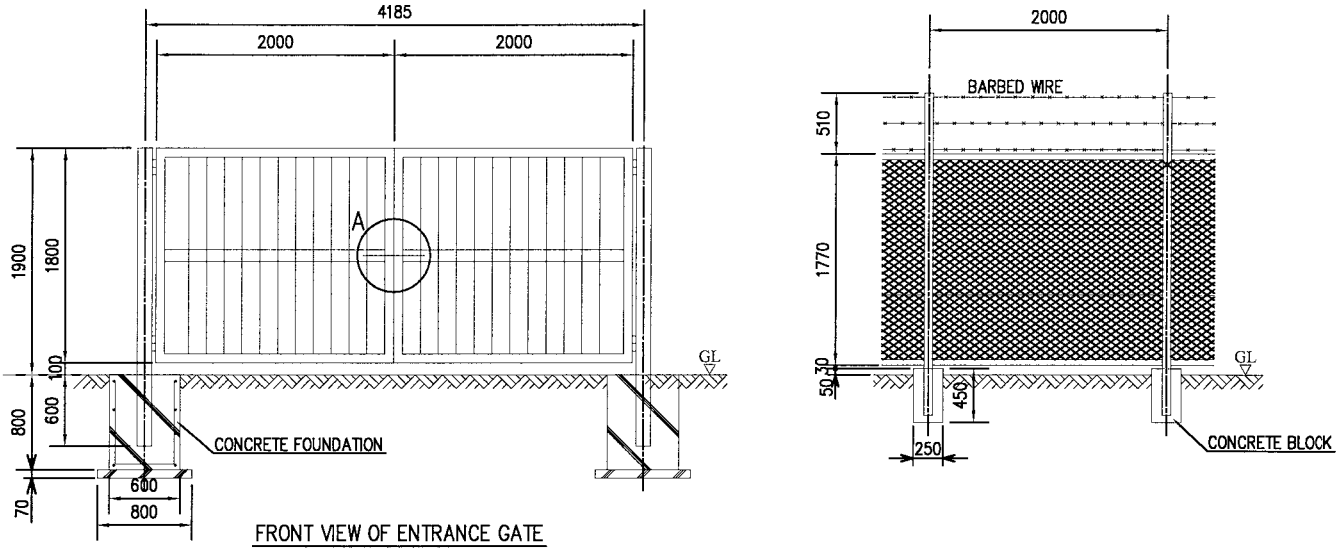




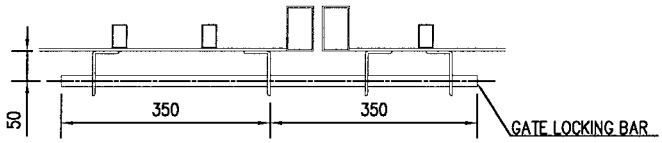
Legend

H1 : Station Service
H2 : AVR Primary
H3 : Incoming
H4 : Outgoing
H5 : AVR Secondary

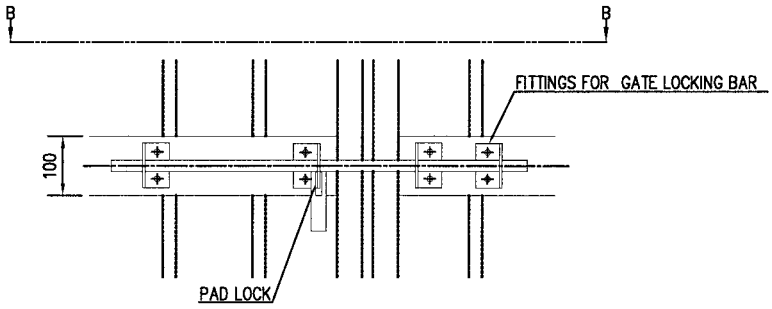
Dwg.No.BS-03: 屋外特別高圧盤概略外形図
Arrangement of Outdoor Switchgear Cubicles



FRONT VIEW OF ENTRANCE GATE

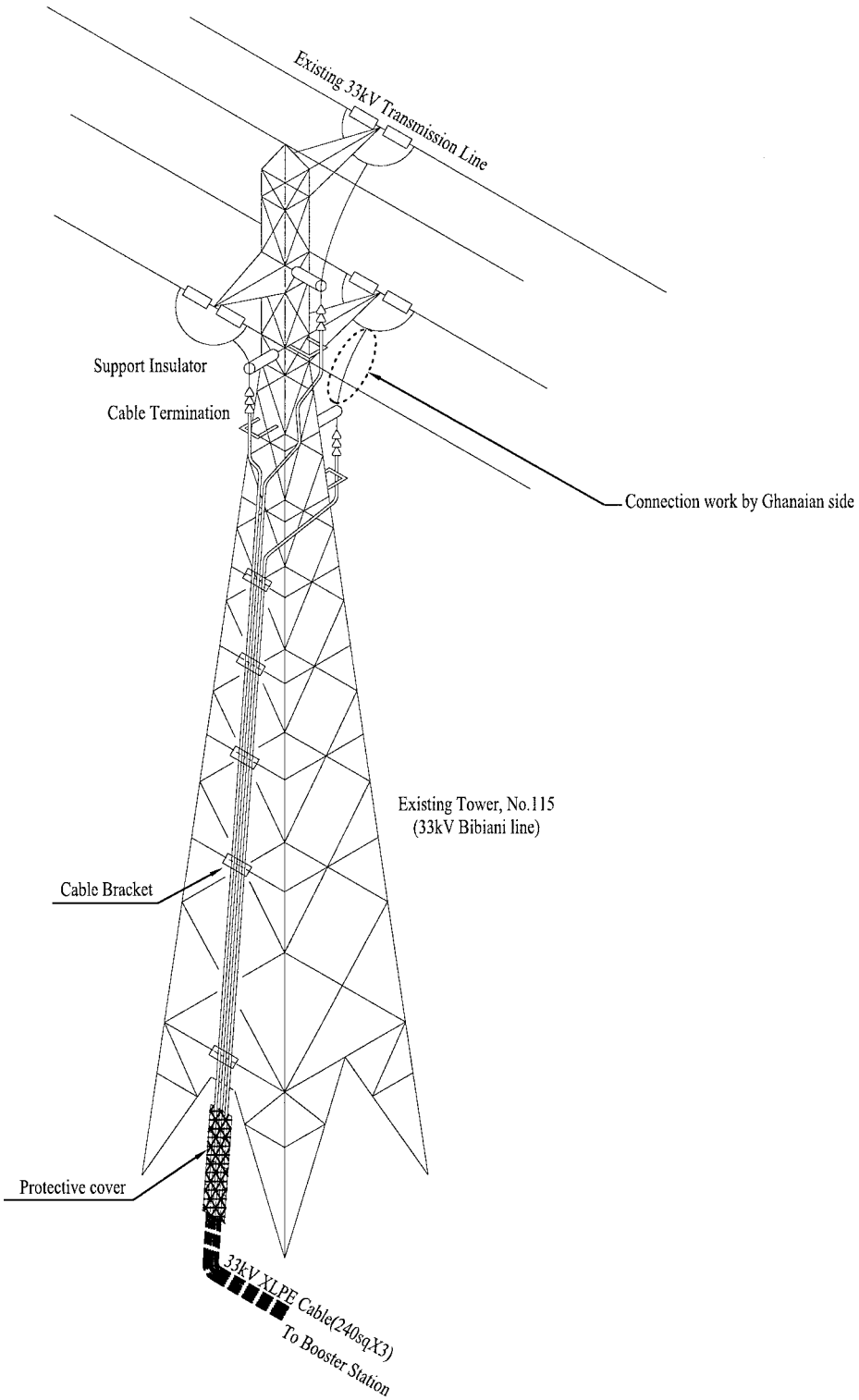


SECTION B–B 1:10

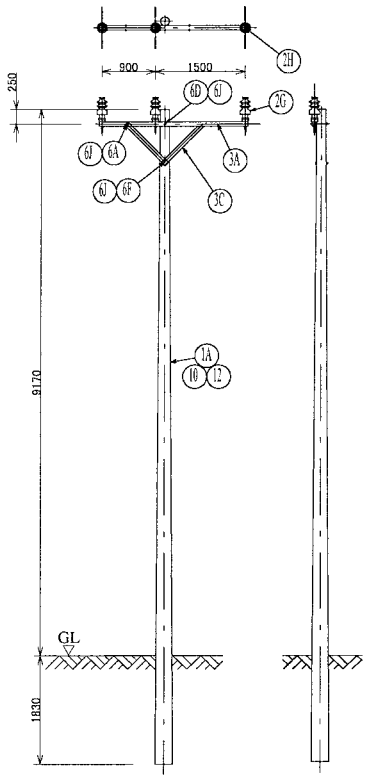


DETAIL–A 1:10

Dwg.No.BS-04: 外塀及び門扉概略外形図
Arrangement of Perimeter Fence and Entrance Gate

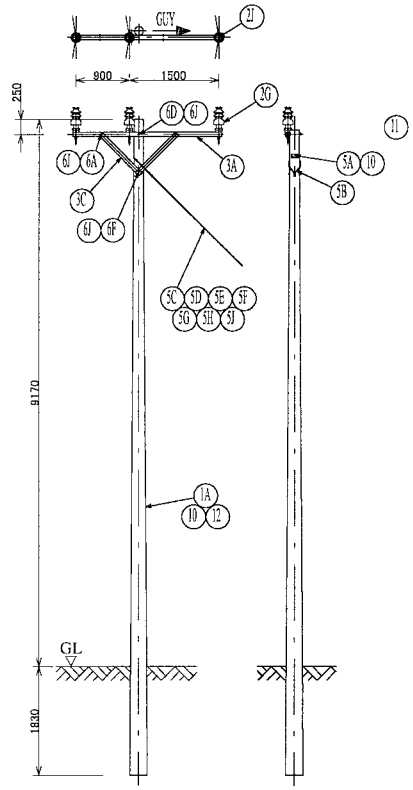


Dwg.No.BS-05: 既設33kV送電線接続図
Outline of the Existing 33kV Transmission Line Connection



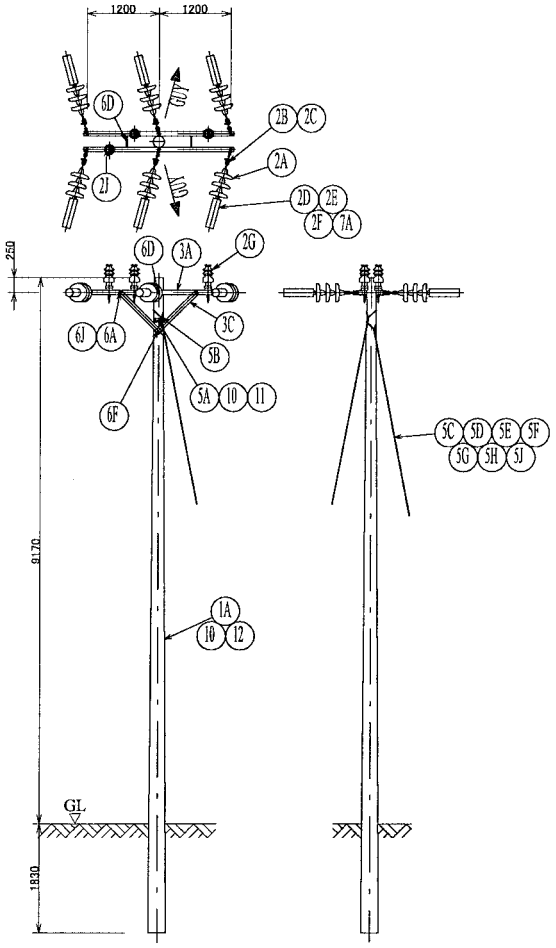
PART.NO.	DESCRIPTION		QTY
1A	Wood Pole 11m	木柱 11m	1
2G	33kV Pin Insulator	33kV ピンがいし	3
2H	Preformed Top Tie for AAC120	頂部タイ AAC120用	3
3A	Crossarm L100×75×7t×2500	腕金 L100x75x7x2500	1
3C	Crossarm Brace Pipe type	パイプアームタイ	2
6A	Bolt&Nut M16×50(Crossarm/Brace)	ボルトナット M16x50	2
6D	Bolt&Nut M16×250(Pole/Crossarm)	ボルトナット M16x250	1
6F	Bolt&Nut M16×350(Pole/Brace)	ボルトナット M16x350	1
6J	Square Washer	角座金	4
10	Nail	釘	4
12	Danger Plate	危険表示札	1

Dwg.No.TPA-A 33kV 引通し柱(0度～4度)[種別A]
33kV Intermediate Pole (Line Angle 0-4deg.) [Type A]



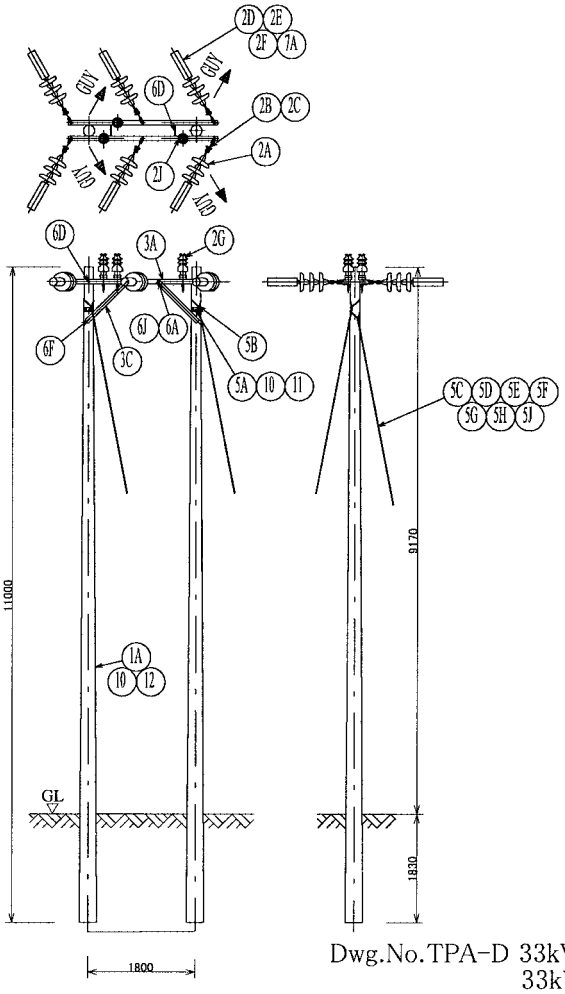
PART.NO.	DESCRIPTION		QTY
1A	Wood Pole 11m	木柱 11m	1
2G	33kV Pin Insulator	33kV ピンがいし	3
2J	Preformed Side Tie for AAC120	側部タイ AAC120用	3
3A	Crossarm L100×75×7t×2500	腕金 L100x75x7x2500	1
3C	Crossarm Brace Pipe type	パイプアームタイ	2
5A	Strain Plate	支線当金物	1
5B	Dead End Grip For Pole 45	巻付グリップ木柱用45sq.mm	1
5C	Dead End Grip For Thimble 45	巻付グリップシンブル用45sq.mm	1
5D	Dead End Grip For Insulator 45	巻付グリップ碍子用45sq.mm	2
5E	Stay Wire 45sq.mm	亜鉛めっき鋼撚り線45sq.mm	15
5F	Stay Insulator 33kV	支線用碍子	1
5G	Turmbuckle	ターンバックル	1
5H	Stay Rod	支線棒	1
5J	Stay Plate	支線プレート	1
6A	Bolt&Nut M16×50(Crossarm/Brace)	ボルトナット M16x50	2
6D	Bolt&Nut M16×250(Pole/Crossarm)	ボルトナット M16x250	1
6F	Bolt&Nut M16×350(Pole/Brace)	ボルトナット M16x350	1
6J	Square Washer	角座金	4
10	Nail	釘	8
11	Staple	ステップル	4
12	Danger Plate	危険表示札	1

Dwg.No.TPA-B 33kV 軽角度柱(4度～20度)[種別B]
33kV Light Angle Pole (Line Angle 4-20deg.)[Type B]



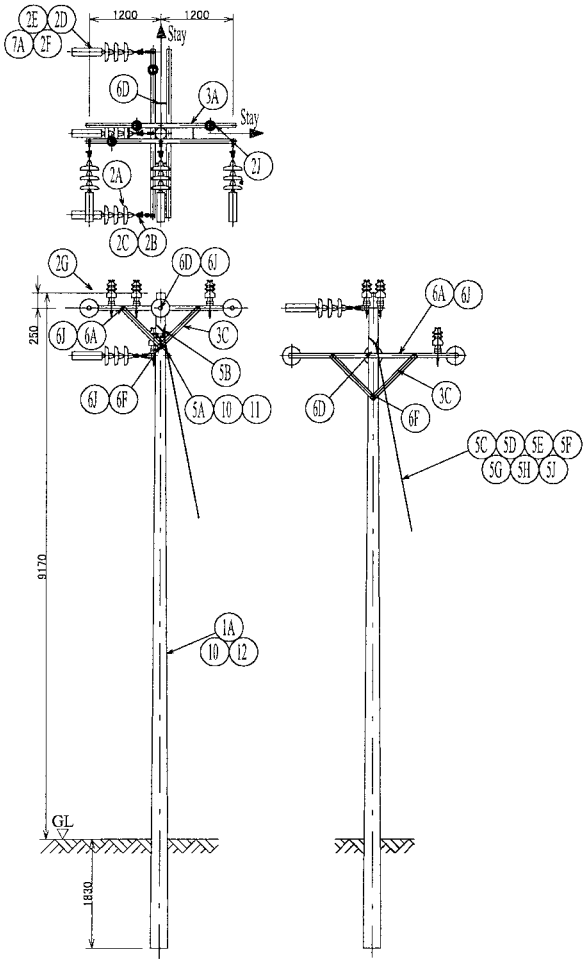
PART.NO.	DESCRIPTION		QTY
1A	Wood Pole 11m	木柱 11m	1
2A	Disc Insulator	懸垂がいし	18
2B	Anchor Shackle	アンカーシャックル	6
2C	Ball Eye	ボールアイ	6
2D	Socket Eye	ソケットアイ	6
2E	Dead End Clamp for 33kV (AAC120)	引留クランプ33kV用	6
2F	Dead End Clamp Adaptor	引留クランプアダプター	6
2G	33kV Pin Insulator	33kV ピンがいし	3
2J	Preformed Side Tie for AAC120	側部タイ AAC120用	3
3A	Crossarm L100×75×7t×2500	腕金 L100x75x7x2500	2
3C	Crossarm Brace Pipe type	パイプアームタイ	4
5A	Strain Plate	支線当金物	2
5B	Dead End Grip For Pole 45	巻付グリップ木柱用45sq.mm	2
5C	Dead End Grip For Thimble 45	巻付グリップシンブル用45sq.mm	2
5D	Dead End Grip For Insulator 45	巻付グリップ碍子用45sq.mm	4
5E	Stay Wire 45sq.mm	亜鉛めっき鋼撚り線45sq.mm	30
5F	Stay Insulator 33kV	支線用碍子	2
5G	Turnbuckle	ターンバックル	2
5H	Stay Rod	支線棒	2
5J	Stay Plate	支線プレート	2
6A	Bolt&Nut M16×50(Crossarm/Brace)	ボルトナット M16x50	4
6D	Bolt&Nut M16×250(Pole/Crossarm)	ボルトナット M16x250	3
6F	Bolt&Nut M16×350(Pole/Brace)	ボルトナット M16x350	1
6J	Square Washer	角座金	4
7A	Bolt Type Connector	締付け型コネクタ AAC120/AAC120	6
10	Nail	釘	12
11	Staple	ステップル	8
12	Danger Plate	危険表示札	1

Dwg.No.TPA-C 33kV 中角度柱(20度～60度)[種別C]
33kV Medium Angle Pole (Line Angle 20-60deg.)[Type C]



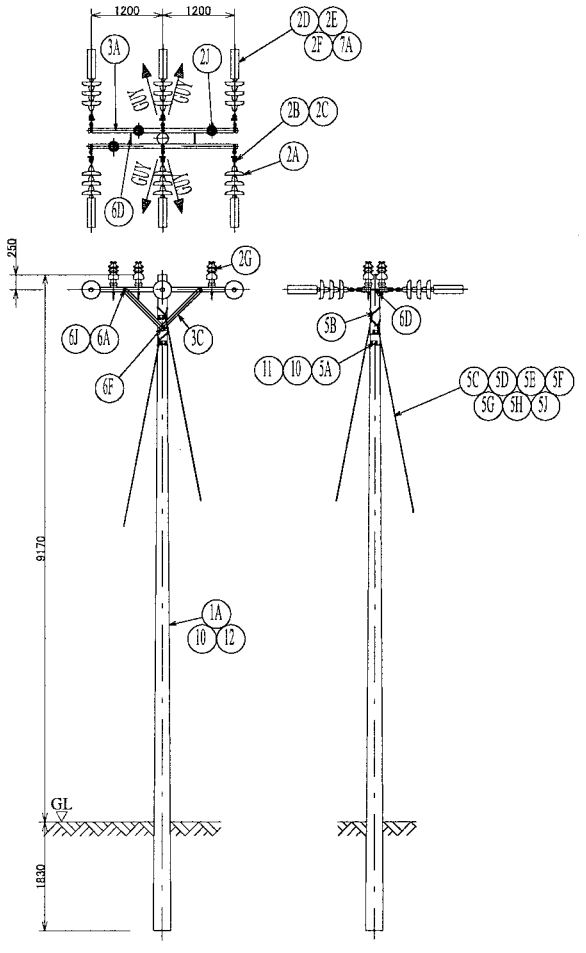
PART.NO.	DESCRIPTION		QTY
1A	Wood Pole 11m	木柱 11m	2
2A	Disc Insulator	懸垂がいし	18
2B	Anchor Shackle	アンカーシャックル	6
2C	Ball Eye	ボールアイ	6
2D	Socket Eye	ソケットアイ	6
2E	Dead End Clamp for 33kV (AAC120)	引留クランプ33kV用	6
2F	Dead End Clamp Adaptor	引留クランプアダプター	6
2G	33kV Pin Insulator	33kV ピンがいし	3
2J	Preformed Side Tie for AAC120	側部タイ AAC120用	3
3A	Crossarm L100×75×7t×2500	腕金 L100x75x7x2500	2
3C	Crossarm Brace Pipe type	パイプアームタイ	4
5A	Strain Plate	支線当金物	4
5B	Dead End Grip For Pole 45	巻付グリップ木柱用45sq.mm	4
5C	Dead End Grip For Thimble 45	巻付グリップシンブル用45sq.mm	4
5D	Dead End Grip For Insulator 45	巻付グリップ碍子用45sq.mm	8
5E	Stay Wire 45sq.mm	亜鉛めっき鋼撚り線45sq.mm	60
5F	Stay Insulator 33kV	支線用碍子	4
5G	Turnbuckle	ターンバックル	4
5H	Stay Rod	支線棒	4
5J	Stay Plate	支線プレート	4
6A	Bolt&Nut M16×50(Crossarm/Brace)	ボルトナット M16x50	4
6D	Bolt&Nut M16×250(Pole/Crossarm)	ボルトナット M16x250	4
6F	Bolt&Nut M16×350(Pole/Brace)	ボルトナット M16x350	2
6J	Square Washer	角座金	4
7A	Bolt Type Connector	締付け型コネクタ AAC120/AAC120	6
10	Nail	釘	20
11	Staple	ステップル	16
12	Danger Plate	危険表示札	1

Dwg.No.TPA-D 33kV 強角度柱(60度～90度未満)[種別D]
33kV Heavy Angle Pole (Line Angle 60-90deg.)[Type D]



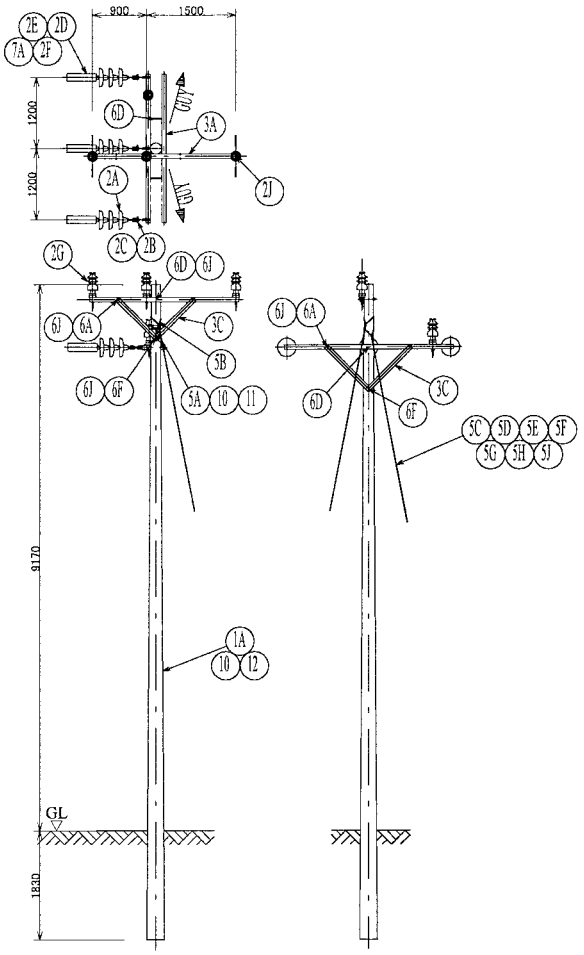
PART.NO.	DESCRIPTION		QTY
1A	Wood Pole 11m	木柱 11m	1
2A	Disc Insulator	懸垂がいし	18
2B	Anchor Shackle	アンカーシャックル	6
2C	Ball Eye	ボールアイ	6
2D	Socket Eye	ソケットアイ	6
2E	Dead End Clamp for 33kV (AAC120)	引留クランプ33kV用	6
2F	Dead End Clamp Adaptor	引留クランプアダプター	6
2G	33kV Pin Insulator	33kV ピンがいし	4
2J	Preformed Side Tie for AAC120	側部タイ AAC120用	4
3A	Crossarm L100×75×7t×2500	腕金 L100x75x7x2500	4
3C	Crossarm Brace Pipe type	パイプアームタイ	8
5A	Strain Plate	支線当金物	2
5B	Dead End Grip For Pole 45	巻付グリップ木柱用45sq.mm	2
5C	Dead End Grip For Thimble 45	巻付グリップシンブル用45sq.mm	2
5D	Dead End Grip For Insulator 45	巻付グリップ碍子用45sq.mm	4
5E	Stay Wire 45sq.mm	亜鉛めっき鋼撚り線45sq.mm	30
5F	Stay Insulator 33kV	支線用碍子	2
5G	Turnbuckle	ターンバックル	2
5H	Stay Rod	支線棒	2
5J	Stay Plate	支線プレート	2
6A	Bolt&Nut M16×50(Crossarm/Brace)	ボルトナット M16x50	8
6D	Bolt&Nut M16×250(Pole/Crossarm)	ボルトナット M16x250	6
6F	Bolt&Nut M16×350(Pole/Brace)	ボルトナット M16x350	2
6J	Square Washer	角座金	8
7A	Bolt Type Connector	締付け型コネクタ AAC120/AAC120	6
10	Nail	釘	12
11	Staple	ステップル	8
12	Danger Plate	危険表示札	1

Dwg.No.TPA-E 33kV 直交柱(90度)[種別E]
33kV Cross Pole (Line Angle 90deg.)[Type E]



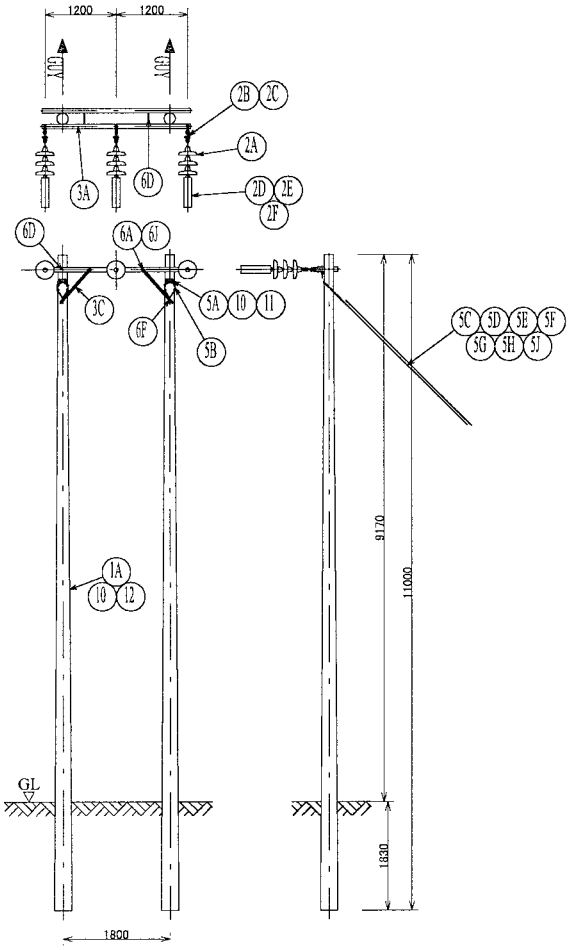
PART.NO.	DESCRIPTION		QTY
1A	Wood Pole 11m	木柱 11m	1
2A	Disc Insulator	懸垂がいし	18
2B	Anchor Shackle	アンカーシャックル	6
2C	Ball Eye	ボールアイ	6
2D	Socket Eye	ソケットアイ	6
2E	Dead End Clamp for 33kV (AAC120)	引留クランプ33kV用	6
2F	Dead End Clamp Adaptor	引留クランプアダプター	6
2G	33kV Pin Insulator	33kV ピンがいし	3
2J	Preformed Side Tie for AAC120	側部タイ AAC120用	3
3A	Crossarm L100×75×7t×2500	腕金 L100x75x7x2500	2
3C	Crossarm Brace Pipe type	パイプアームタイ	4
5A	Strain Plate	パイプアームタイ	4
5B	Dead End Grip For Pole 45	巻付グリップ木柱用45sq.mm	4
5C	Dead End Grip For Thimble 45	巻付グリップシンブル用45sq.mm	4
5D	Dead End Grip For Insulator 45	巻付グリップ碍子用45sq.mm	8
5E	Stay Wire 45sq.mm	亜鉛めっき鋼撚り線45sq.mm	60
5F	Stay Insulator 33kV	支線用碍子	4
5G	Turnbuckle	ターンバックル	4
5H	Stay Rod	支線棒	4
5J	Stay Plate	支線プレート	4
6A	Bolt&Nut M16×50(Crossarm/Brace)	ボルトナット M16x50	4
6D	Bolt&Nut M16×250(Pole/Crossarm)	ボルトナット M16x250	3
6F	Bolt&Nut M16×350(Pole/Brace)	ボルトナット M16x350	1
6J	Square Washer	角座金	4
7A	Bolt Type Connector	締付け型コネクタ AAC120/AAC120	6
10	Nail	釘	20
11	Staple	ステップル	16
12	Danger Plate	危険表示札	1

Dwg.No.TPA-F 33kV 両引留め柱[種別F]
33kV Section Pole[Type F]



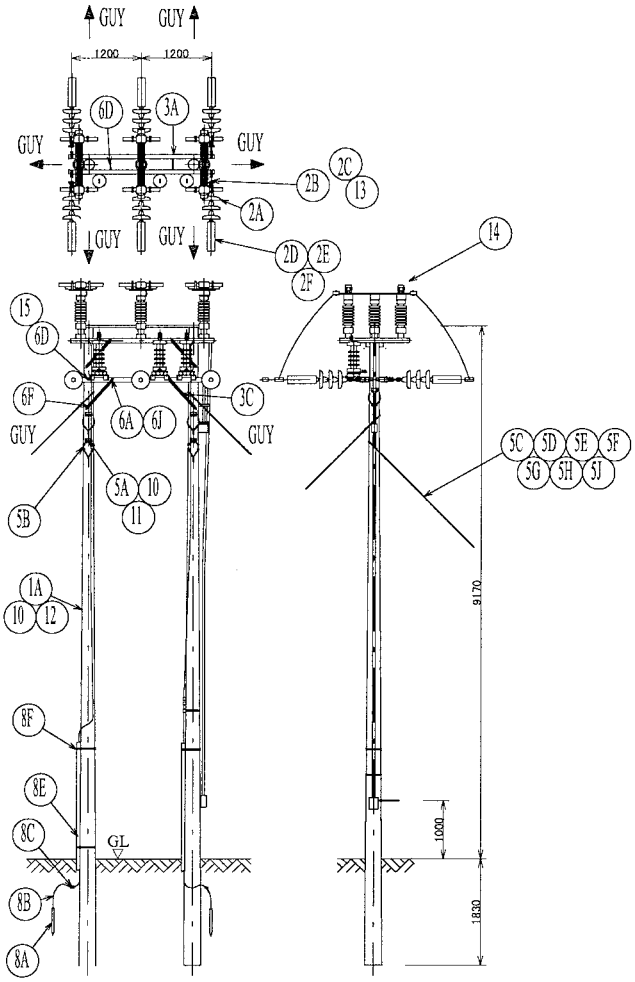
PART.NO.	DESCRIPTION		QTY
1A	Wood Pole 11m	木柱 11m	1
2A	Disc Insulator	懸垂がいし	9
2B	Anchor Shackle	アンカーシャックル	3
2C	Ball Eye	ボールアイ	3
2D	Socket Eye	ソケットアイ	3
2E	Dead End Clamp for 33kV (AAC120)	引留クランプ33kV用	3
2F	Dead End Clamp Adaptor	引留クランプアダプター	3
2G	33kV Pin Insulator	33kV ピンがいし	4
2J	Preformed Side Tie for AAC120	側部タイ AAC120用	4
3A	Crossarm L100×75×7t×2500	腕金 L100x75x7x2500	3
3C	Crossarm Brace Pipe type	パイプアームタイ	6
5A	Strain Plate	支線当金物	2
5B	Dead End Grip For Pole 45	巻付グリップ木柱用45sq.mm	2
5C	Dead End Grip For Thimble 45	巻付グリップシンブル用45sq.mm	2
5D	Dead End Grip For Insulator 45	巻付グリップ碍子用45sq.mm	4
5E	Stay Wire 45sq.mm	亜鉛めっき鋼撚り線45sq.mm	30
5F	Stay Insulator 33kV	支線用碍子	2
5G	Turnbuckle	ターンバックル	2
5H	Stay Rod	支線棒	2
5J	Stay Plate	支線プレート	2
6A	Bolt&Nut M16×50(Crossarm/Brace)	ボルトナット M16x50	6
6D	Bolt&Nut M16×250(Pole/Crossarm)	ボルトナット M16x250	4
6F	Bolt&Nut M16×350(Pole/Brace)	ボルトナット M16x350	2
6J	Square Washer	角座金	8
7A	Bolt Type Connector	締付け型コネクタ AAC120/AAC120	6
10	Nail	釘	12
11	Staple	ステップル	8
12	Danger Plate	危険表示札	1

Dwg.No.TPA-G 33kV 分岐柱[種別G]
33kV T-off Pole[Type G]



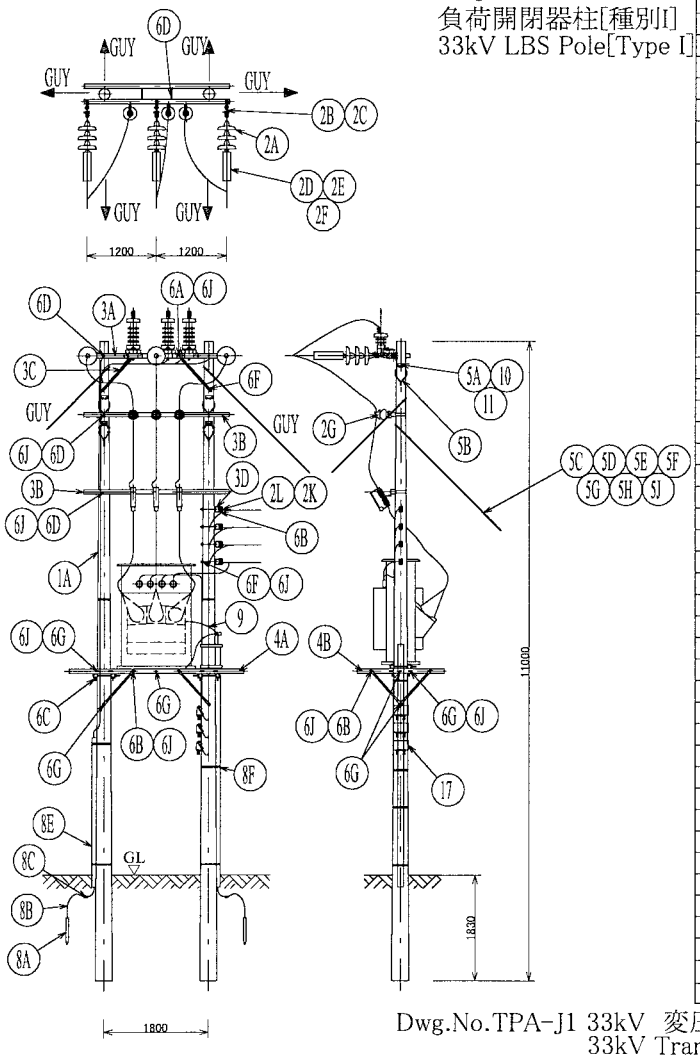
PART.NO.	DESCRIPTION		QTY
1A	Wood Pole 11m	木柱 11m	2
2A	Disc Insulator	懸垂がいし	9
2B	Anchor Shackle	アンカーシャックル	3
2C	Ball Eye	ボールアイ	3
2D	Socket Eye	ソケットアイ	3
2E	Dead End Clamp for 33kV (AAC120)	引留クランプ33kV用	3
2F	Dead End Clamp Adaptor	引留クランプアダプター	3
3A	Crossarm L100×75×7t×2500	腕金 L100x75x7x2500	2
3C	Crossarm Brace Pipe type	パイプアームタイ	4
5A	Strain Plate	支線当金物	2
5B	Dead End Grip For Pole 45	巻付グリップ木柱用45sq.mm	2
5C	Dead End Grip For Thimble 45	巻付グリップシンブル用45sq.mm	2
5D	Dead End Grip For Insulator 45	巻付グリップ碍子用45sq.mm	4
5E	Stay Wire 45sq.mm	亜鉛めっき鋼撚り線45sq.mm	30
5F	Stay Insulator 33kV	支線用碍子	2
5G	Turnbuckle	ターンバックル	2
5H	Stay Rod	支線棒	2
5J	Stay Plate	支線プレート	2
6A	Bolt&Nut M16×50(Crossarm/Brace)	ボルトナット M16x50	4
6D	Bolt&Nut M16×250(Pole/Crossarm)	ボルトナット M16x250	4
6F	Bolt&Nut M16×350(Pole/Brace)	ボルトナット M16x350	2
6J	Square Washer	角座金	4
10	Nail	釘	12
11	Staple	ステップル	8
12	Danger Plate	危険表示札	1

Dwg.No.TPA-H 33kV 終端柱[種別H]
33kV Terminal Pole[Type H]



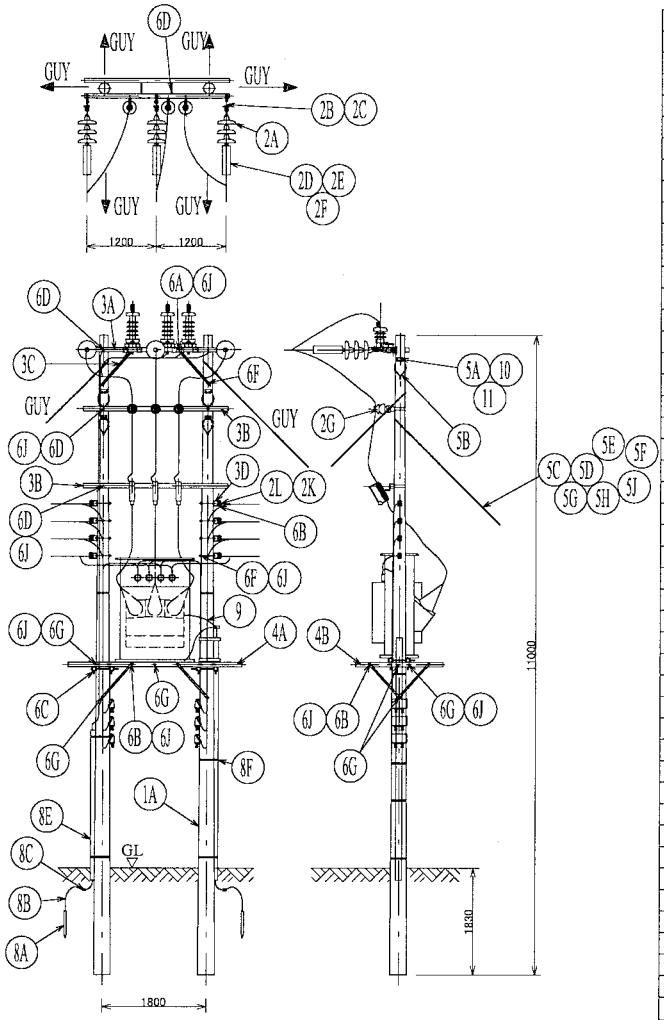
PART.NO.	DESCRIPTION		QTY
1A	Wood Pole 11m	木柱 11m	2
2A	Disc Insulator	懸垂がいし	18
2B	Anchor Shackle	アンカーシャックル	6
2C	Ball Eye	ボールアイ	6
2D	Socket Eye	ソケットアイ	6
2E	Dead End Clamp for 33kV (AAC120)	引留クランプ33kV用	6
2F	Dead End Clamp Adaptor	引留クランプアダプター	6
3A	Crossarm L100×75×7t×2500	腕金 L100x75x7x2500	2
3C	Crossarm Brace Pipe type	パイプアームタイ	4
5A	Strain Plate	支線当金物	6
5B	Dead End Grip For Pole 45	巻付グリップ木柱用45sq.mm	6
5C	Dead End Grip For Thimble 45	巻付グリップシンブル用45sq.mm	6
5D	Dead End Grip For Insulator 45	巻付グリップ碍子用45sq.mm	12
5E	Stay Wire 45sq.mm	亜鉛めっき鋼撚り線45sq.mm	90
5F	Stay Insulator 33kV	支線用碍子	6
5G	Turnbuckle	ターンバックル	6
5H	Stay Rod	支線棒	6
5J	Stay Plate	支線プレート	6
6A	Bolt&Nut M16×50(Crossarm/Brace)	ボルトナット M16x50	4
6D	Bolt&Nut M16×250(Pole/Crossarm)	ボルトナット M16x250	4
6F	Bolt&Nut M16×350(Pole/Brace)	ボルトナット M16x350	4
6J	Square Washer	角座金	4
7A	Bolt Type Connector	締付け型コネクタAAC120/AAC120	6
7D	Bolt Type Connector	締付け型コネクタAAC120/PDC22	3
8A	Ground Rod 14×1500	接地棒 14x1500	20
8B	Lead Wire Terminal	リード端子	10
8C	Compression Connector(38/38)	圧縮コネクタ 38-38	12
8D	Grounding Wire Cu 38sq.mm	接地線38sq.mm	32
8E	PVC Protection Pipe L=4.0m	接地線保護パイプ	2
8F	Stainless Band L=1200mm	ステンレスバンド L=1200mm	18
10	Nail	釘	28
11	Staple	ステップル	24
12	Danger Plate	危険表示札	1
13A	Transformer Primary Conductor PPC 22sq.mm	変圧器1次側引下げ用リード線 22sq.mm	6
14	33kV Lighting Arrester	33kV 避雷器	3
15	33kV Load Break Switch	33kV 負荷開閉器	1

Dwg.No.TPA-I 33kV
負荷開閉器柱[種別I]
33kV LBS Pole[Type I]



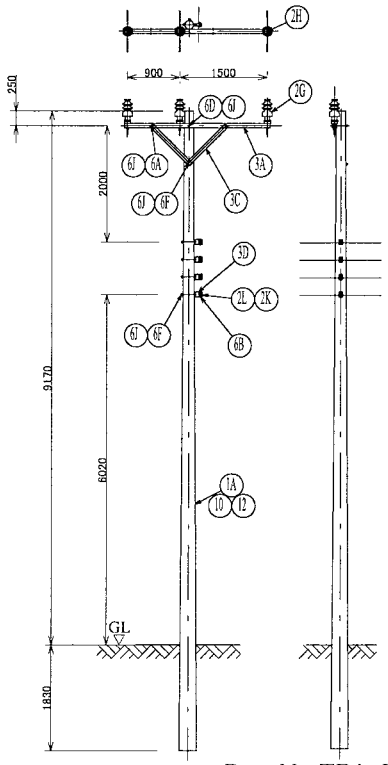
PART.NO.	DESCRIPTION		QTY
1A	Wood Pole 11m	木柱 11m	2
2A	Disc Insulator	懸垂がいし	9
2B	Anchor Shackle	アンカーシャックル	3
2C	Ball Eye	ボールアイ	3
2D	Socket Eye	ソケットアイ	3
2E	Dead End Clamp for 33kV (AAC120)	引留クランプ33kV用	3
2F	Dead End Clamp Adaptor	引留クランプアダプター	3
2G	33kV Pin Insulator	33kV ピンがいし	3
2K	Aluminum Bind Wire 4.0mm	アルミバンド線 4.0mm	12
2L	LV Shackle Insulator	低圧シャックルがいし	4
3A	Crossarm L100×75×7t×2500	腕金 L100x75x7x2500	2
3B	Crossarm for Pin Support L100×75×7t×2500	支持碍子用腕金 L100x75x7x2500	2
3C	Crossarm Brace Pipe type	パイプアームタイ	16
3D	LV Rack	低圧ラック	4
4A	Tr.Support(A) 75×75×3.2t ×3000	変圧器架台(A) 75x75x3.2x3000	2
4B	Tr.Support(B) 75×75×3.2t×1500	変圧器架台(B) 75x75x3.2x1500	4
5A	Strain Plate	支線当金物	6
5B	Dead End Grip For Pole 45	巻付グリップ木柱用45sq.mm	6
5C	Dead End Grip For Thimble 45	巻付グリップシンブル用45sq.mm	6
5D	Dead End Grip For Insulator 45	巻付グリップ碍子用45sq.mm	12
5E	Stay Wire 45sq.mm	亜鉛めっき鋼撚り線45sq.mm	90
5F	Stay Insulator 33kV	支線用碍子	6
5G	Turnbuckle	ターンバックル	6
5H	Stay Rod	支線棒	6
5J	Stay Plate	支線プレート	6
6A	Bolt&Nut M16×50(Crossarm/Brace)	ボルトナット M16x50	4
6B	Bolt&Nut M16×150(LV Rack/Spool)	ボルトナット M16x150	16
6C	Bolt&Nut M16×200(Tr.arm A/B)	ボルトナット M16x200	8
6D	Bolt&Nut M16×250(Pole/Crossarm)	ボルトナット M16x250	4
6E	Bolt & Nut M16×300(Pole/LV Rack)	ボルトナット M16x300	4
6F	Bolt&Nut M16×350(Pole/Brace)	ボルトナット M16x300	6
6G	Bolt&Nut M16×450	ボルトナット M16x450	15
6J	Square Washer	角座金	36
7D	Bolt Type Connector	締付け型コネクタAAC120/PDC22	6
7E	Bolt Type Connector	締付け型コネクタCV70/AAC50	4
8A	Grouund Rod 14×1500	接地棒 14x1500	20
8B	Lead Wire Terminal	リード端子	10
8C	Compression Connector(38/38)	圧縮コネクタ 38-38	14
8D	Grounding Wire Cu 38sq.mm	接地線38sq.mm	27
8E	PVC Protection Pipe L=4.0m	接地線保護パイプ	2
8F	Stainless Band L=1200mm	ステンレスバンド L=1200mm	18
9	IBT Band	自在バンド	4
10	Nail	釘	28
11	Staple	ステップル	24
12	Danger Plate	危険表示札	1
13A	Transformer Primary Conductor PPC 22sq.mm	変圧器1次側引下げ用リード線 22sq.mm	24
13B	Transformer Secondary Conductor CV70sq.mm	変圧器2次側リード線 CV70sq.mm	48
14	33kV Lightning Arrester	33kV 避雷器	3
16	33kV Fused Cutout Switch	33kV ヒューズカットアウト	3
17	Transformer	変圧器	1
18	LV Fuse Cutout	低圧ヒューズカットアウト	3

Dwg.No.TPA-J1 33kV 変圧器柱[種別J1]
33kV Transformer Pole(50kVA)[Type J1]



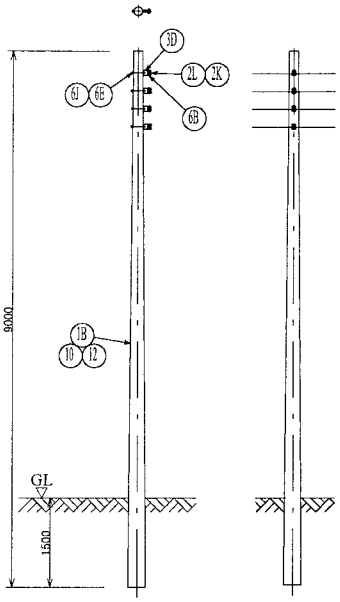
PART.NO.	DESCRIPTION		QTY
1A	Wood Pole 11m	木柱 11m	2
2A	Disc Insulator	懸垂がいし	9
2B	Anchor Shackle	アンカーシャックル	3
2C	Ball Eye	ボールアイ	3
2D	Socket Eye	ソケットアイ	3
2E	Dead End Clamp for 33kV (AAC120)	引留クランプ33kV用	3
2F	Dead End Clamp Adaptor	引留クランプアダプター	3
2G	33kV Pin Insulator	33kV ピンがいし	3
2K	Aluminum Bind Wire 4.0mm	アルミバンド線 4.0mm	24
2L	LV Shackle Insulator	低圧シャックルがいし	8
3A	Crossarm L100×75×7t×2500	腕金 L100x75x7x2500	2
3B	Crossarm for Pin Support L100×75×7t×2500	支持碍子用腕金 L100x75x7x2500	2
3C	Crossarm Brace Pipe type	パイプアームタイ	16
3D	LV Rack	低圧ラック	8
4A	Tr.Support(A) 75×75×3.2t×3000	変圧器架台(A) 75x75x3.2x3000	2
4B	Tr.Support(B) 75×75×3.2t×1500	変圧器架台(B) 75x75x3.2x1500	4
5A	Strain Plate	支線当金物	6
5B	Dead End Grip For Pole 45	巻付グリップ木柱用45sq.mm	6
5C	Dead End Grip For Thimble 45	巻付グリップシンブル用45sq.mm	6
5D	Dead End Grip For Insulator 45	巻付グリップ碍子用45sq.mm	12
5E	Stay Wire 45sq.mm	亜鉛めっき鋼撚り線45sq.mm	90
5F	Stay Insulator 33kV	支線用碍子	6
5G	Turnbuckle	ターンバックル	6
5H	Stay Rod	支線棒	6
5J	Stay Plate	支線プレート	6
6A	Bolt&Nut M16×50(Crossarm/Brace)	ボルトナット M16x50	4
6B	Bolt&Nut M16×150(LV Rack/Spool)	ボルトナット M16x150	20
6C	Bolt&Nut M16×200(Tr.arm A/B)	ボルトナット M16x200	8
6D	Bolt&Nut M16×250(Pole/Crossarm)	ボルトナット M16x250	4
6F	Bolt&Nut M16×350(Pole/Brace)	ボルトナット M16x300	6
6G	Bolt&Nut M16×450	ボルトナット M16x450	15
6J	Square Washer	角座金	40
8A	Grouund Rod 14×1500	接地棒 14x1500	20
8B	Lead Wire Terminal	リード端子	10
8C	Compression Connector(38/38)	圧縮コネクタ 38-38	14
8E	PVC Protection Pipe L=4.0m	接地線保護パイプ	2
8F	Stainless Band L=1200mm	ステンレスバンド L=1200mm	18
9	IBT Band	自在バンド	4
10	Nail	釘	28
11	Staple	ステップル	24
12	Danger Plate	危険表示札	1
13A	Transformer Primary Conductor PPC 22sq.mm	変圧器1次側引下げ用リード線 22sq.mm	24
13B	Transformer Secondary Conductor CV70sq.mm	変圧器2次側リード線 CV70sq.mm	96
14	33kV Lightning Arrester	33kV 避雷器	3
16	33kV Fused Cutout Switch	33kV ヒューズカットアウト	3
17	Transformer	変圧器	1
18	LV Fuse Cutout	低圧ヒューズカットアウト	6

Dwg.No.TPA-J2 33kV 変圧器柱[種別J2]
33kV Transformer Pole(100,200kVA)[Type J2]



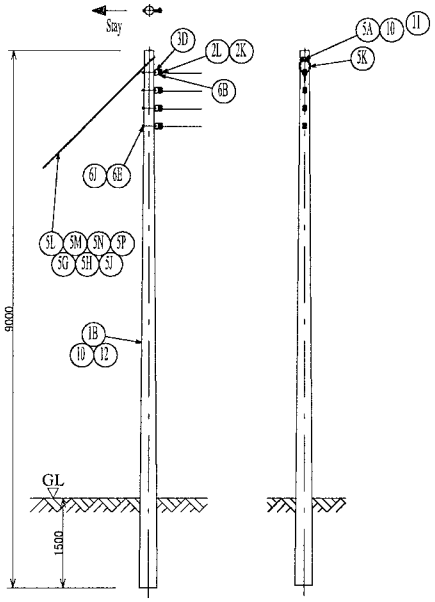
PART.NO.	DESCRIPTION		QTY
1A	Wood Pole 11m	木柱 11m	1
2G	33kV Pin Insulator	33kV ピンがいし	3
2H	Preformed Top Tie for AAC120	頂部タイ AAC120用	3
2K	Aluminum Bind Wire 4.0mm	アルミバインド線 4.0mm	12
2L	LV Shackle Insulator	低圧シャックルがいし	4
3A	Crossarm L100×75×7t×2500	腕金 L100x75x7x2500	1
3C	Crossarm Brace Pipe type	パイプアームタイ	2
3D	LV Rack	低圧ラック	4
6A	Bolt&Nut M16×50(Crossarm/Brace)	ボルトナット M16x50	2
6B	Bolt&Nut M16×150(LV Rack/Spool)	ボルトナット M16x150	4
6D	Bolt&Nut M16×250(Pole/Crossarm)	ボルトナット M16x250	1
6F	Bolt&Nut M16×350(Pole/Brace)	ボルトナット M16x350	5
6J	Square Washer	角座金	8
10	Nail	釘	4
12	Danger Plate	危険表示札	1

Dwg.No.TPA-K 高低圧共架柱[種別K]
HV and LV Combination Pole[Type K]



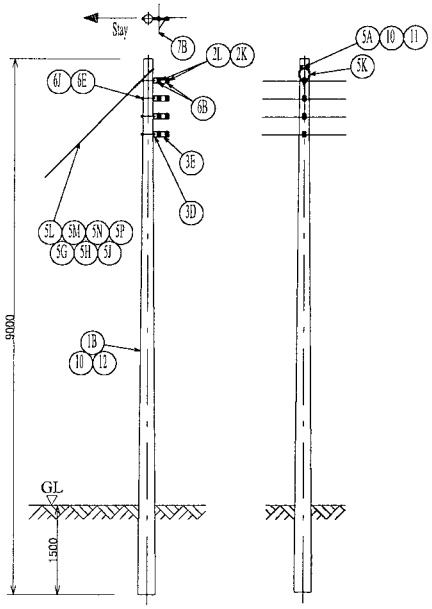
PART.NO.	DESCRIPTION		QTY.
1B	Wood Pole 9M	木柱 9m	1
2K	Aluminum Bind Wire 4.0mm	アルミバインド線 4.0mm	12
2L	LV Shackle Insulator	低圧シャックルがいし	4
3D	LV Rack	低圧ラック	4
6B	Bolt&Nut M16×150(LV Rack/Spool)	ボルトナット M16x150	4
6E	Bolt&Nut M16×300(Pole/LV Rack)	ボルトナット M16x300	4
6J	Square Washer	角座金	4
10	Nail	釘	4
12	Danger Plate	危険表示札	1

Dwg.No.TPA-LA 低圧引通し柱[種別LA]
LV Intermediate Pole[Type LA]



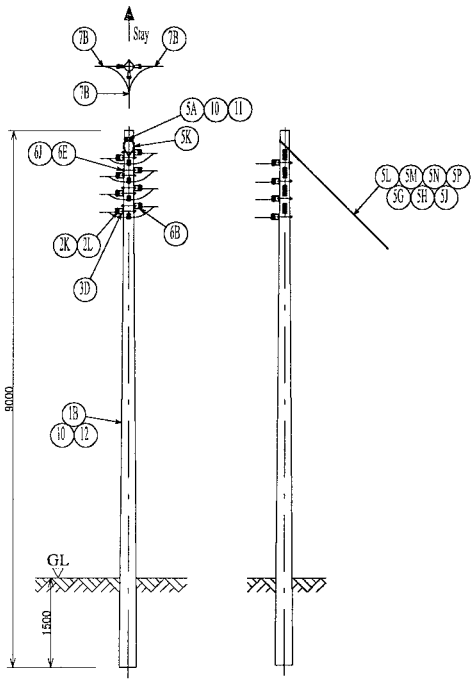
PART.NO.	DESCRIPTION		QTY.
1B	Wood Pole 9M	木柱 9m	1
2K	Aluminum Bind Wire 4.0mm	アルミバインド線 4.0mm	12
2L	LV Shackle Insulator	低圧シャックルがいし	4
3D	LV Rack	低圧ラック	4
5A	Strain Plate	支線当金物	1
5G	Turnbuckle	ターンバックル	1
5H	Stay Rod	支線棒	1
5J	Stay Plate	支線プレート	1
5K	Dead End Grip For Pole 38	巻付グリップ木柱用38sq.mm	1
5L	Dead End Grip For Thimble 38	巻付グリップシンブル用38sq.mm	1
5M	Dead End Grip For Insulator 38	巻付グリップ碍子用38sq.mm	2
5N	Stay Wire 38sq.mm	亜鉛めっき鋼撚り線38sq.mm	12
5P	Stay Insulator LV	玉碍子	1
6B	Bolt&Nut M16×150(LV Rack/Spool)	ボルトナット M16x150	4
6E	Bolt&Nut M16×300(Pole/LV Rack)	ボルトナット M16x300	4
6J	Square Washer	角座金	4
10	Nail	釘	8
11	Staple	ステップル	4
12	Danger Plate	危険表示札	1

Dwg.No.TPA-LB 低圧終端柱[種別LB]
LV Terminal Pole[Type LB]



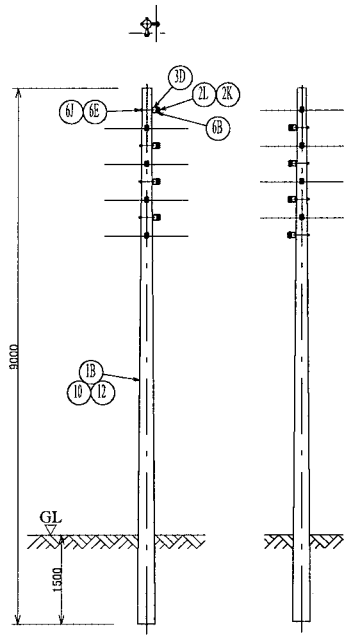
PART.NO.	DESCRIPTION		QTY
1B	Wood Pole 9M	木柱 9m	1
2K	Aluminum Bind Wire 4.0mm	アルミバインド線 4.0mm	24
2L	LV Shackle Insulator	低圧シャックルがいし	8
3D	LV Rack	低圧ラック	4
3E	Strap	ストラップ	8
5A	Strain Plate	支線当金物	1
5G	Turmbuckle	ターンバックル	1
5H	Stay Rod	支線棒	1
5J	Stay Plate	支線プレート	1
5K	Dead End Grip For Pole 38	巻付グリップ木柱用38sq.mm	1
5L	Dead End Grip For Thimble 38	巻付グリップシンブル用38sq.mm	1
5M	Dead End Grip For Insulator 38	巻付グリップ碍子用38sq.mm	2
5N	Stay Wire 38sq.mm	亜鉛めっき鋼撚り線38sq.mm	12
5P	Stay Insulator LV	玉碍子	1
6B	Bolt&Nut M16×150(LV Rack/Spool)	ボルトナット M16x150	8
6E	Bolt&Nut M16×300(Pole/LV Rack)	ボルトナット M16x300	4
6J	Square Washer	角座金	4
7B	Bolt type Connector (LV/LV)	締付け型コネクタ AAC50/AAC50	4
10	Nail	釘	8
11	Staple	ステップル	4
12	Danger Plate	危険表示札	1

Dwg.No.TPA-LCA　低圧分岐柱A[種別LCA]
LV T-off Pole A[Type LCA]



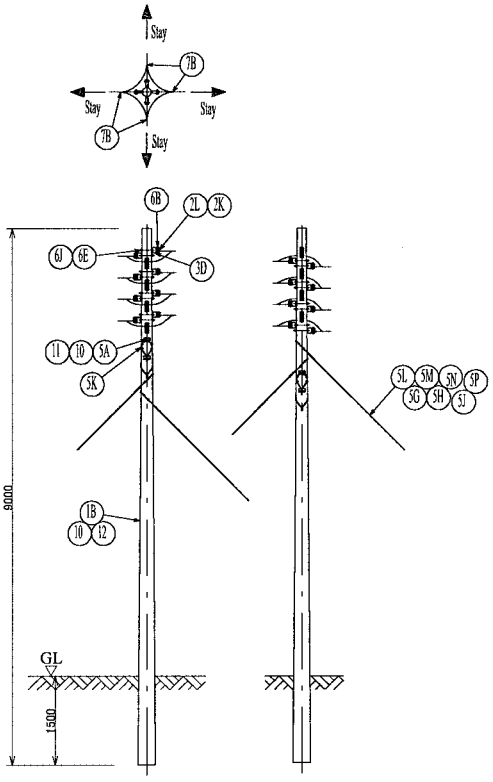
PART.NO	DESCRIPTION		QTY
1B	Wood Pole 9M	木柱 9m	1
2K	Aluminum Bind Wire 4.0mm	アルミバインド線 4.0mm	36
2L	LV Shackle Insulator	低圧シャックルがいし	12
3D	LV Rack	低圧ラック	12
5A	Strain Plate	支線当金物	1
5G	Turmbuckle	ターンバックル	1
5H	Stay Rod	支線棒	1
5J	Stay Plate	支線プレート	1
5K	Dead End Grip For Pole 38	巻付グリップ木柱用38sq.mm	1
5L	Dead End Grip For Thimble 38	巻付グリップシンブル用38sq.mm	1
5M	Dead End Grip For Insulator 38	巻付グリップ碍子用38sq.mm	2
5N	Stay Wire 38sq.mm	亜鉛めっき鋼撚り線38sq.mm	12
5P	Stay Insulator LV	玉碍子	1
6B	Bolt&Nut M16×150(LV Rack/Spool)	ボルトナット M16x150	12
6E	Bolt&Nut M16×300(Pole/LV Rack)	ボルトナット M16x300	12
6J	Square Washer	角座金	12
7B	Bolt type Connector (LV/LV)	締付け型コネクタ AAC50/AAC50	12
10	Nail	釘	8
11	Staple	ステップル	4
12	Danger Plate	危険表示札	1

Dwg.No.TPA-LCB　低圧分岐柱B[種別LCB]
LV T-off Pole B[Type LCB]



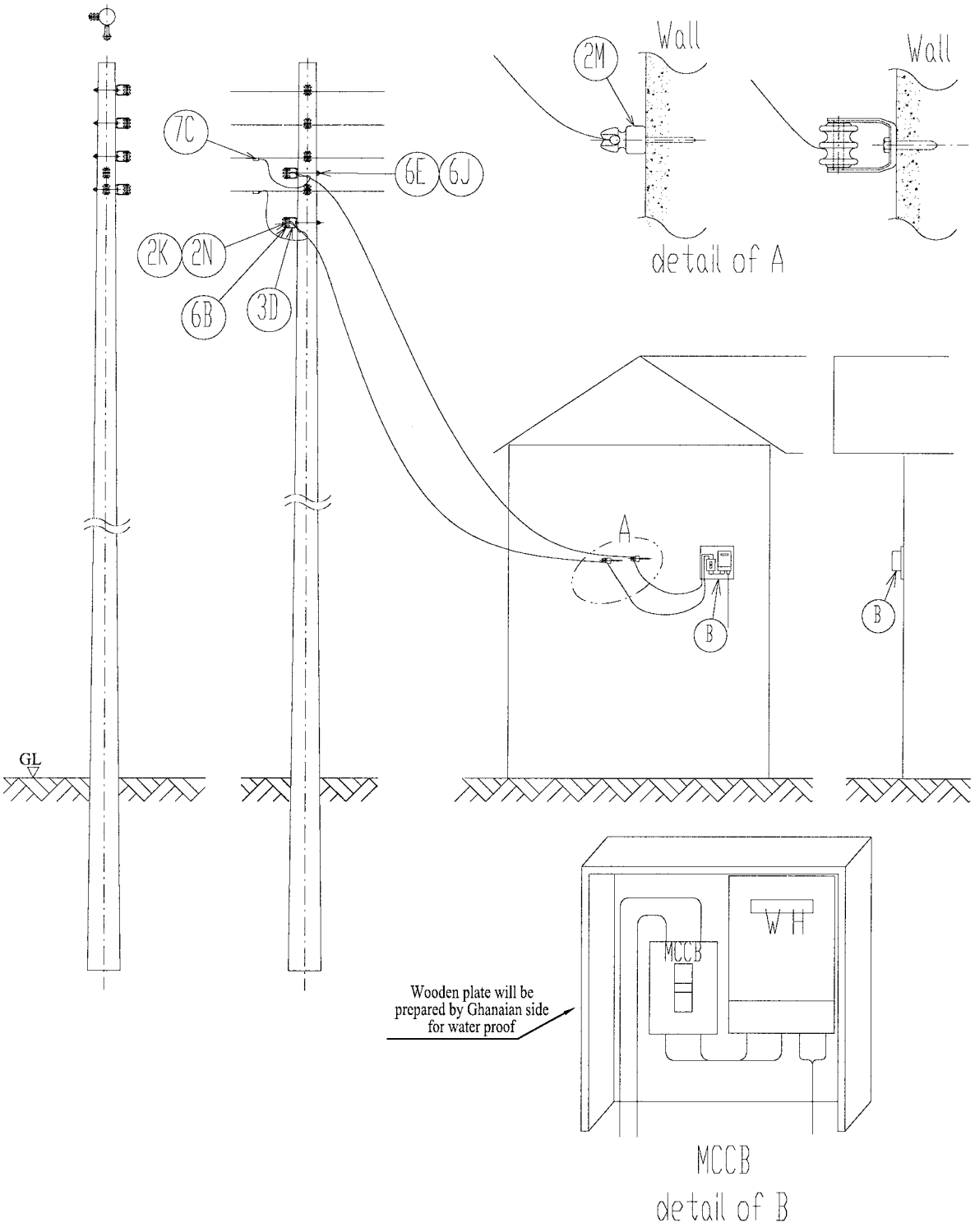
PART.NO.	DESCRIPTION		QTY
1B	Wood Pole 9M	木柱 9m	1
2K	Aluminum Bind Wire 4.0mm	アルミバインド線 4.0mm	24
2L	LV Shackle Insulator	低圧シャックルがいし	8
3D	LV Rack	低圧ラック	8
6B	Bolt&Nut M16×150(LV Rack/Spool)	ボルトナット M16x150	8
6E	Bolt&Nut M16×300(Pole/LV Rack)	ボルトナット M16x300	8
6J	Square Washer	角座金	8
10	Nail	釘	4
12	Danger Plate	危険表示札	1

Dwg.No.TPA-LCC　低圧分岐柱C[種別LCC]
LV T-off Pole C[Type LCC]



PART.NO.	DESCRIPTION		QTY
1B	Wood Pole 9M	木柱 9m	1
2K	Aluminum Bind Wire 4.0mm	アルミバインド線 4.0mm	48
2L	LV Shackle Insulator	低圧シャックルがいし	16
3D	LV Rack	低圧ラック	16
5A	Strain Plate	支線当金物	4
5G	Turnbuckle	ターンバックル	4
5H	Stay Rod	支線棒	4
5J	Stay Plate	支線プレート	4
5K	Dead End Grip For Pole 38	巻付グリップ木柱用38sq.mm	4
5L	Dead End Grip For Thimble 38	巻付グリップシンブル用38sq.mm	4
5M	Dead End Grip For Insulator 38	巻付グリップ碍子用38sq.mm	8
5N	Stay Wire 38sq.mm	亜鉛めっき鋼撚り線38sq.mm	48
5P	Stay Insulator LV	玉碍子	4
6B	Bolt&Nut M16×150(LV Rack/Spool)	ボルトナット M16x150	16
6E	Bolt&Nut M16×300(Pole/LV Rack)	ボルトナット M16x300	16
6J	Square Washer	角座金	16
7B	Bolt type Connector (LV/LV)	締付け型コネクタ AAC50/AAC50	16
10	Nail	釘	20
11	Staple	ステップル	16
12	Danger Plate	危険表示札	1

Dwg.No.TPA-LCD　低圧分岐柱D[種別LCD]
LV T-off Pole D[Type LCD]



PART.NO.	DESCRIPTION		QTY	
			2P	3P
2P	Copper Bind Wire 1.6mm Insulated	銅バインド線1.6mm(絶縁)	12	24
2M	Coach Screw Insulator	コーチスクリューがいし	2	4
2N	Spool Insulator(Double Groove)	スプールがいし(2溝型)	2	4
3D	LV Rack	低圧ラック	2	4
6B	Bolt&Nut M16×150(LV Rack/Spool)	ボルトナット M16x150	2	4
6E	Bolt&Nut M16×300(Pole/LV Rack)	ボルトナット M16x300	2	4
6J	Square Washer	角座金	2	4
7C	Bolt type Connector (LV/Service Drop)	締付け型コネクタAAC 50/Cu10-16	2	4

Dwg.No.LV-G01: 低圧配電資機材据付計画図
LV Distribution Equipment and Materials Installation Scheme Drawing

2-2-4 Implementation Plan

2-2-4-1 Implementation Policy

The Project will be implemented within the framework of Japan's grant aid cooperation scheme and, therefore, its implementation will only take place after approval of the Project by the Government of Japan and the Exchange of Notes (E/N) between the Government of Japan and the Government of Ghana. The basic issues and points to note in the process of implementing the Project are described below.

(1) Project Implementation Body

The organization responsible for the Project on the Ghanaian side is the Ministry of Energy (MOE). Although the Electricity Department of the MOE will be directly responsible for the Project, the Electricity Company of Ghana (ECG) will oversee the construction, operation and maintenance of relevant facilities after the commencement of electricity supply services. It will, therefore, be necessary for the Electricity Department of the MOE to maintain close contact and to consult with Japanese consultants and subcontractors and to select a person responsible for the Project to ensure its smooth progress.

The person responsible for the Project at the MOE will be required to explain fully the contents of the Project to staff members of the MOE, ECG and local residents of the Project sites in order to facilitate their understanding of the Project and to encourage their cooperation in its implementation.

(2) Consultants

A Japanese consultant will conclude a consulting services agreement with the MOE and will provide detailed design and work supervision for the Project to realize the planned procurement and installation of equipment and materials. The consultant will also prepare tender documents and provide necessary assistance for MOE, the Project implementation body, to conduct tenders.

(3) Equipment Supplier

In accordance with the Japan's grant aid cooperation scheme, a Japanese equipment supplier selected by the Ghanaian side through competitive tendering will carry out the procurement and installation of equipment and materials. The supplier will be required to

submit the implementation schedule to the Ghanaian side and coordinate such matters as the schedule before the commencement of site construction work.

As it is deemed necessary that the contract to provide after-services, including the supply of spare parts and an appropriate response to breakdowns, the equipment supplier must pay proper attention to adequate communication channels with the Ghanaian side after handing over the equipment and materials.

(4) Necessity for Dispatch of Japanese Engineers

The Project is to be implemented in a short period of time and will be complex, extensive work that will include 33kV transmission line installation, foundation work and construction of a booster station including installation of boosters such as transformers and switchgear panels. Consequently, careful coordination of all types of work is essential. Since much of the various types of work will be conducted simultaneously, it is essential that a site manager capable of controlling and guiding all works in an integral manner be dispatched from Japan to ensure work progress, quality and safety.

Since highly skilled engineers are required for adjustment and testing when installing the equipment and materials at substation facilities and after installation, it will be difficult to effectively utilize local companies other than workers. Accordingly, engineers must be dispatched from Japan to ensure quality, technical guidance and schedule control.

2-2-4-2 Implementation Conditions

(1) State of the Construction Industry in Ghana and Technology Transfer

As previously mentioned in 2-2-1-4, there are a few general contractors and electric firms in Accra and Kumasi cities, so it is possible to place orders at local companies for on-site recruitment and procurement of workers, transportation vehicles, construction work equipment and materials within Ghana for transmission lines construction and foundation work for the booster station under the Project. However, given the fact that the Project is being made possible through grant aid cooperation of the Government of Japan under stringent terms, and that the quantity of locally procured wooden poles, etc. may not be completely satisfactory, the dispatch of Japanese engineers is vital to scheduling, quality and safety control.

For now, there are few cases of substation installation work and the equipment installation work, trial operation and adjustment after installation will demand well-experienced engineers. As it will be difficult to utilize local companies effectively,

except for the recruitment of workers, the dispatch of Japanese engineers by the Japanese equipment supplier is preferred when recruiting workers and procuring the required installation equipment from local companies. These Japanese engineers will provide on-the-job training (OJT) for the Ghanaian engineers during the relevant installation work period to transfer knowledge.

(2) Effective Use of Local Equipment and Materials

The local procurement of aggregate, cement and reinforcing bars, etc. for foundation work, conductors and wooden poles, etc. in the installation of transmission and distribution lines is available in Ghana even though quality guidance and work progress will be needed to meet the delivery terms. In fact, such items have been procured in Ghana for many similar projects. Accordingly, the work plan utilizes locally available equipment and materials as much as possible. However, since locally manufactured products are unavailable Ghana is depending on importation of Japanese equipment and materials for the Project.

(3) Security Measures

Public unrest in Ghana is relatively rare and the Project sites have good access from Kumasi City, the second largest city. Therefore, the Project sites are situated in the locations where monitoring, etc. can be easily carried out. However, special attention will still be necessary to prevent theft of equipment and materials and to ensure the safety of work-related personnel since some areas of Ghana are out of range of cellular phones. Although the Government of Ghana has promised to take the necessary steps to ensure safety, the Japanese side will also provide the following.

① The 33/33kV booster station will be constructed in Nyinahin Area and temporary equipment and materials yard will be at the same location. Therefore, the Japanese side will also provide a gate and fencing to protect local residents from any accidents.

② A liaison system with work-related personnel will be created.

(4) Tax Exemption

The procedure for tax exemption (including VAT) of equipment and materials to be procured under the Project in the Ghanaian side is as follows. After a subcontractor submits an application for tax exemption to the MOE, the MOE requests a letter for tax exemption from the Ministry of Finance, which is sent to customs (copies are issued simultaneously to the MOE and the subcontractor). When equipment and materials arrive at a port or an airport in Ghana, the subcontractor presents the prescribed shipment

documents with an attached copy of the above-mentioned tax exemption letter to customs. Tax is then exempted. Therefore, it is important to pay special attention to the process of acquiring tax exemption in order to prevent any delays which may have a negative impact on the progress of the Project.

2-2-4-3 Scope of Works

As for the work demarcation between the Japanese side and the Ghanaian side, the Japanese side will conduct procurement of equipment and materials with installation works for the new booster station and 33kV transmission lines under the Project, in consideration of engineering and fiscal capability of the Ghanaian side. Also the Japanese side will conduct the procurement of equipment and materials for all LV distribution lines, 50% of consumers' service drop equipment such as service drop wires, watt-hour meters and MCCBs, whereas the Ghanaian side will procure the rest half of consumers' service drop equipment as well as install those equipment and materials. Accordingly, the Ghanaian side will be responsible for the procurement and installation of electric poles for said wires. A detailed description of the work demarcation between the Japanese and Ghanaian sides is shown on Table 2.2.4.3-1.

Table 2.2.4.3-1 Work Demarcation between the Japanese and Ghanaian Sides

Work Item	Procurement		Installation		Remarks
	Japan	Ghana	Japan	Ghana	
1. Common Requirements					
(1) Bush clearing along the proposed transmission & distribution lines before installation work for poles (Estimated area:：10m×91km = 0.91km2)		○		○	To be completed prior to commencement of Japanese construction.
(2) Providing storage yard for materials & equipment prior to delivery to the site		○		○	To be prepared prior to the arrival of equipment and materials
(3) Assuring worker security at the site		○		○	
(4) Managing any disputes from consumers regarding power outage caused by construction work (including compensation for consumers)		○		○	Especially when the new lines are connected to the existing lines.
(5) Public notice of scheduled power interruptions for existing consumers during the implementation stage when necessary		○		○	
(6) Removal of trees and bushes around transmission & distribution lines to protect poles from bushfires after commencement of operation		○		○	To be implemented periodically.
2. Construction of New Booster Station					
(1) 33kV voltage regulating transformer	○		○		
(2) 33kV switchgear panels	○		○		
(3) Station auxiliary supply	○		○		
(4) Equipment & materials required for connection of (1) through (3) above	○		○		

Work Item	Procurement		Installation		Remarks
	Japan	Ghana	Japan	Ghana	
(5) Civil engineering, foundation & exterior work required for (1) through (4)	○		○		Premises only, including outdoor lighting
(6) Jumper connection between existing 33kV transmission lines and underground cable terminals	○		○	○ (Note)	(Note) The Ghanaian side is responsible for connection work between cable terminals and existing electric wires
(7) Spare parts, testing equipment & installation/maintenance manuals	○		(○)	○ (Storage)	Spare parts: one-year supply. Test equipment & maintenance tools will be used for the installation work by the Japanese side
(8) On-site testing before handing over			○		(Note) AC dielectric test and protective relay test will be carried out by the Ghanaian side
(9) OJT			○ (Guidance)		
(10)Construction of perimeter fence & gate	○		○		
(11)Site leveling (northwest corner shall be considered the base level) & access road		○		○	To be completed prior to the commencement of Japanese construction
(12)Guard house		○		○	
(13)Drainage system for access road		○		○	
3. Construction of 33kV Transmission Lines					
(1) Conductor, lightning arrestors, insulators, cross- -arms, load break switches, fused cutouts, fixing metal-ware & accessories	○		○		
(2) Distribution transformers	○		○		
(3) Electric poles	○		○		
(4) Civil engineering work (foundation, excavation, refilling work, etc.)	○		○		
(5) Installation/maintenance manual	○		○		
(6) Test equipment & tools	○		(○)	○ (Storage)	Test equipment & tools will be used for installation work
(7) On-site testing before handing over	○		○		
(8) Removal of obstructions (including trees)				○	To be completed prior to the commencement of Japanese construction
4. Construction of LV Distribution Lines					
(1) Conductor, service drop wires, insulators, cross-arms, fixing metal-ware, kWh meters & MCCBs	○			○	
(2) Wooden boards (for the above-mentioned kWh meters & MCCBs)		○		○	
(3) Electric poles		○		○	
(4) Installation/maintenance manuals	○			○	
(5) Test equipment & tools		○		○	
(6) On-site testing before handing over		○		○	
(7) Technical guidance			○ (Guidance)		
(8) Spare parts		○		○	
(9) Removal of obstructions (including trees)				○	

(Note) ○ indicates the side responsible for necessary work/procurement.

2-2-4-4 Consultant Supervision

The consultant will organize a reliable project team to conduct detailed design and work supervision to ensure smooth implementation of the Project taking the objectives of the basic design into consideration and in accordance with the Japan's grant aid scheme. Given the dispersion of the Project sites, the planned parallel implementation of the 33kV transmission line installation work by the Japanese side and low voltage distribution line installation work by the Ghanaian side, the consultant will appoint at least one full-time site engineer during the work period to supervise schedule control, quality control, and commissioning test and safety control. In addition, the consultant will dispatch other engineers in line with the progress of the equipment installation, trial operation and adjustment and completion testing, etc. to supervise relevant work conducted by the equipment supplier. Furthermore, the consultant will assign Japanese experts to observe factory and pre-shipment testing of equipment manufactured in Japan so that any problems on the equipment after arrival in Ghana can be prevented in advance.

(1) Basic Principles of Work Supervision

The basic principles behind the work assigned to the consultant include supervision of the work progress in order to ensure completion within the established schedule, to ensure quality, quantity and delivery dates of equipment and materials specified in the contract, and to supervise the subcontractor so that the site work is carried out safely.

Important points to note for work supervision are described below.

1) Schedule Control

The implementation schedule planned at the conclusion of the contract and actual state of progress will be compared monthly or weekly to ensure that the equipment supplier meets the handing over date specified in the contract. If any delay of work is anticipated, the consultant will issue a warning to the subcontractor and will request that the subcontractor take steps to improve the situation so that the work is completed within the contract period. The above comparison is mainly conducted by confirming the following items.

① Quantity of work completed (Quantity of equipment manufactured at the factory, and equipment for completed civil work on-site)

② Quantity of equipment and materials delivered (substation, transmission and distribution equipment and materials for civil engineering work)

③ State of temporary work and preparation of construction machinery

④ Actual number of engineers, skilled workers and laborers and their ratio compared to the original plan

2) Quality Control

The consultant will carry out the items listed below to ensure that the equipment and materials manufactured, delivered and installed and the facilities installed meet the quality and specifications set by the contract. If any doubt exists with regard to their quality or specifications, the consultant will immediately ask the equipment supplier to rectify, alter or improve the situation.

① Checking of shop drawings and specifications of equipment and materials

② Observing factory inspection of equipment and materials or checking factory test results

③ Checking of packing, transporting and temporary on-site storage methods

④ Checking of equipment installation drawings and instructions

⑤ Checking of manuals on test operation, adjustment, testing and inspection of equipment

⑥ Supervision of equipment installation work and observing of trial operation, adjustment, testing and inspection

⑦ Checking of civil work drawings, factory fabrication drawings, and checking as-built drawings and products against original drawings

3) Safety Control

The consultant will conduct safety supervisions to prevent site accidents involving workers and/or third persons during the installation period through consultations and cooperation with subcontractor’s site representatives. The following points regarding on-site safety control should be carefully noted.

① Enforcement of safety control rules and appointment of a safety control manager

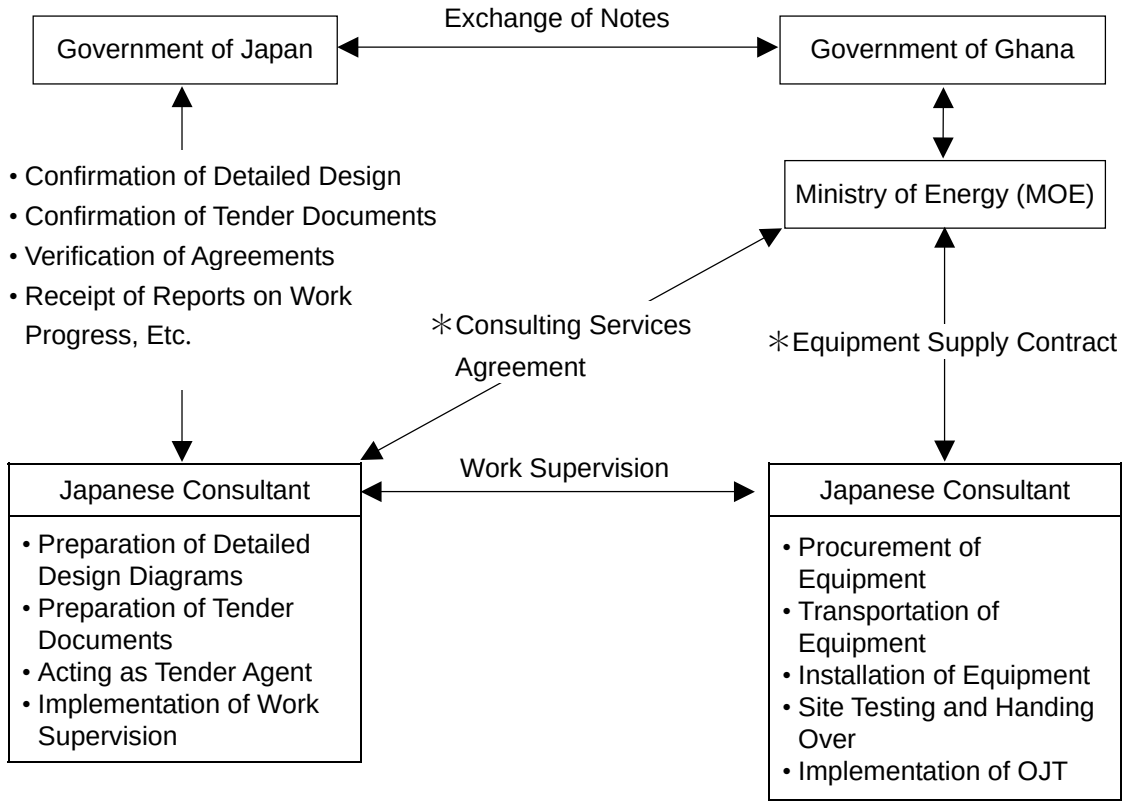
② Prevention of faults through regular inspection of construction machinery

③ Clear explanation of travel routes for work-related vehicles and construction machinery and strict enforcement of safe driving speeds on site

④ Enforcement of welfare measures and work holidays

(2) Project Implementation System

The relationship between those involved in the implementation of the Project, including the work supervision stage, is shown in Figure 2.2.4.4-1.



＊Note: The consulting services agreement and the equipment supply contract must be verified by the Government of Japan.

Fig. 2.2.4.4-1 Project Implementation System

(3) Supervising Engineers

Apart from the 33kV transmission line construction, booster station construction work and necessary civil engineering work, the equipment supplier will employ local construction companies in Ghana in accordance with the contract agreements. Since it will be necessary for the equipment supplier to fully understand the contents of the subcontract regarding the work schedule, work quality and compliance with the specifications and safety measures, the equipment supplier will dispatch Japanese engineers with oversees experience similar to the Project to provide guidance and training for the equipment supplier.

Given the scale and contents of the planned booster station installation under the Project, the equipment supplier should dispatch full-time at least those engineers listed in Table 2.2.4.4-1.

Table 2.2.4.4-1 Engineers Dispatched by Equipment Supplier

	Type of Engineer	No.	Assign Work	Assignment Period
Nyinahin Area	Site Manager	1	Overall work management, consultation and coordination with related organizations and obtaining of necessary permits, etc.; OJT, supervision, equipment procurement control, customs clearance, personnel control, accounting	Entire installation period
	Electrical Engineers (Transmission)	2	Installation supervision of 33kV transmission lines	Relevant installation work period
	Electrical Engineers (Substation Equipment)	2	Installation supervision of transformer, switchgear panels, cabling, etc.	Relevant installation work period
	Civil Engineer	1	Supervision of civil engineering work and foundation work for substation equipment	Relevant civil work period
	Testing and Adjustment Engineer (Transmission)	1	Testing and adjustment and OJT of transmission lines and circuit breakers, etc.	Relevant testing and adjustment period
	Testing and Adjustment Engineer (Transformer)	1	Testing and adjustment and OJT of transformers and switchgear panels	Relevant testing and adjustment period
Amansie West District	Site Manager	1	Overall work management, consultation and coordination with related organizations and obtaining of necessary permits, etc.; OJT, supervision, equipment procurement control, customs clearance, personnel control, accounting	Entire installation period
	Electrical Engineers (Transmission)	2	Installation supervision of 33kV transmission lines	Relevant installation work period
	Testing and Adjustment Engineer (Transmission)	1	Testing and adjustment and OJT of transmission lines and circuit breakers, etc.	Relevant testing and adjustment period

2-2-4-5 Procurement Plan

The substation equipment (including pole mounted transformers and fuses) to be procured and installed under the Project will not be manufactured in Ghana. Accordingly, all substation equipment and related materials, including transformers and switchgears, etc. will be imported from a variety of sources, such various European nations as the UK, France, Italy, the Netherlands and Germany and Japan due to the funding background of various projects. Although some European substation equipment manufacturers have agents in Ghana, few manufacturers provide local aftercare service or spare parts, etc. for high voltage substation equipment. Consequently, during the selection of supply sources for the substation equipment and materials for the Project, it is necessary to carefully examining the current situation when selecting sources. To be more precise, the ease of operation and maintenance of the

equipment by the Ghanaian engineers and the availability of aftercare service and availability of spare parts in Ghana, etc. must be taken into consideration.

ECG, which will be responsible for operation and maintenance of the equipment and materials after the completion of the Project, is quite familiar with the operation and maintenance methods of Japanese equipment as Japanese-made transformers and other distribution transformers previously procured are still functioning well. ECG is confident in the performance of the Japanese-made main substation equipment and aftercare service provided by Japanese manufacturers. Therefore, they have requested Japanese substation equipment and materials for the Project through the grant aid project of the Government of Japan.

Also 33kV All Aluminum Conductors which have been procured in the third country under the past grant aid projects by the Government of Japan will be procured from the third country because they have not experienced any major problems after installation at sites, and the unit price is more competitive than the Japanese one.

Based on the above, the equipment and materials required for the Project will be procured in the following manner.

(1) Equipment and Materials to be Procured in Ghana

1) Civil Work and Materials to be Procured in Ghana

Cement, sand, aggregate for concrete, concrete blocks, bricks, reinforcing bars, timber, petrol, diesel oil, work-related vehicles, cranes, trailers, equipment and materials for temporary work

2) Equipment and Materials for Transmission and Distribution Lines

Wooden poles, LV Aluminum conductors, and kWh meters

(2) Equipment and Materials to be Procured in Japan

1) Substation Equipment and Materials

Equipment and materials for transformers and 33kV switchgear

2) Equipment and Materials for Transmission and Distribution Lines

Equipment and materials for electric wires, distribution transformers, insulators, lightning arrestors, load break switches, primary cutout switches and others

(3) Equipment and Materials to be Procured in the third country

33kV All Aluminum Conductors

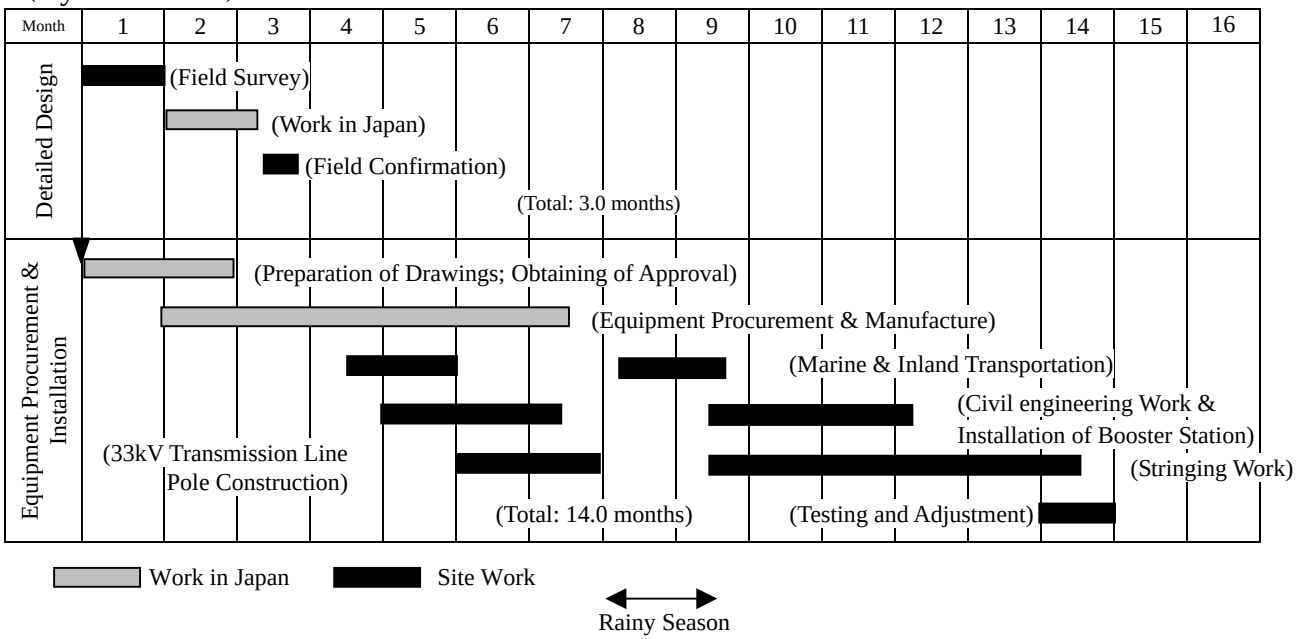
For the transportation of the products procured from Japan, adequate packaging will be employed to ensure safe transportation during the long marine voyage, port landing, land transportation to the Project sites and storage.

Tema Port appears to be the most convenient port of landing as its major loading and unloading facilities are best suited for equipment to be procured under the Project. The paving conditions of major trunk roads from Tema Port to the Project sites are good. Although the branch roads to Amansie West District are unpaved, they are still accessible by trailer at low speeds.

2-2-4-6 Implementation Schedule

The recommended project implementation schedule based on the Japan's grant aid cooperation scheme is shown in Fig. 2.2.4.6-1.

（Nyinahin Area）



（Amansie West District）

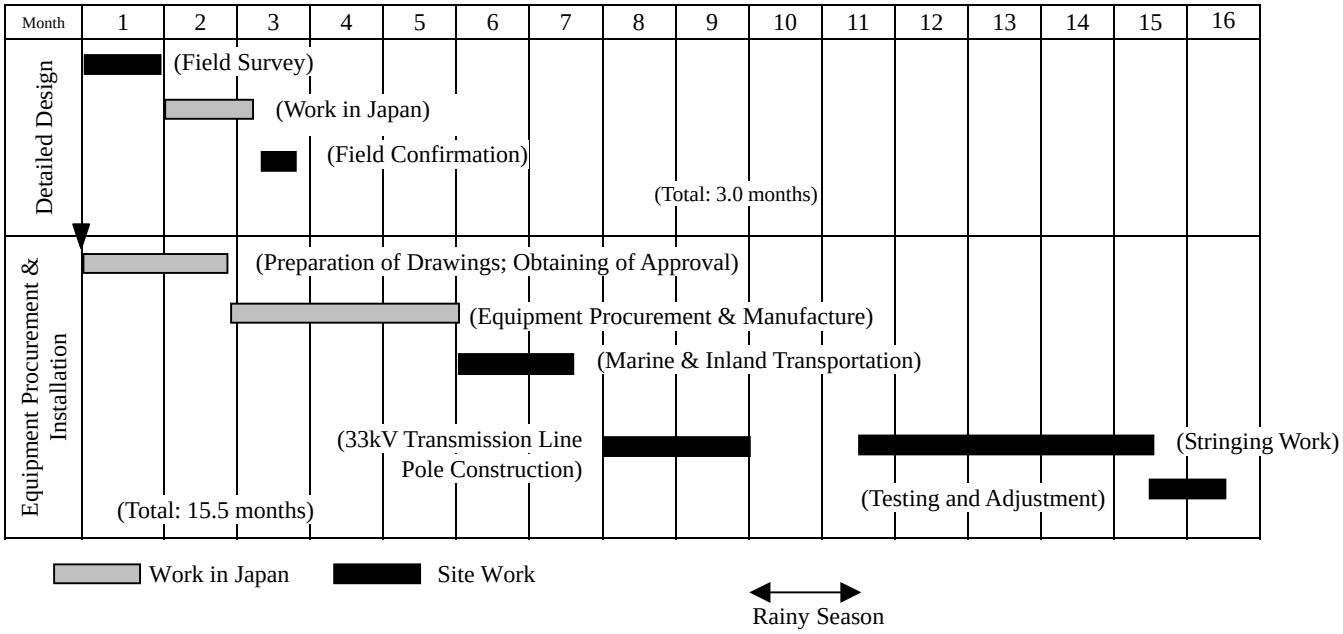


Fig. 2.2.4.6-1 Project Implementation Schedule

2-3 Obligations of Recipient Country

During the implementation of the Project, apart from the work responsibilities of the Ghanaian side as outlined in 2-2-4-3 (Scope of Work), the Ghanaian side will be responsible for the following items.

(1) To provide necessary data and information for the Project

(2) To ensure speedy unloading, customs clearance and tax exemption of goods for the Project at ports and/or airports

(3) To accord Japanese nationals whose services may be required in connection with the supply of products and services under verified contracts for necessary entry and stay in Ghana therein in the performance of work

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

(5) To bear commissions to a Japanese bank for banking services based on banking arrangements

(6) To bear all expenses other than those borne by grant aid necessary in the implementation of the Project

(7) To assign exclusive counterpart engineers and technicians for the Project to transfer operation and maintenance knowledge under the Project and to observe and confirm construction/installation work and quality of equipment and materials when inspections are carried out

(8) To use and maintain appropriately and effectively all equipment and materials provided through Japan's grand aid

(9) To provide proper disposal sites for excavated soil, wastewater and waste oil discharged during the construction period

(10) To provide proper instruction and education for the safety of local residents

2-4 Project Operation Plan

2-4-1 Basic Concept

Proper operation and maintenance (O & M) of transmission and substation equipment and the preservation of a proper working environment are essential to improving the reliability of the electricity supply system for the purpose of providing stable electricity supply services for consumers at the Project sites. Appropriate preventive maintenance aimed at reducing the fault rate and improving reliability, safety and efficiency of substation, transmission and distribution equipment is strongly recommended.

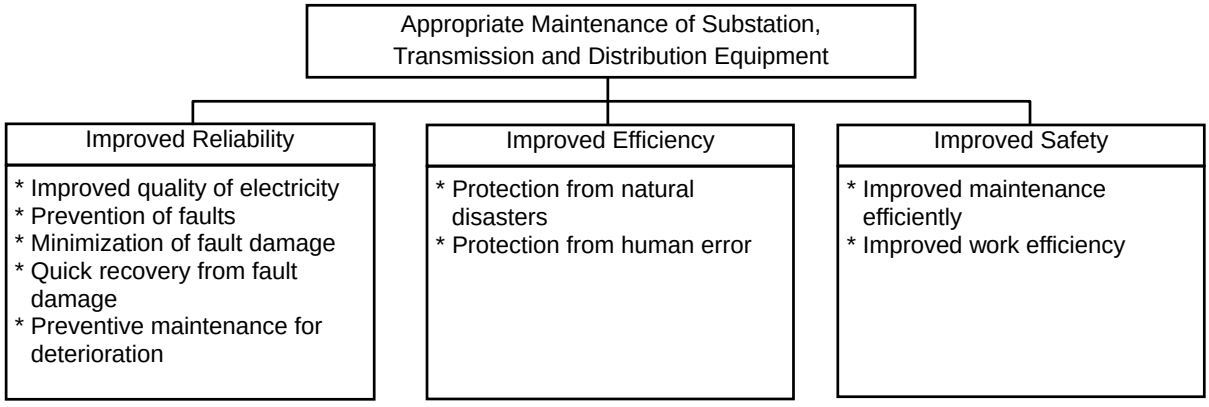


Fig. 2.4.1-1 Basic Model for Substation, Transmission and Distribution Equipment Maintenance

Figure 2.4.1-1 represents the basic maintenance model. Based on the basic maintenance model described above, emphasis for procured and installed equipment and facilities under the Project should be on preventive maintenance to avoid failure.

Implementation of OJT for operation and maintenance of relevant substation (booster station) equipment is planned by engineers to be dispatched by the Japanese equipment supplier during installation work, testing and adjustment work periods. At the same time, necessary spare parts, testing devices, maintenance tools, operation and maintenance manuals will be provided by the Japanese side and an operation and maintenance system to be implemented after commencement of electricity supply services is proposed. Therefore, it will be possible to sufficiently display its effects.

In addition, the number of ECG staff in charge of operation and maintenance after implementation of the Project will be increased by 5 field maintenance workers (currently 6) and 2 tariff collectors (currently 2) mainly at the Bibiani Office in the Western Region which has jurisdiction over Nyinahin Area. Therefore, an organizational and personnel system for appropriate electricity business operations can be expected.

2-4-2 Regular Inspections

(1) Regular Inspection of Substation Equipment

Standard inspection items for substation equipment to be procured and installed under the Project are shown in Table 2.4.2-1.

As shown in the table, substation equipment inspections are classified as ① "patrolling inspections" which are daily hands-on checks for abnormal heat or sounds, etc. from the equipment, ② "standard inspections" which supplement daily patrolling inspections and include the checking of equipment bolt tightness and the cleanliness of/or damage to the surface of insulated items, etc., and ③ "detailed inspections" to check the proper functioning of interlocking mechanisms between equipment and the accuracy of instruments, etc.

Standard inspections are carried out every one or two years while detailed inspections are conducted approximately once every four (4) years. Regular replacement of certain parts, either during standard or detailed inspections, is desirable after the characteristics are confirmed and the frequency of use of such parts. These include fuses, measuring instruments and relays, etc. installed in the switchgear panels and others susceptible to deterioration in performance, including insulation performance, abrasion of contact points and changes in characteristics.

Table 2.4.2-1 Regular Inspection Items for Standard Substation Equipment

Subject	Inspection Item (Method)	Patrolling Inspection	Standard Inspection	Detailed Inspection
Equipment Condition	Switchgear indicator and indication light	○	○	
	Abnormal sound or odor	○	○	
	Thermal discoloration of terminals	○	○	
	Cracks, damage or staining of bushing and insulator	○	○	
	Rust on casings and frames	○	○	
	Abnormal temperature (thermometer)	○	○	
	Fastening of bushing terminals (mechanical check)	○	○	
Operating Apparatus and Control Panel	Correct indication by various instruments	○	○	○
	Counter indication		○	○
	Condensation, rust and damage inside console and panels		○	○
	State of oil supply and cleaning		○	○
	Fastening of cable terminals	○	○	○
	State of switchgear indication		○	○
	Air leakage and oil leakage		○	○
	Pressure before and after operation (such as air pressure)		○	○
	Working of instruments		○	○
	Rust, deformation and/or damage to springs	○	○	○
	Abnormality of fastening pins		○	○
	Auxiliary switchgear and relays		○	○
	DC control power source	○		
Measurement/ Testing	Measurement of insulation resistance		○	○
	Measurement of contact resistance			○
	Breaking of heater cable		○	○
	Testing of relay function		○	○

(2) Regular Inspection of Transmission and Distribution Lines

One important consumer service is the maintenance of transmission and distribution lines by detecting breakdowns and damage through regular patrols and immediate repair. In addition, if short-circuiting or any other fault is anticipated due to transmission or distribution lines coming in contact with trees, etc., preventive measures must be taken, even if it involves felling of trees. The major items for patrol inspections are listed below.

① Breakdown of conductors
② Damage to insulators
③ Contact between conductors and trees
④ Damage to poles
⑤ Straightness of poles
⑥ Positioning and oil leakage from distribution transformers

⑦ Operational status of circuit switches

(3) Spare Parts Procurement Plan

Spare parts for the substation, transmission and distribution equipment include replacement and emergency parts required during a breakdown, etc. The procurement of spare parts should be carried out if necessary after the Ghanaian side examines the need during regular checks described earlier.

The procurement of a one-year supply of spare parts and maintenance tools is planned under the Project as a minimum requirement and is listed in Table 2.4.2-2. The Ghanaian side will be responsible for appropriating the necessary funds for the procurement of additional spare parts by the end of the first year after the completion of the Project.

Table 2.4.2-2 Spare Parts and Maintenance Tools to be Procured under the Project

Item	Unit	Quantity	
		Nyinahin	Amansie West
1. Spare Parts			
1.1 Booster Station			
(1) For voltage regulating transformer			
1) 33kV bushing	piece	1	
2) Silica gel for dehumidifier	set	1	
3) Various lamps	%	100	
4) Various fuses	%	100	
5) Various MCCBs	set	1	
6) Various relays	set	1	
7) Thermometer	set	1	
8) Oil gauge	set	1	
9) Space heater (with thermostat)	set	1	
10) Packing for repair	set	1	
11) Pressure relief plate	piece	1	
12) Lightning arrestor (single phase)	piece	3	
(2) For switchgear cubicle			
1) Vacuum circuit breaker	set	1	
2) Various lamps	%	100	
3) Various fuses	%	100	
4) Various MCCBs	set	1	
5) Various protective relays	set	1	
6) Various auxiliary relays	set	1	
7) Space heater (with thermostat)	set	1	
8) Various instruments (V, A, kW, kVar and Wh meters)	set	1	
9) Various current transformer for instruments	set	1	
10) Various voltage transformer for instruments	set	1	
11) Various switches	set	1	
(3) For DC Power Source System			
1) Various lamps	%	100	
2) Various fuses	%	100	
3) Various MCCBs	set	1	
4) Various auxiliary relays	set	1	

Item	Unit	Quantity	
		Nyinahin	Amansie West
5) Various switches	set	1	
(4) For Outdoor lighting			
1) Lamp	piece	5	
2) Ballast	piece	1	
3) Photocell	piece	1	
4) Lamp cover	piece	1	
1.2 33kV Transmission Lines			
(1) For Load Break Switch			
1) Various contacts	set	1	commonly used at both sites
2) Load Break Switch	set	1	-ditto-
(2) Lightning arrester (single phase)	piece	9	6
(3) 33kVCable Termination Materials (indoor/outdoor)	set	3	commonly used at both sites
(4) Primary Cutout	piece	3	3
(5) Fuses for Primary Cutout	piece	9	6
(6) LV Cutouts	piece	3	3
(7) Fuses for LV Cutouts	piece	18	9
2. Testing Equipment/Tools			
(1) Insulation oil tester	unit	1	commonly used at both sites
(2) Analogue-type tester	piece	1	-ditto-
(3) Phase rotation meter	piece	1	-ditto-
(4) Voltage detectors (high and low voltage use)	piece	1	-ditto-
(5) Insulation resistance tester (megger) 500V	set	1	-ditto-
(6) Insulation resistance tester (megger) 1000V	set	1	-ditto-
(7) Portable earth resistance tester	set	1	-ditto-
(8) Digital-type multi-meter	set	1	-ditto-
(9) Clip-on meter	set	1	-ditto-
3. General Maintenance Tools			
1) Hydraulic compression tool (with dice)	set	1	1
2) Hydraulic termination pliers (10 – 120mm^2)	set	1	1
3) Cable cutter	set	1	1
4) Ring anger	set	1	1
5) Bolt cripper	set	1	1
6) Wire stripper	set	1	1
7) Portable earth set	set	1	1
8) Primary cutout switch operating stick	piece	1	1

2-4-3 Operation and Maintenance Vehicles

Although the total number of consumers at the Bibiani Office which has jurisdiction over Nyinahin Area is 3,680 households as of March 2002, approximately 7,600 consumers will be added in Nyinahin Area after completion of the Project. Consequently, the total number of consumers will be approximately 3 times the current figure. Therefore, in the case of the appropriate maintenance of transmission and distribution equipment, new arrangements for

operation and maintenance vehicles should be prepared. The Project sites extend over a wide area, so if an outage resulting from a fault in the transmission or distribution lines occurs, safe and urgent recovery work is necessary. Accordingly, 3-ton crane truck will be provided for Bibiani and Kumasi offices for the purpose of equipment maintenance during the installation of transmission and distribution lines, and after all work is completed. The basic specifications of operation and maintenance vehicles to be procured under the Project are shown in Table 2.4.3-1.

Table 2.4.3-1 Operation and Maintenance Vehicles to be procured under the Project

Vehicle	Item	Specifications	Number of vehicles procured	
			Nyinahin	Amansie West
Crane Truck	Base vehicle	Approximately 10m (length) ×3m (wide) ×3m (high)	1	1
	Hoisting load	Approximately 3 tons		
	Load capacity	Approximately 8tons		

2-5 Other Relevant Issues

ECG is responsible for operation and maintenance of the Project and has implemented similar rural electrification projects under the Japan's grant aid cooperation scheme on three previous occasions. Therefore, operation and maintenance after installation of 33kV transmission line facilities is considered to be feasible through their own initiative. However, based on specific conditions listed below, the method of business operation after commencement of electricity supply service should be taken into account.

- Since the rate of surreptitious use of electricity (non-technical loss) can reach 15% of the total electric energy (2000) in the distribution networks within the jurisdiction of ECG, illegal service drop wires and illegal measurement of kWh meters by consumers has become a concern.

- As for an issue of third party responsible in the Project, although molded case circuit breakers (MCCBs) should be installed in the primary side of kWh meters, the said equipment has not yet been procured under the past grant aid cooperation scheme, so its conformity during installation of kWh meters should be supervised.

- Past rural electrification projects were carried out in the areas of relatively large population, such as district capitals; whereas, the sites for the Project are small-scale rural communities.

Consequently, it is feared that local residents with little knowledge of electrical facilities may become involved in accidents.

- The Ghanaian side should complete the installation of low voltage distribution lines 5 months after low voltage equipment and materials are delivered in order to display the prescribed effects at the completion of the Project. In addition, cooperative efforts during the construction at Project sites, which are scattered over a number of areas, should be supervised.

For the reasons above, with respect to the installation of low voltage distribution equipment and materials to be implemented by the Ghanaian side, technical instructors will be dispatched by the Japanese consultant to ensure the quality, to make sure that the construction work is completed on schedule, and to provide guidance on installation and operation of service drop wires and kWh meters (including MCCBs).

CHAPTER 3

PROJECT EVALUATON AND RECOMMENDATIONS

CHAPTER 3

PROJECT EVALUATON AND RECOMMENDATIONS

3-1 Project Effects

The following effects are expected from the Project.

(1) Direct Effects

Current Situation and Problems	Remedial Measures under the Project	Positive Effects and Degree of Improvement
1.Although Ghana is promoting the National Electrification Scheme (NES) and the Self Help Electrification Project (SHEP) as a rural electrification project, the electrification rate (about 20%)of households in rural areas still remains lower than in urban areas (about 60%), which indicates a disparity in living standards.	33kV transmission lines will be extended in Nyinahin Area (24 sites, approx. 39,000 residents) and Amansie West District (10 sites, approx. 16,000 residents) in Ashanti Region where and pole-mounted transformers will be installed. At the same time, low voltage distribution equipment and materials will be procured for each consumer.	Due to electrification in 2 areas, the electrification rate of households in Ashanti Region (approx.3.2 million residents) will increase from about 32% to about 35%.
2.At Nyinahin town, electrification was partially implemented through diesel generators. However, the cost of fuel was so high that currently they are not being used. In addition, kerosene for household lighting is also too expensive (about US$25 annually / household) and is an economic burden for poor residents.	Same as above	The cost of electricity for residential customers is estimated to be about US$13 annually/household after electrification, thus energy-related expenditures of poor residents will be reduced approx. 48%.

(2) Indirect Effects

Current Situation and Problems	Remedial Measures under the Project	Positive Effects and Degree of Improvement
1.There are national hospitals and clinics in the Project sites that are utilized by residents. Although some medical institutions have installed sterilizers and medical treatment equipment, except for national hospitals, most institutions have not been electrified, so there is a sanitation problem.	33kV transmission lines will be extended to Nyinahin Area (24 sites) and Amansie West District (10 sites) in Ashanti Region where pole-mounted transformers will be installed. At the same time, low voltage distribution equipment and materials will be procured for each consumer.	It will be possible to introduce medical equipment and refrigerators for pharmaceuticals with electricity. Therefore, improvement in public health and sanitation will be promoted.

Current Situation and Problems	Remedial Measures under the Project	Positive Effects and Degree of Improvement
2.From the educational aspect, the national average literacy rate in Ghana is about 46% which is low. In particular, this is a hindrance to women who are forced to engage in domestic labor to participate in primary education.	Same as above	It will be possible to introduce vocational training equipment and lighting in school classrooms. That will stimulate educational activities, accordingly, the disparity in educational standard between rural and urban areas will be alleviated as well as improving the literacy rate in rural areas.
3.Women and girls must carry water by utilizing hand pumps at Project sites, which is a major burden for local residents.	Same as above	A stable supply of electricity will make it possible to utilize electric pumps so that local residents can obtain safer, higher quality drinking water. At the same time, it will help alleviate female labor for drawing water.
4.From an agricultural standpoint, expensive diesel fuel is utilized for corn mills to grind corn, which is a major source of income for local residents. This has become an economic burden for residents.	33kV transmission lines will be extended in Nyinahin Area (24 sites) and Amansie West District (10 sites) in Ashanti Region where pole-mounted transformers will be installed. At the same time, low voltage distribution equipment and materials will be procured for each consumer.	Since many residents will be able to utilize agricultural production equipment with inexpensive and stable power, productivity is expected to improve and farming operations will be modernized and enhanced.

3-2 Recommendations

This Project is expected to have many wide-ranging benefits as earlier described, while helping to improve Basic Human Needs (BHN). Accordingly, the Project can be implemented more smoothly and effectively if the following recommendations are accepted by the Ghanaian side.

(1) In line with work schedule of substation equipment and 33kV transmission lines to be procured and installed by the Japanese side under the Project, procurement and installation of equipment and materials for low voltage distribution equipment (including service drop wires and kWh meters) borne by the Ghanaian side should be carried out smoothly. Therefore, the Ghanaian side should promote construction efficiency by formulating a schedule plan, personnel plan and equipment and materials procurement plan.

(2) Although the stability of electricity supply to consumers under the Project will be improved, in due consideration of future expansion in power demand, the Ghanaian side should consider to improve living standards and redress regional disparity by reviewing the installation plan for low voltage distribution lines and by expanding service areas as the occasion arises.

(3) In order to reduce transmission and distribution line faults and to ensure a stable electricity supply system, the Ghanaian side should take preventive measures by implementing periodical field patrols and maintenance and tree clearing along transmission and distribution line routes.

(4) In order to establish a fair system for collecting electricity payments, the Ghanaian side should install individual kWh meters on the premises of all consumers and appropriately operate a reliable customer billing information system (CBIS) through meter reading.

(5) In order to ensure sound and sustainable operation for electric power industry, the Ghanaian side should establish appropriate tariff system in accordance with the ongoing national plan to revise the current price of electricity.